Technical Change and Entrepreneurship*

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Abstract

I document a significant decline in the share of entrepreneurs among US households over the last three decades. Most of this decline is accounted for by a drop in the share of entrepreneurs among college graduates. Using a standard entrepreneurial choice model with two skill groups—high- and low-skill individuals—I then argue that the decline is the outcome of two technological forces that increased the returns to high-skill labor: the skill-biased technical change and the decrease in the price of capital. I find that these two forces account for three-quarters of the decline in the share of entrepreneurs.

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1 Introduction

An increasing number of studies have documented a significant decline in the pace of new business formation and other measures of entrepreneurship in the United States starting in the early 1980s.[1] This decline in entrepreneurship, which is at the center of the decline in "dynamism" experienced by the US economy in recent decades (Decker, Haltiwanger, Jarmin and Miranda, 2016), has raised concern among scholars and policymakers because of the importance of entrepreneurs and new firms for aggregate productivity, job creation, and economic growth.[2]

Recent studies have suggested that the decline in firm creation and economic "dynamism" may be driven by an increase in frictions or start-up costs that prevent firm adjustment (Decker, Haltiwanger, Jarmin and Miranda, 2018), a decline in the growth rate of the labor force (Hopenhayn, Neira and Singhania (2020), Karahan, Pugsley and Sahin (2019)), or the ongoing aging of the US population (Engbom (2020), Bornstein (2018)). In this paper, instead, I argue that a large component of the decline in entrepreneurship and firm creation is the equilibrium response to technological improvements that have changed the incentives of individuals to start their own business. To do so, I first use household-level data to provide new empirical evidence on the decline in entrepreneurship and firm creation in the United States. Then, using a quantitative model of entrepreneurial choice, I show that the same forces that have been suggested to account for the increase in the returns to high-skill labor, namely, the skill-biased technical change (Krueger (1993), Acemoglu (2002)) and the decrease in the price of capital goods (Krusell, Ohanian, Rios-Rull and Violante, 2000), can account for a significant fraction of the decrease in the population share of entrepreneurs and firm creation observed in the United States since the mid-1980s.[3]

An intuition for my quantitative results is as follows. Consider an economy in which individuals choose whether to be workers or entrepreneurs comparing wages and profits. Individuals differ along two dimensions: as workers, they are either high- or low-skill, and as entrepreneurs, they differ in their productivity which is drawn from a continuous distribution. Entrepreneurs produce using high-skill labor, low-skill labor, capital, and their own productivity. Furthermore, assume that capital and high-skill labor are complements, whereas capital and low-skill labor are substitutes (Krusell *et al.*, 2000).

In this context, one can show that a decline in the price of capital *decreases* the share of entrepreneurs among high-skill individuals. This is because a decline in the price of capital increases

[1] Reedy and Strom (2012) and Decker, Haltiwanger, Jarmin and Miranda (2014a, 2015) show evidence of the decline in the start-up rate (the share of the firm population accounted for by age-zero firms) and in the share of fast-growing firms (which are disproportionally young). Pugsley and Sahin (2019) show evidence of the increasing concentration of economic activity in older and larger firms.

[2] See, for instance, Davis and Haltiwanger (2014), Haltiwanger, Decker and Jarmin (2015), Yellen (2016), Dent, Karahan, Pugsley and Sahin (2016), and Pugsley, Sedlacek and Sterk (2019).

[3] The rapid increase in the returns to high-skill workers in the United States has been extensively documented. See for instance, Acemoglu (2002), Autor, Katz and Kearney (2008), Acemoglu and Autor (2011), and the references therein.

entrepreneurs' profits and their demand for high-skill labor, as high-skill labor and capital are complements. Hence to induce the marginal entrepreneur to become a worker—and increase the amount of high-skill labor supplied in equilibrium—the increase in high-skill wages needs to exceed the increase in profits, thus decreasing the share of entrepreneurs among high-skill individuals. The same intuition follows from an increase in productivity that is biased towards high-skill labor.

Following a similar logic, a decline in the price of capital *increases* the share of entrepreneurs among low-skill individuals: since capital and low-skill labor are substitutes, the decline in the price of capital reduces the demand for low-skill labor, reducing the equilibrium wage, and increasing the share of entrepreneurs among low-skill individuals. Given these countervailing forces, the quantitative impact on the aggregate share of entrepreneurs depends on the relative strengths of the decline in the price of capital, the skill-biased technical change, and the increase in the relative supply of high-skill labor observed in the United States between 1985 and 2015, all of which I discipline using empirical estimates.

Turning to my empirical results, in the first part of the paper, I document three new findings on the decline in entrepreneurship and firm creation in the United States. First, using household-level data from the Panel Study of Income Dynamics (PSID), I document that the share of entrepreneurs among US households declined by half between 1985 and 2014, from 7.8% to 3.9% respectively. This observation is robust to changes in the definition of entrepreneurs, for different sample selection criteria, and across different datasets. Second, by separating households into different education groups, I show that the decline in the share of entrepreneurs is larger among college graduates. In fact, the share of entrepreneurs among college graduates declined from 12.2% in 1985 to 5.3% in 2014, whereas the share entrepreneurs among high school graduates and dropouts declined from 4.7% to 2.7% over the same period.

Third, I show that entry rate into entrepreneurship, that is, the share of households that start a new business in a given period, has also declined significantly over the last 30 years and that this decline in the entry rate has been accompanied by an increase in the average skill-level of new entrepreneurs. In particular, using past labor earnings as a measure of individuals' skill, I show that among college graduates, the average past labor earnings of new entrepreneurs grew by 35% over the last 30 years, whereas the average past labor earnings among individuals that stayed as workers grew by only 10%. In contrast, I do not find significant differences among high school graduates and dropouts. These findings suggests that among college graduates, new entrepreneurs are increasingly coming from the ranks of more productive workers.

Motivated by this empirical evidence, in the second part of the paper I study a dynamic model of entrepreneurial choice with two distinct skill groups—high skill and low skill. Similarly to other papers in the literature (Quadrini (2000), Cagetti and De Nardi (2006)) in the model, individuals decide in each period whether to be a worker or an entrepreneur conditional on their labor skill type, a time-varying entrepreneurial productivity, and assets, which serve as collateral and determine the size of the entrepreneur's business. I choose the main parameters of the model to match several salient features of the US economy in the mid-1980s, including the population share of entrepreneurs, the proportion of high- and low-skill entrepreneurs, and the wage skill premium.

To discipline my quantitative exercise, I take the observed time series of the price of capital goods as given (DiCecio, 2009) and choose the relative supply of high-skill labor to match the increase in the share of college graduates observed in the United States since 1985. Then, I feed these time series into my model and estimate a time series for the skill-biased technical change so that the difference in equilibrium wages for high- and low-skill workers implied by the model, matches the increase in the college premium between 1985 and 2015 in the United States. This allows me to compute the entire dynamic transition of the population share of entrepreneurs, the distribution of wealth, aggregate output, and other macroeconomic aggregates.

The main quantitative finding of this paper is that a standard entrepreneurial choice model, with the three aforementioned trends, can account for most of the decline in the population share of entrepreneurs observed in the United States between 1985 and 2014. In the model, the population share of entrepreneurs declines 3.8 percentage points, and thus the model accounts for essentially all of the 3.9 percentage points decline observed in the data. Given these results, I then use my model to decompose the contribution of each technological force to the decline in the share of entrepreneurs. I find that the skill-biased technical change accounts for half of the decline in the share of entrepreneurs implied by the model, whereas the other half is equally accounted for by the decrease in the cost of capital goods and the increase in the supply of high-skill labor. I find similar results when I decompose the time series of the entry rate into entrepreneurship implied by the model.

The decline in firm creation and "dynamism" has been considered a worrying sign of the state of the US economy because of their implications for job creation, aggregate productivity, and output growth (Decker *et al.* (2017), Haltiwanger *et al.* (2015), Yellen (2016)). My quantitative results, in contrast, suggest that an important fraction of this decline is a result of technological improvement, and therefore it should not be cause for concern. These results, however, do not eliminate the scope for policy intervention. To illustrate this point, in the last part of the paper, I consider a simple input cost subsidy. Similarly to the subsidized loans program implemented by the US Small Business Administration, the subsidy in my model ultimately relaxes entrepreneurs' borrowing constraint, especially for small but productive entrepreneurs that do not have enough wealth to self-finance and increase the size of their businesses. To provide a benchmark to this exercise, I consider a subsidy that brings the entry rate of entrepreneurs in 2014 to the level observed in 1985.

I find that this policy generates a sizable increase in the share of entrepreneurs and an increase in output and productivity. Specifically, relative to the baseline stationary economy, the population share of entrepreneurs increases by 2.4 percentage points, output increases by 4.0 percent, and productivity increases by 9.2 percent. The increase in output and productivity stems from two factors: first, the reallocation of resources to existing entrepreneurs that can operate their firms closer to the optimal scale, and second, the entrance of new, high-productivity entrepreneurs that were constrained in the unsubsidized equilibrium. Welfare also improves, with the group of high-skill entrepreneurs experiencing the largest increase. The cost of this subsidy, however, is quite substantial, amounting to 3.2 percent of GDP.

This paper relates to the growing literature on the causes and consequences of the decline in firm creation and entrepreneurship observed in the United States since the mid-1980s. Several papers have documented a decrease in the share of economic activity accounted for by small and new businesses in the United States (see, for instance Haltiwanger *et al.* (2012), Reedy and Strom (2012), Hathaway and Litan (2014), Decker *et al.* (2014b), Pugsley and Sahin (2014), Alon, Berger, Dent and Pugsley (2018), among others). This decline in the pace of firm creation lacks a definitive explanation, but the literature has suggested several potential candidates. For instance, Karahan *et al.* (2019) and Hopenhayn *et al.* (2020) propose that the decline in the growth rate of labor supply observed in the United States is at the heart of the decline in the formation of new businesses. Liang, Wang and Lazear (2014), Engbom (2020), and Bornstein (2018) study whether the continuing aging of the US population reduces the incentives of individuals to start new firms. My work is complementary to these studies in that I analyze an additional channel to account for the decline in the share of entrepreneurs in the economy and the formation of new businesses. Jian and Sohail (2017) and Kozeniauskas (2018) document a decline in the population share of self-employed workers and analyze the importance of the skill-biased technical change in accounting for this decline in a static setting. Relative to these papers, mine analyzes a model in which the dynamics aspects of the entrepreneurial decision are central by incorporating key features such as assets accumulation and entrepreneurial risk.

The rest of the paper is organized as follows. Section 2 provides evidence for the decline in the share of entrepreneurs among US households and within education groups. Then, in Section 3, I present a static model of entrepreneurial choice that highlights the basic intuition of the quantitative model that I study in Section 4. In Section 5, I show my main quantitative results, and in Section 6 I present the policy and welfare analysis. Section 7 concludes.

2 Empirical Evidence

In this section, I document that the US economy has experienced a steady decline in the share of households participating in entrepreneurial activities and that this decline is stronger among workers with a college degree or more (Section 2.2). I also show that the entry rate into entrepreneurship, that is, the share of workers that start a business in the following year, has also fallen in recent decades, and that new entrepreneurs are increasingly selected from higher ranks of the labor income distribution (Section 2.3).

2.1 Data and Definitions

The primary data source is the PSID, a nationally representative survey that was conducted annually in the United States from 1968 to 1997, and every two years thereafter, on a sample of approximately 5,000 families. From the raw data, I choose a sample of heads of households from 1985 to 2014 that includes information on gender, income, education, occupation, self-employment status, and whether the household owns a business. The sample comprises those who are in the labor force and between 22 and 60 years old (both ends included). All the statistics presented below are calculated using population weights. Appendix B describes the sample selection and variable construction in full detail.[4]

The empirical literature has suggested several alternative definitions of entrepreneurship. For instance, Evans and Leighton (1989) consider as entrepreneurs those that are self-employed, Hurst and Lusardi (2004) as all households that own a business, and Gentry and Hubbard (2004) business owners with businesses that have a total market value of $5,000 or more. Quadrini (2000) considers both business owners and self-employed as entrepreneurs whereas Cagetti and De Nardi (2006) and Michelacci and Schivardi (2016) define entrepreneurs as self-employed business owners that have an active management role in the firm. To capture these different alternatives, the results in this section refer to four classifications of entrepreneurs that encompass the different definitions suggested in the literature.

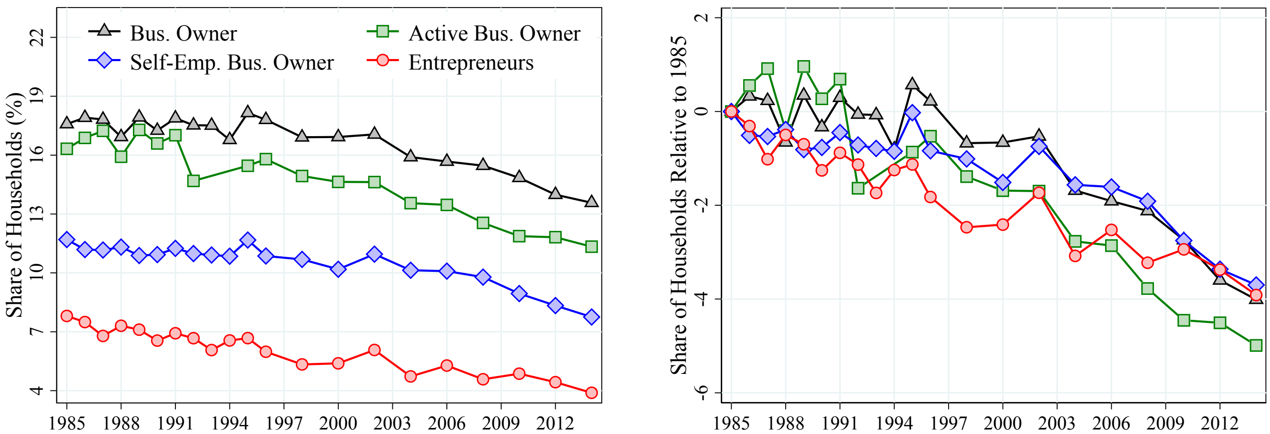
In particular, using information from the PSID, I construct four nested classifications of entrepreneurship. The first considers all households who are "business owners". Between 1985 and 2014, this group represented an average of 16.7% of all households in the United States. The second classification considers business owners that actively worked for their businesses during the year, denoted as "active business owners." These households account, on average, for 14.8% of the population. The third classification considers households who are, at the same time, business owners, worked for their businesses, and whose head is self-employed, that is, "self-employed business owners." These households represented an average of 10.0% of the population between 1985 and 2014. Finally, I define as "entrepreneurs" the subset of "self-employed business owners" who have a managerial or professional occupation. These households, which are closer to the definition of an entrepreneur in the model I discuss in the following sections, represented an average of 6.0% of the population between 1985 and 2014.[5] Relative to the rest of the population in general, and

[4]The PSID has been subject to several revisions over the years to account for the changes in the population of households in the United States. To have a consistent sample, in this study I focus on the Survey Research Center sample (SRC), the core subset of the PSID.

[5]By comparison, using data from the Survey of Consumers Finance (SCF), Cagetti and De Nardi (2006) report a population share of entrepreneurs (denoted in their classification as self-employed business owners) of 7.6%. The SCF over samples rich households, which are most likely entrepreneurs. Appendix (C.1) shows that the decline in the population share of entrepreneurs is also present in the SCF for a similar sample of households

Figure 1 – The Share of Entrepreneurs has Declined since 1985

(a) Share of Entrepreneurs (b) Share of Entrepreneurs Relative to 1985



Note: Panel A of Figure 1 shows the population shares of entrepreneurs in each year for different classifications. From top to bottom, the slopes are -0.13, -0.20, -0.10, and -0.12, respectively. Slopes are statistically significant at the 1% level of confidence. Panel B panel shows the population shares of entrepreneurs relative to their 1985 values.

to other types entrepreneurs in particular, households that fall into this last classification tend to be older, more educated, and wealthier. Appendix Table A.1 reports several characteristics of the sample within the different classifications of entrepreneurs.

2.2 The Declining Share of Entrepreneurs

In this section, I discuss the two main empirical results of the paper: first, the decline in the proportion of entrepreneurs among US households over the last 30 years, and second, that the decline is mostly accounted for a decline in the share of entrepreneurs among those households with a college degree. The differential decline among households of different skills will be crucial to inform the mechanism that drives the aggregate drop in entrepreneurship in the model I present in Section (4).

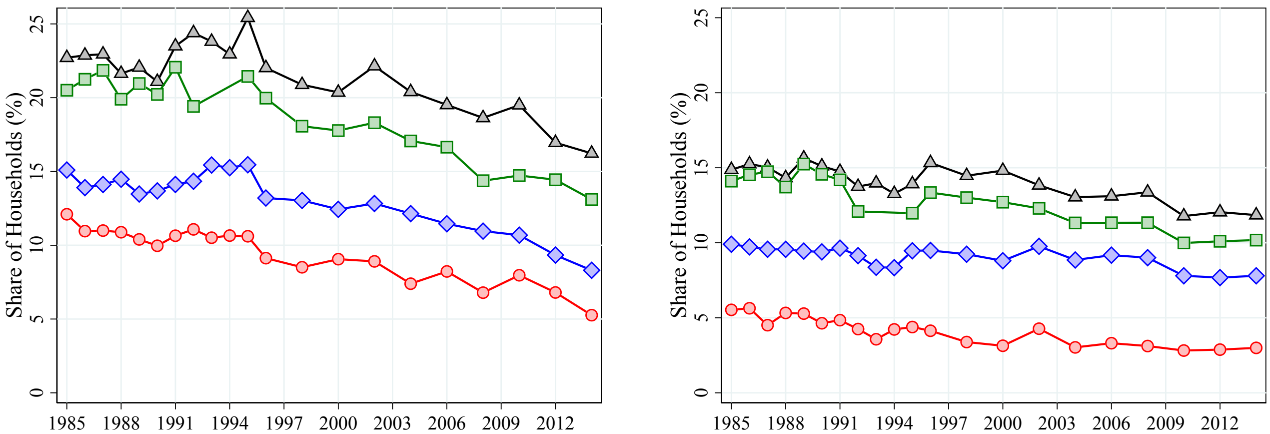
Panel of A of Figure 1 shows the significant decline in the population share of entrepreneurs across all definitions. For instance, in 1985, 16% of households in the United States were active business owners, whereas in 2014 only 12% of households were classified as such. Similarly, the share of entrepreneurs in the population—the most restrictive definition—declined from 7.8% in 1985 to 3.9% in 2014. To better appreciate the decline in the share of entrepreneurs across definitions, panel B of Figure 1 shows the same time series but relative to their corresponding values in 1985. It is easy to see that, independent of the definition, the share of entrepreneurs has declined since the mid-1980s.[6]

Figure 2 shows the time series of the share of entrepreneurs after separating the sample of households into two education groups: college graduates and high school graduates or dropouts.

[6] The decline in the share of entrepreneurs among US households is a robust fact of the US economy. As shown in Appendix C, one finds a similar decline using data from the Survey of Consumer Finances or the Current Population Survey.

Figure 2 – Decline in Share of Entrepreneurs is Stronger for College Graduates

(a) College Graduates (b) High School Graduates and Dropouts



Note: Figure 2 show the share of entrepreneurs within two education groups: college graduates (panel A) and high school graduates and dropouts (panel B).

Two patterns are worth noting. First, the share of entrepreneurs among college graduates is significantly larger than the share of entrepreneurs among high school graduates and dropouts. This finding is robust to different definitions of entrepreneurship. Second, although both groups have experienced a decline in the share of entrepreneurs, the drop is steeper for college graduates. Within the group of households whose head is a college graduate, the share of entrepreneurs (red line with squares) declined roughly 7 percentage points between 1985 and 2014. In contrast, the decline within the group of households whose head has a high school diploma or less was about 2.5 percentage points.[7]

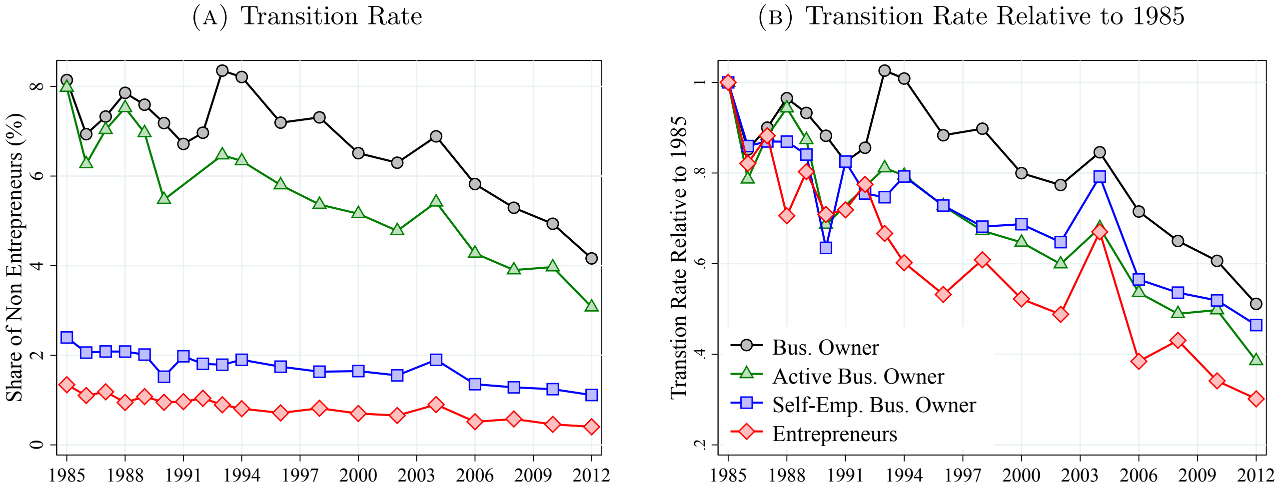
2.3 Transition into Entrepreneurship and Selection

The decline in the share of entrepreneurs has been accompanied by a decrease in the rate at which workers transition into entrepreneurship. To illustrate this, I calculate the transition rate into entrepreneurship across the population and over the years. To have a more direct comparison between the different classifications of entrepreneurial households, I measure the transition rate into entrepreneurship as the share of households that is neither a business owner nor self-employed in year t, but by year $t+2$ has transitioned into one of the four definitions of an entrepreneur.[8] Figure 3 shows that the transition rates have declined for each classification since 1985. The drop is substantial: in 1985, 8.1% of the households that did not own a business or were self-employed started a business two years after. This figure was only 4.2% in 2014, which implies a decline of

[7] A simple decomposition shows that the decline within the college graduates group is fundamental to accounting for the aggregate decline in the share of entrepreneurs. As shown in shown in Appendix Figure A.1, if the share of college graduates that are entrepreneurs would have remained constant at its value in 1985, the aggregate share of entrepreneurs would have declined by only 1 percentage point instead of the 4 percentage points decline observed in the data.

[8] I construct two-year transition rates to accommodate the biannual waves of the PSID after 1997.

Figure 3 – The Transition Rate into Entrepreneurship Has Declined since 1985



Note: Panel A of Figure 3 shows the transition rate into entrepreneurship among US household. The transition rates is calculated as the proportion of households that are neither business owners nor self-employed in period t that are classified as entrepreneurial households in period $t+2$ for the different definitions of entrepreneurship. Panel B shows the transition rate as a fraction of its value in 1985 for different classifications.

50% in the transition rate. I find a similar drop in the transition rates for the rest of the definitions of entrepreneurial households, as the right panel of Figure 3 shows.[9]

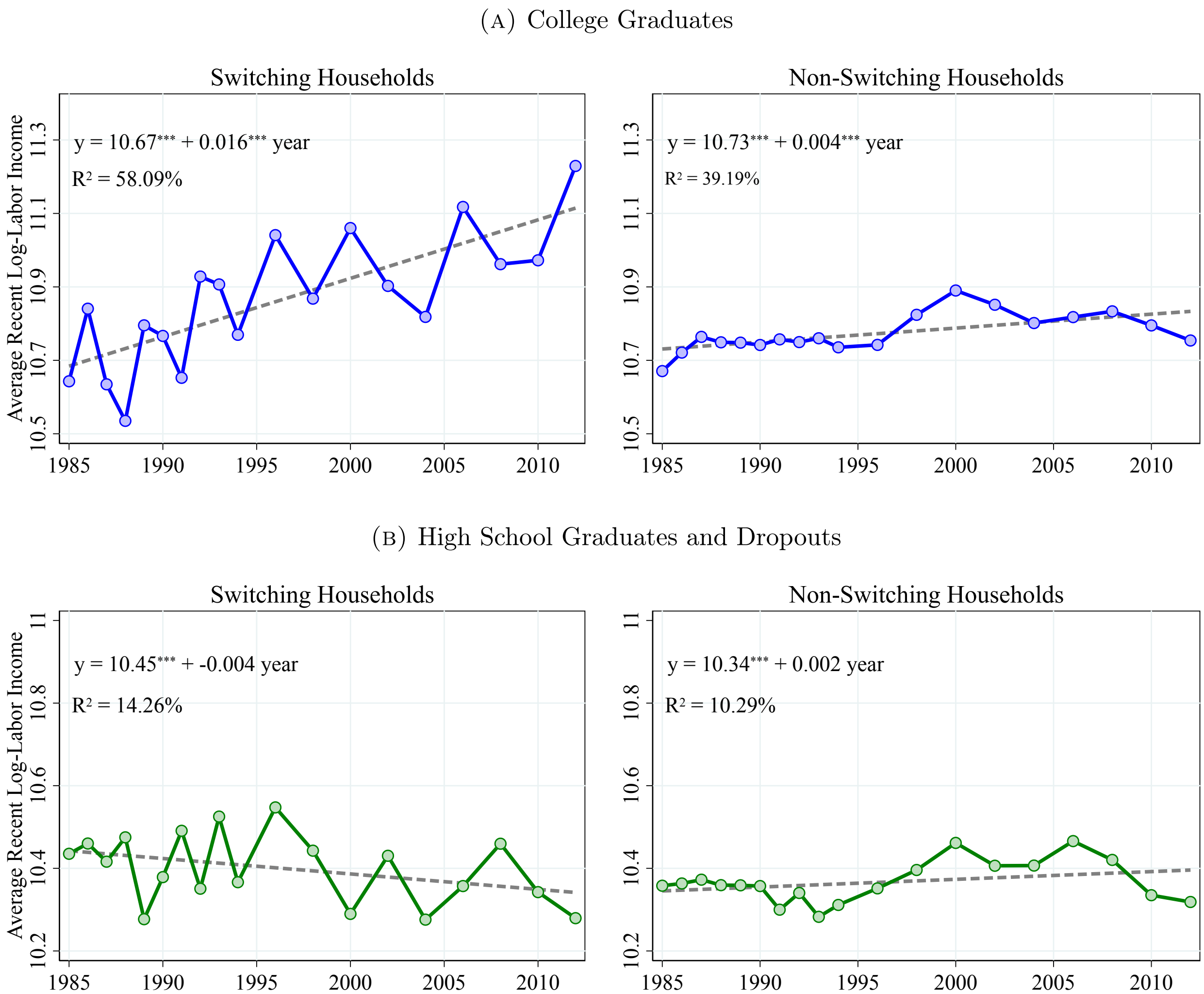
Next, I use the panel dimension of the PSID to study how the characteristics of the households transition into entrepreneurship have changed over time. Specifically, I look at the wage level of entrepreneurs before they started their business. Arguably, workers with higher wages are more skilled than workers with lower wages. Therefore, an increase in the wage level of the households that transition into entrepreneurship might indicate that new entrepreneurs are more skilled and expect higher future profits, since they gave up higher earnings to start their firms. In that case, the decline in the share of entrepreneurs would have been accompanied by a selection of more talented individuals. To see if this is the case, I consider a sample of male heads of household who are neither self-employed nor business owners in year t. For each individual, I measure recent labor earnings as the average of total labor earnings between years t and $t-2$.[10] To be consistent with my previous analysis, I divide the sample of heads of household into two groups: those with a college degree and those with a high school diploma or less. Then, I calculate the average recent labor earnings within the group of individuals that become business owners in $t+2$ (switching households) and within those that stay as workers (non-switching households).

Panel A of Figure 4 shows that, among college graduates, the average labor earnings of individuals who became entrepreneurs grew faster than the average labor earnings of individuals who remained as workers. The difference in the growth rate is both economically and statistically significant (at the 1% level of confidence): the average recent earnings of workers that became

[9]The exit rate out of entrepreneurship, that is, the share of active entrepreneurs in period t that transitioned to being wage workers in $t+2$, is quite noisy and does not show any particular trend between 1985 and 2014.

[10]I calculate recent labor earnings to reduce the impact of business cycle variations that disproportionally affect workers at the bottom of the income distribution.

Figure 4 – Labor Income for Switching and Non-Switching Workers



Note: Panel A of Figure 4 shows the average log labor earnings for a sample of male heads of household who are neither business owner nor self-employed in year t and have a college degree or more. The left plot shows the average log labor earnings within the group of households that become business owners in year $t+2$ (switching households), whereas the right plot show the same statistics for individuals that remain as workers in period $t+2$ (non-Switching households). The difference in the slope between the left and right panels is statistically significant at the 1% level. Panel B shows the same statistics for the households whose head has a high school degree or less.

entrepreneurs grew 1.6% per year between 1985 and 2014, accumulating an increase of more than 35% over three decades. In contrast, the average labor earnings for those who remained as workers grew less than 0.4% on average during the same period of time, accumulating roughly a 10% increase. This finding suggests that new entrepreneurs that are college graduates are increasingly selected from a pool of workers with higher average labor earnings. Notice also that the growth rate of labor earnings did not differ significantly between switching and non-switching workers among those individuals with a high school diploma or less. In fact, panel B of Figure 4 shows that the average recent earnings for individuals without a college degree who become entrepreneurs decreased during the sample period, whereas earnings increased less than 0.1% per year for individuals that remained as workers.[11]

[11] The results presented in Figure 4 are robust to different sample selection and specifications. For instance, I

In summary, in this section I have documented that the US economy has experienced a decline in the population share of entrepreneurs, which is stronger among households with a college degree. To account for this decline, in the following sections I study a model of entrepreneurial choice, in which the decline in entrepreneurship is the equilibrium result of the same forces that have driven the increase in the earnings of college graduates over the last 30 years.

3 A Simple Model of Entrepreneurial Choice

To built the intuition of the results derived in the quantitative model of Section 4, here I review a simple application of Lucas' span-of-control model (Lucas, 1978) that illustrates the key tradeoff of households' entrepreneurial decisions. In particular, the model of this section ties the decline in the population share of entrepreneurs to two of the technological trends I consider in the quantitative model of Section 4, namely, the decline in the price of capital goods and the skill-biased technical change.

Consider an economy endowed by a fixed amount of K units of capital and a continuum of households with idiosyncratic entrepreneurial talent z distributed according to a continuous function $G(z)$. Households have one unit of labor that they can offer in the labor market, in which case they receive a wage w, or use it as managers of their own firm, in which case they receive profits, $\pi(z)$, given by

$$\pi(z) = \max_{n,k} \left\{ z \left[\left((An)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \right]^{\gamma} - wn - p^{k}k \right\},$$

where p^k denotes the price capital, k, and n denotes the number of units of labor used by the manager. In this specification, $\gamma < 1$ is the span-of-control parameter, A is the relative productivity of labor, and $1/(1-\rho)$ is the elasticity of substitution between productive inputs. In the quantitative model studied in Section 4, the price of capital and workers' productivity, p^k and A, respectively, are allowed to vary over time, and the entrepreneurial talent, z, changes stochastically.

It is easy to show that the solution of the household's problem implies an entrepreneurial talent cutoff, z^*, such that, for any household with talent above the threshold, the profits obtained by running a firm are higher than the wages obtained as workers. Lemma 1 in Appendix D estates this result formally. Theorem 1 uses Lemma 1 to show that if $\rho < 0$—that is, capital and labor are complementary—a decrease in the price of capital, p^k, reduces the share of entrepreneurs in this economy.

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find similar results if I consider pooled sample of households across education level. In this case, the growth rate of recent earnings for switching households grew an average of 1.3% per year between 1985 and 2014 but only 0.5% for non-switching households. These results do not change much if one considers wages and salaries instead of total labor earnings (Appendix Figure A.17), if individuals are classified by current labor earnings (Appendix Figure A.18), or if one looks at the median of the labor earnings distribution instead of the mean (Appendix Figure A.19a).

Theorem 1. *If $\rho < 0$, a decrease in the price of capital, p^k, or an increase in the relative productivity of labor, A, increases the entrepreneurial talent cutoff, z^*, thus reducing the share of entrepreneurs.*

Proof. See Appendix D. □

Intuitively, a decline in the price of capital, p^k, increases capital demand from incumbent entrepreneurs, but because capital is complementary to labor ($\rho < 0$), existing entrepreneurs also increase their demand for labor. Given a fixed supply of labor, this induces an increase in the equilibrium wage, which, for the marginal entrepreneur, rises faster than the value of profits obtained by running a firm. Hence, the cutoff value of z that makes entrepreneurs indifferent between staying as a worker and running a firm increases, reducing the population share of entrepreneurs. More precisely, the derivative of z^* with respect to k/n, which depends negatively on p^k, is given by

$$\frac{\partial z^*}{\partial k/n} \quad = \quad -\rho\left[\frac{(1-\gamma)^{-1}}{n\,(z^*)^{\gamma-1}\,n'\,(z^*)}\frac{\frac{k}{n}^{\rho-1}A^{\rho+1}}{\left(A^{\rho}+\left(\frac{k}{n}\right)^{\rho}\right)^2}\right],$$

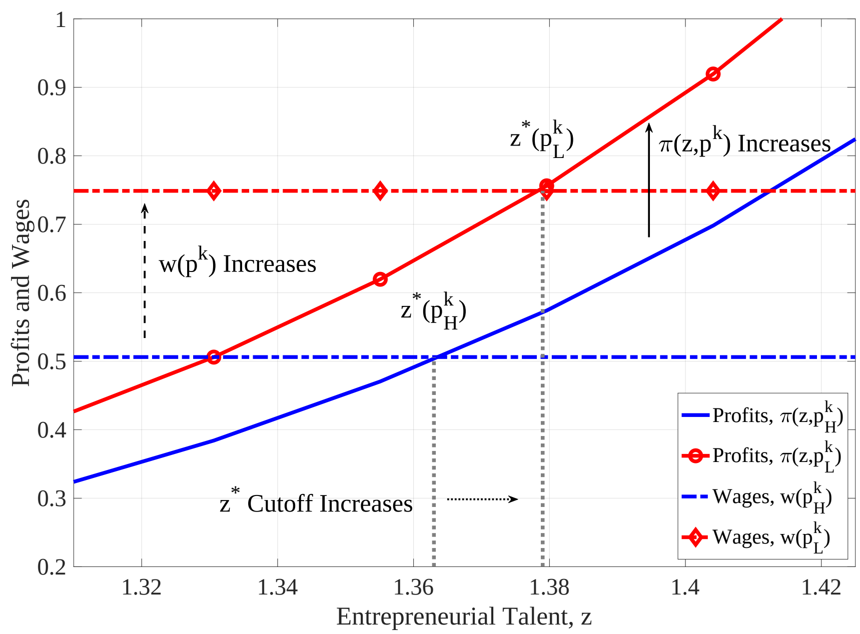
which is positive if $\rho < 0$. Then, a decrease in p^k increases k/n, which in turn increases the entrepreneurial talent cutoff, z^*, thus reducing the share of entrepreneurs. As I show in Appendix D, a similar results follows from an increase in the productivity of labor, A.

To illustrate how a decrease in the relative price of capital generates a decline in the share of entrepreneurs, Figure 5 shows workers' wages and entrepreneurs' profits as a function of the entrepreneurial talent, z, for a given set of parameters and two different levels of the price of capital, p^k_H and p^k_L, with $p^k_H > p^k_L$. For a value of $\rho < 0$, a decrease in the price of capital from p^k_H to p^k_L increases both wages and profits, but because capital and labor are complements, the increase in labor demand from incumbent entrepreneurs increases wages more than the increase in profits induced by the decline in prices, moving the z^* cutoff to the right, from z^*_H to z^*_L, reducing the population share of entrepreneurs (the share of individuals with entrepreneurial talent higher than z^*).

This simple example indicates that the ability of the model to account for the decline in the population share of entrepreneurs depends crucially on the complementarity between capital and labor. Krusell *et al.* (2000) find that capital and high-skill labor are complementary, whereas capital and low-skill labor are substitutes. Hence, in principle, a decline in the price of capital goods (or an increase in the productivity of high-skill labor) would imply a decline in the share of entrepreneurs that are high-skill workers (the college graduates) but would have an ambiguous effect on the aggregate share of entrepreneurs in the economy, as the share of entrepreneurs that are low skill (high school graduates and dropouts in the data) might increase or decrease.[12] This simple

[12] In Appendix D.2, I extend the model of this section to have two skill types, high and low skill, using the

Figure 5 – Entrepreneurial Talent Cutoff, z^*, Increases After Decline in the Price of Capital



Note: Figure 5 shows profits and wages as a function of entrepreneurial talent as a function of z for a given set of parameters.

model, however, abstracts from several important elements that shape the decision of individuals to become entrepreneurs (e.g. asset accumulation and entrepreneurial risk). The next section consider these additional features in a fully fledged quantitative model.

4 The Model

The empirical evidence presented in Section 2 indicates a substantial decline in the share of entrepreneurs since the mid-1980s, which is more concentrated among college graduates. During the same period, the US economy experienced a large increase in the wage differential between high- and low- skill workers. In this section, I study a model that connects these two trends. In particular, I use a quantitative model of entrepreneurial choice to study whether a decline in the price of capital goods and a skill-biased technical change—both of which have been found important in explaining the increase in the skill premium—can account for the decline in the share of entrepreneurs.

In comparison with the simple model presented in Section (3), the quantitative model of this Section includes two distinct types of workers (high- and low-skill) which I equate to college

same CES production function I consider in the quantitative model of Section 4. Using this model, and standard parameters for the production function, I show that keeping the wages of high and low skill constant, either a decrease in p_k or an increase in A, reduces the share of high- and low-skill workers who become entrepreneurs. However, when wages are allowed to adjust to this changes, the share of low skill entrepreneurs might increase. The effect on the aggregate population share of entrepreneurs depends on the specific shares of high- and low-skill workers in the population, which in my quantitative model match the share of college and non-college workers in the US population.

and non-college households in the data. Additionally, I consider time-varying entrepreneurial ability, asset accumulation, and idiosyncratic labor risk, all of which are standard in models of entrepreneurial choice (Cagetti and De Nardi (2006), Quadrini (2000)). At the aggregate level, I consider the increase in the share of high-skill labor in the economy (college graduates). As I discuss below, the increase in the share of high skill workers is crucial to account for the decline in the population share of entrepreneurs in the United States.

4.1 Households and Technology

Demographics

Consider an economy with a continuum of individual households of measure one. In each period, there is a fraction H_t of high-skill individuals and a fraction L_t of low-skill individuals. An individual dies with probability $(1-\chi)$, in which case an offspring enters the economy. The offspring of an individual of skill type $s \in \{H, L\}$, for high and low skill respectively, enters the economy with skill type s' with probability $\zeta_{s,s'}$.

Preferences and Discounting

An individual household i values consumption by means of the period utility function $c_{i,t}^{1-\sigma}/(1-\sigma)$ and supplies one unit of labor inelastically. Individuals discount future streams of utility at the rate $\beta < 1$, and the utility of their offspring by a proportion $\beta\eta$ with $\eta \in [0,1]$.

Production Technology

In each period, an individual decides whether to be a worker or an entrepreneur. As a worker, the individual receives an income of $\omega_t^s y_{i,t}$, where $y_{i,t}$ is an idiosyncratic, positively autocorrelated shock, and ω_t^s is the wage of a worker of type s in period t. Workers can save in a risk-free asset, $a_{i,t}$, with return r_t, but cannot borrow. As an entrepreneur, the individual gains access to a production technology that uses four different factors: the individual's own entrepreneurial talent (described below), low-skill labor, $n_{i,t}^L$, high-skill labor, $n_{i,t}^H$, and capital, $k_{i,t}$. All entrepreneurs produce the same homogeneous good.

An individual's entrepreneurial talent has two components: a fixed part, denoted by θ_s, which depends on the skill type of the individual, and an idiosyncratic part, $z_{i,t}$, which is positively autocorrelated and independent of $y_{i,t}$. Hence, the production technology available for an entrepreneur of type s is $z_{i,t}\theta_s\left[f\left(n_{i,t}^H, n_{i,t}^L, k_{i,t}\right)\right]^\gamma$, where $\gamma < 1$ is the span-of-control parameter that determines the degree of decreasing returns to scale (Lucas, 1978). The function $f\left(n_{i,t}^H, n_{i,t}^L, k_{i,t}\right)$ is given by

$$f\left(n_{i,t}^H, n_{i,t}^L, k_{i,t}\right) = \left[\psi\left(\tau\left(A_t^H n_{i,t}^H\right)^\rho + (1-\tau)\, k_{i,t}^\rho\right)^{\frac{\alpha}{\rho}} + (1-\psi)\left(n_{i,t}^L\right)^\alpha\right]^{\frac{1}{\alpha}}, \tag{1}$$

where ρ determines the elasticity of substitution between high-skill labor and capital and α determines the elasticity of substitution between the composite of capital and high-skill labor to low-skill labor. The parameter τ determines the output share of capital, whereas ψ the output share of low-skill labor. The value A_t^H captures the relative contribution of high-skill workers to output, and therefore how skill biased is the production technology. Production entails no fixed cost, however, when an individual transitions from being a worker to being an entrepreneur, the individual pay a one-period cost of κ units of the consumption good to create a new firm.

Borrowing Constraint

I assume that entrepreneurs need to rent capital and pay wages before revenues are realized. This assumption captures the idea that entrepreneurs need some working capital to run their businesses. To finance this working capital, an entrepreneur obtains an intra-period loan with gross interest of $(1 + r_t)$ and total amount $p_t^k k_{i,t} + \omega_t^H n_{i,t}^H + \omega_t^L n_{i,t}^L$, where p_t^k is the price of capital in terms of consumption, ω_t^H is the wage rate for high-skill workers, and ω_t^L is the wage rate for low-skill workers. Several papers have documented the importance of borrowing constraints in the decision to become an entrepreneur.[13] Consequently, I assume that maximum amount of the loan, and hence the scale of the firm, is constrained by the wealth of the entrepreneur. In particular, each entrepreneur faces a simple collateral constraint given by

$$p_t^k k_{i,t} + \omega_t^H n_{i,t}^H + \omega_t^L n_{i,t}^L \leq \lambda a_{i,t},$$

with $\lambda \geq 1$.[14]

Exogenous Aggregate Processes

The economy is subject to three exogenous aggregate trends: a process for the investment-specific technological change that decreases the relative price of capital goods, p_t^k, an increase in the supply of high-skill workers, H_t, and a skill-biased improvement in technology that increases the productivity of high-skill workers, A_t^H. I assume there is no aggregate uncertainty and the time series of each of these processes are fully known by the households.

The Household Problem

At the beginning of each period t, each individual household is characterized by its fixed skill type, $s_i \in \{H, L\}$, asset level, $a_{i,t}$, entrepreneurial ability, $z_{i,t}$, worker ability, $y_{i,t}$, and previous-period occupation, $d_{i,t-1} \in \{w, e\}$, where w identifies a worker and e an entrepreneur. To simplify the notation, define the vector of idiosyncratic states by $\Omega_{i,t} \equiv \{s_i, a_{i,t}, z_{i,t}, y_{i,t}, d_{i,t-1}\}$, the distribution of individuals of skill type s in period t over idiosyncratic states by μ_t^s with $\mu_t \equiv \left\{\mu_t^H, \mu_t^L\right\}$, and the vector of aggregate states by $\Theta_t \equiv \left\{p_t^k, A_t^H, H_t\right\}$. Denote the value of an individual of being a worker as $V_{i,t}^w(\Omega_{i,t}, \Theta_t, \mu_t)$ and the value of being an entrepreneur as $V_{i,t}^e(\Omega_{i,t}, \Theta_t, \mu_t)$. An

[13]See, for instance, Evans and Jovanovic (1989), Hurst and Lusardi (2004), Cagetti and De Nardi (2006), Mondragón-Vélez (2009), Fairlie and Krashinsky (2012), among others.

[14]This type of borrowing constraint can arise from a limited enforcement problem, as in Jermann and Quadrini (2012), Buera (2009), and Buera and Shin (2013). Appendix F compares my quantitative results to those obtained by using a collateral constraint that only limits the amount of capital the entrepreneur can rent.

individual then chooses whether to be a worker or an entrepreneur in period t by solving

$$V_{i,t}\left(\Omega_{i,t},\Theta_{t},\mu_{t}\right)=\max_{d_{i,t}\in\{w,e\}}\left\{V_{i,t}^{w}\left(\Omega_{i,t},\Theta_{t},\mu_{t}\right),V_{i,t}^{e}\left(\Omega_{i,t},\Theta_{t},\mu_{t}\right)\right\}, \tag{2}$$

where the value of being a worker is given by (omitting the dependence of $V_{i,t+1}$ on next's period states)

$$V_{i,t}^{w}\left(\Omega_{i,t},\Theta_{t},\mu_{t}\right)=\max_{c_{i,t},a_{i,t+1}}\left\{\frac{c_{i,t}^{1-\sigma}}{1-\sigma}+\beta\left[\chi\mathbb{E}\left[V_{i,t+1}|z_{i,t},y_{i,t}\right]+(1-\chi)\,\eta\sum_{s'\in\{H,L\}}\zeta_{s,s'}\mathbb{E}\left[V_{i,t+1}\right]\right]\right\} \tag{3}$$

$$\text{subject to,}\quad c_{i,t}+a_{i,t+1}\leq\left(1+r_{t}\left(\Theta_{t},\mu_{t}\right)\right)a_{i,t}+\omega_{t}^{s}\left(\Theta_{t},\mu_{t}\right)y_{i,t}$$
$$a_{i,t+1}\geq 0$$

and subject to the laws of motion of $y_{i,t}$ and $z_{i,t}$, the law of motion of the distribution of individuals over idiosyncratic states, $\mu_{t+1}=\Psi\left(\Theta_{t},\mu_{t}\right)$, and the evolution of the aggregate states, Θ_{t+1}. In the problem of the worker described by Equation (3), the first expectation is taken over the conditional distributions of $z_{i,t+1}$ and $y_{i,t+1}$ and over the next period's distribution of idiosyncratic states, whereas the second expectation is taken over the unconditional distributions of $z_{i,t+1}$ and $y_{i,t+1}$ and over the next period's distribution of idiosyncratic states. This is because, if an individual dies, the offspring inherits the households' assets and business—in the case the individual dies as an entrepreneur—and draws a new labor productivity and entrepreneurial talent levels from the corresponding unconditional productivity distribution.

The value of being an entrepreneur is given by

$$V_{i,t}^{e}\left(\Omega_{i,t},\Theta_{t},\mu_{t}\right)=\max_{c_{i,t},a_{i,t+1}}\left\{\frac{c_{i,t}^{1-\sigma}}{1-\sigma}+\beta\left[\chi\mathbb{E}\left[V_{i,t+1}|z_{i,t},y_{i,t}\right]+(1-\chi)\,\eta\sum_{s'\in\{H,L\}}\zeta_{s,s'}\mathbb{E}\left[V_{i,t+1}\right]\right]\right\} \tag{4}$$

$$\text{subject to,}\quad c_{i,t}+a_{i,t+1}+\mathbb{I}_{(d_{i,t-1}=w)}\kappa\leq\left(1+r_{t}\left(\Theta_{t},\mu_{t}\right)\right)a_{i,t}+\pi_{i,t}\left(z_{i,t},a_{i,t}\right)$$
$$a_{i,t+1}\geq 0$$

and subject to the laws of motion of $y_{i,t}$ and $z_{i,t}$, the law of motion of the distribution of individuals over idiosyncratic states, $\mu_{t+1}=\Psi\left(\Theta_{t},\mu_{t}\right)$, and the law of motion of the aggregate states, Θ_{t+1}. Here, $\mathbb{I}_{(d_{i,t-1}=w)}$ is an indicator function equal to 1 if the individual was a worker in period $t-1$ (i.e., $d_{i,t-1}=w$) so that the fixed cost of creating a firm, κ, is paid only by those individuals transitioning from being worker to being an entrepreneur.

The entrepreneur chooses high- and low-skill labor and capital to maximize profits, $\pi_{i,t}\left(z_{i,t},a_{i,t}\right)$, subject to the collateral constraint, that is

$$\max_{n^H_{i,t},n^L_{i,t},k_{i,t}} \left\{ z_{i,t}\theta_s f\left(n^H_{i,t}, n^L_{i,t}, k_{i,t}\right)^{\gamma} - p^k_t \left(r_t + \delta\right) k_{i,t} - \left(1 + r_t\right) \left(\omega^H_t \left(\Theta_t, \mu_t\right) n^H_{i,t} + \omega^L_t \left(\Theta_t, \mu_t\right) n^L_{i,t}\right)\right\}$$

$$\text{subject to,} \quad p^k_t k_{i,t} + \omega^H_t \left(\Theta_t, \mu_t\right) n^H_{i,t} + \omega^L_t \left(\Theta_t, \mu_t\right) n^L_{i,t} \leq \lambda a_{i,t}.$$

The solution to the household's problem described by (2), (3), and (4) is characterized by a talent threshold that depends on the idiosyncratic and the aggregate states of the economy, $z^*_{i,t}\left(\Omega_{i,t}, \Theta_t, \mu_t\right)$, so that any individual with $z_{i,t} \geq z^*_{i,t}\left(\Omega_{i,t}, \Theta_t, \mu_t\right)$ chooses to be an entrepreneur.

The Non-Entrepreneurial Sector

In reality, a large fraction of firms are not managed by individuals weighing the costs and benefits of running their own business or working in someone else's company. Therefore, as in Quadrini (2000) and Cagetti and De Nardi (2006), I model a non-entrepreneurial sector populated by a large number of homogeneous firms that use the production technology defined by (1). Both entrepreneurial and non-entrepreneurial sectors produce the same good, and in both sectors capital depreciates at the rate δ. Hence, the problem of the representative firm in the non-entrepreneurial sector is to choose high-skill labor, N^H_t, low-skill labor, N^L_t, and capital, K_t, to maximize

$$\pi^c_t = \max_{N^H_t,N^L_t,K_t} \left\{ F\left(N^H_t, N^L_t, K_t\right) - p^k_t \left(r_t\left(\Theta_t, \mu_t\right) + \delta\right) K_t - \omega^H_t \left(\Theta_t, \mu_t\right) N^H_t - \omega^L_t \left(\Theta_t, \mu_t\right) N^L_t \right\} \quad (5)$$

subject to the non-negativity constraints of factor demands.

4.2 Equilibrium

Given an initial distribution μ_0 and an exogenous path of $\Theta_t = \left\{p^k_t, A^H_t, H_t\right\}^{\infty}_{t=0}$, the recursive competitive equilibrium in this economy is given by:

i. A time path for prices, $\left\{\omega^H_t\left(\Theta_t, \mu_t\right), \omega^L_t\left(\Theta_t, \mu_t\right), r_t\left(\Theta_t, \mu_t\right)\right\}^{\infty}_{t=0}$, and a sequence of distributions over idiosyncratic states $\left\{\mu_{t+1}\left(\Theta_t, \mu_t\right)\right\}^{\infty}_{t=0}$,

ii. a sequence of policy functions $\left\{c_{i,t}\left(\Omega_{i,t}, \Theta_t, \mu_t\right), a_{i,t+1}\left(\Omega_{i,t}, \Theta_t, \mu_t\right), d_{i,t}\left(\Omega_{i,t}, \Theta_t, \mu_t\right)\right\}^{\infty}_{t=0}$, talent thresholds $\left\{z^*_t\left(\Omega_{i,t}, \Theta_t, \mu_t\right)\right\}^{\infty}_{t=0}$, and factor demands $\left\{k_{i,t}\left(\Omega_{i,t}, \Theta_t, \mu_t\right), n^H_{i,t}\left(\Omega_{i,t}, \Theta_t, \mu_t\right), n^L_{i,t}\left(\Omega_{i,t}, \Theta_t, \mu_t\right)\right\}^{\infty}_{t=0}$, with $\left\{V_{i,t}\left(\Omega_{i,t}, \Theta_t, \mu_t\right)\right\}^{\infty}_{t=0}$, the associated value functions,

iii. factor demands of the non-entrepreneurial sector, $\left\{K_t\left(\Theta_t, \mu_t\right), N^H_t\left(\Theta_t, \mu_t\right), N^L_t\left(\Theta_t, \mu_t\right)\right\}^{\infty}_{t=0}$,

such that

i. the policy functions, value functions, and factor demands solve the individual's problem given by (2), (3), and (4); the factor demands of the non-entrepreneurial sector solve (5),

ii. labor markets for high- and low-skill workers clear,

$$\begin{aligned}
\int \mathbb{I}_{(d_{i,t}=w)} d\mu_t^H &= N_t^H(\Theta_t, \mu_t) + \sum_{s\in H,L} \int n_{i,t}^H(\Omega_{i,t}, \Theta_t, \mu_t)\, \mathbb{I}_{(d_{i,t}=e)} d\mu_t^s \\
\int \mathbb{I}_{(d_{i,t}=w)} d\mu_t^L &= N_t^L(\Theta_t, \mu_t) + \sum_{s\in H,L} \int n_{i,t}^L(\Omega_{i,t}, \Theta_t, \mu_t)\, \mathbb{I}_{(d_{i,t}=e)} d\mu_t^s
\end{aligned}$$

iii. and the capital market clears,

$$\sum_{s\in H,L} \int a_{i,t}(\Omega_{i,t}, \Theta_t, \mu_t)\, d\mu_t^s = p_t^k K_t(\Theta_t, \mu_t) + \sum_{s\in H,L} \int \Bigg(p_t^k k_{i,t}(\Omega_{i,t}, \Theta_t, \mu_t) + \\ \omega_t^H(\Theta_t, \mu_t)\, n_{i,t}^H(\Omega_{i,t}, \Theta_t, \mu_t) + \omega_t^L(\Theta_t, \mu_t)\, n_{i,t}^L(\Omega_{i,t}, \Theta_t, \mu_t) \Bigg) \mathbb{I}_{(d_{i,t}=e)} d\mu_t^s.$$

A stationary competitive equilibrium is similarly defined but over a constant path of Θ_t and a corresponding sequence of prices and distributions over idiosyncratic states. The solution to the model requires an initial and a final steady state and the complete transition path of aggregate states and factor prices, given an exogenous sequence of Θ_t. Appendix E describes in detail the algorithm that I use to solve the model.

4.3 Parameterization

This section describes the quantitative specification of the model. To parameterize my model, I take some parameters from the literature (e.g., the risk aversion or the depreciation rate), calculate others directly from the data (e.g., the parameters governing the stochastic process of labor income), and choose other parameters such that the stationary equilibrium of the model matches several features of the US economy in 1985. In this section, I also describe how I pin down the three exogenous time series that I will consider in my quantitative exercise: the relative price of capital, the share of high-skill workers, and the relative productivity of high-skill workers. To highlight the effects of the change in wages on entrepreneurs, I assume that this is a small open economy and the interest rate is constant, $r_t \equiv r$.[15]

Frequency, Preferences, and Discounting

I set the time period to a year. I take a standard value of 2.0 for the coefficient of risk aversion. In the baseline case, I set $\eta = 1$ so parents are perfectly altruistic. The interest rate is fixed to 3.0% and set β equal to 0.88 to obtain a debt-to-GDP ratio of 3.[16]

[15] In Appendix F, I show how my quantitative results change when I allow the interest rate to be determined in equilibrium.

[16] I choose the value of β equal to 0.88 to be consistent with my calibration in the general equilibrium case. See Appendix F for the solution to the general equilibrium case of the model.

Demographics

I set the value of χ equal to 0.025 so that the average working life of an individual is 40 years. In the baseline case, I assume that when an individual dies, the offspring inherits the individual's fixed skill type, H or L, with probability one, so $\zeta_{hh} = \zeta_{ll} = 1$ and draws new levels of the idiosyncratic labor productivity, $y_{i,t}$, and entrepreneurial talent, $z_{i,t}$, from the corresponding unconditional distributions.

Production Technology and Capital Depreciation

Following Krusell *et al.* (2000), I assume that capital is complementary to high-skill labor but a substitute for low-skill labor. Hence, I set ρ equal to -0.495 and α equal to 0.401. The value of γ in the technology of the entrepreneur is equal to 0.88, as in Cagetti and De Nardi (2006), and the annual depreciation rate of capital, δ, is equal to 0.06.

Labor Income Shocks

I assume that $y_{i,t}$ follows a standard first-order autoregressive process in logs with an autocorrelation ρ_y and a variance of the innovations given by σ_y^2. The values for ρ_y and σ_y are estimated from the PSID using a sample of workers for the period 1970 to 1996.[17] In the model, all households are subject to the same stochastic shocks to wages, independent of their skill type s. Therefore, I select a pooled sample of heads of household with positive labor income that are neither business owners nor self-employed in periods t and $t-1$. Then, I estimate the following equation

$$\log W_{i,t} = \beta_0 + \rho_w \log W_{i,t-1} + \xi_{i,t},$$

where $\log W_{i,t}$ is the residual real log labor earnings of the head of the household in period t after controlling for life-cycle effects and other observable characteristics and $\xi_{i,t}$ is a residual.[18] The estimated autocorrelation of log labor earnings, ρ_w, is 0.73, and the standard deviation of $\nu_{i,t}$ is 0.53. Using these values for ρ_y and σ_y, I discretize the continuous process using Tauchen's method (Tauchen, 1986). Panel A of Table I summarizes the parameters obtained from the literature and the parameters calculated from the data.

Exogenous Aggregate Processes

Here I discuss how I choose the time series of the relative price of capital goods, p_t^k, the supply of high-skill labor, H_t, and the productivity of high-skill workers, A_t^H, all of which are considered exogenous to the model. The first two time series have direct empirical counterparts, whereas the third needs to be pinned down using additional model conditions.

[17] After 1997, the PSID becomes biannual and it is not possible to calculate the one-year changes.

[18] Specifically, $\log W_{i,t}$ is the residual obtained from an OLS panel regression of the real labor income of the head of the household (which is the sum of wages and salaries, bonuses, tips, and commissions, excluding the labor part of businesses income and income from farming) on a set of observable characteristics, including a cubic in age, a set of dummies for gender, race, and two education groups, and a full set of year fixed effects. The sample selection and additional estimation results are described in Appendix B.1.

For the time series of p_t^k, I use the quality-adjusted relative price of capital goods calculated by DiCecio (2009) which shows a 55% decline in the relative price of capital between 1985 and 2015.[19] In my simulation, I assume that from 2015 on, p_t^k remains fixed at its 2015 level for the rest of the simulation. This is an extreme case, but, as I show in Appendix F, my results do not change substantially if, for instance, one assumes a constant growth rate for the price of capital after 2015.

I equate the share of high skill workers in the model, H_t, to the fraction of individuals with a college degree or more calculated from a sample of heads of household between 22 and 60 years old drawn from the Current Population Survey (CPS). The share of college graduates in this sample increased from 26% in 1985 to 39% in 2015. As with the price of capital, I assume that the share of high-skill workers remains constant after 2015.

Finally, I choose the time series of A_t^H such that the increase in the skill premium implied by the model, measured as the log difference between the wage of high-skill workers and the wage of low-skill workers, matches the increase in the college premium observed over the last 30 years in the United States. I measure the college premium as the log difference in the real annual labor income of college graduates and the real annual labor income of high school graduates on a sample of workers from the CPS. Using this sample, I find that the college premium increased 21 log points from 1985 to 2015.[20]

Notice, however, that the model does not imply a direct mapping between the college premium and the evolution of A_t^H. In particular, since high-skill workers are more complementary to capital than low-skill workers (recall that $\alpha > \rho$ in the production function), the decline in p_t^k and the rise in H_t will affect the skill premium in opposite directions. Hence, to pin down the trajectory of A_t^H I take a simple approach. First, I fix the value of A_t^H in the initial stationary economy to be equal to 1 and choose the value of A_t^H in the final stationary equilibrium so that my model matches a skill premium of 60% conditional on the values of p_t^k and H_t in 2015. Then, the sequence $\left\{A_t^H\right\}_{t=1}^T$ grows linearly between these two fixed points for 30 years. As I do with the other two aggregate exogenous processes, I assume that the value of A_t^H remains constant after 2015. Appendix Figure A.2 shows the time series of the relative price of capital goods, the share of college graduates, and

[19] DiCecio (2009) extrapolates the quality-adjusted price time series of Gordon (2007) to 2010 using the same techniques of Cummins and Violante (2002). I take the updated time series up to 2015 from the Federal Reserve Bank of St. Louis Economic Database (FRED). Alternatively, one could use the measure of the price of capital goods calculated by the Bureau of Economic Analysis (BEA). Using this measure, the relative price of capital declined by 50% between 1985 and 2015. See Appendix B.3 for additional details and a comparison of the relative price of investment calculated by DiCecio (2009), the time series using the BEA's data, and an additional measure that only considers equipment and software.

[20] Appendix B.2 provides additional details on the construction of the skill premium. Alternatively, one could use the PSID sample to calculate the increase in the supply of college graduates and the college premium. In that case, the share of college graduates among males increased from 34% to 39% from 1985 to 2014, whereas the college premium increased from 39 to 61 log points over the same period. Using these time series to parameterize my model would strengthen my results as they imply a lower increase in the share of college graduates and the same increase in the college premium.

Table I – Parameterization of Benchmark Model

Panel A: Fixed Parameters

Parameter		Value	
Risk Aversion	σ	2.0	-
Prob. Dying	$1-\chi$	2.5%	40 yrs work
Perfect Altruism	η	1	Altruism
Depreciation	δ	0.06	-
Capital-High Skill ES	ρ	-0.495	KORV
Capital-Low Skill ES	α	0.401	KORV
Span-of-Control	γ	0.88	CD
Autocorrelation of $y_{i,t}$	ρ_y	0.75	PSID
Standard Dev. of $\epsilon_{i,t}$	σ_y	0.53	PSID

Panel B: Parameters Chosen in Equilibrium

Parameter		Value
Capital Share	τ	0.48
Labor Share	ψ	0.50
Borrowing Limit	λ	2.5
Entry Cost	κ	0.10
Productivity L_t	θ_L	0.96
Autocorrelation of $z_{i,t}$	ρ_z	0.82
Standard Dev. of $\nu_{i,t}$	σ_z	0.22

Panel C: Model Fit

	Data	Model	Source
Log-Skill Premium	0.39	0.39	CPS
Labor share	0.63	0.63	BLS
Debt to GDP	0.88	0.90	FF
Entrepreneurs (%)	7.80	7.87	PSID
H_t Entrepreneurs (%)	4.20	4.15	PSID
Transition Rate (%)	2.40	3.10	PSID
New Entrepreneurs (%)	23.1	35.0	PSID

Note: Panel A of Table I reports the set of fixed parameters used in the baseline model. KORV refers to Krusell *et al.* (2000) and CD refers to Cagetti and De Nardi (2006). Panel B of Table I reports the set of parameters chosen to match the moments displayed in Panel C. Debt to GDP is obtained from the flow of funds (FF).

the college premium in the data that I use to discipline the aggregate processes in my model.

Parameters Determined Jointly in Equilibrium

The rest of the parameters of the model are chose so that the equilibrium of the model matches salient features of the US economy in 1985. These parameters are the factor shares in the production function, τ and ψ, the borrowing limit, λ, the entry cost, κ, and the parameters of entrepreneurial ability, θ_s and $z_{i,t}$. I normalize θ_H to 1, and assume that $\log z_{i,t+1} = \rho_z \log z_{i,t} + \sigma_z \nu_{i,t+1}$ where $\nu_{i,t+1}$ has a standard normal distribution. This leaves seven parameters to be determined jointly with the equilibrium of the model.

I use these seven parameters to match the same number of moments generated by my model in the first steady state, which I assume is the year 1985 in the data. I select this particular year because it is the first for which I have information about each of the moments that I seek to match. I normalize the relative price of capital goods, p_t^k, and the productivity of high-skill workers, A_t^H, to 1 in 1985, and I set the share of high-skill workers, H_t, to 0.26, which is the fraction of heads of household with a college degree in the CPS sample in 1985. Conditional on these three fixed values, I choose the rest of the parameters to match:

i. a skill premium of 39%, which is the value of the college premium in 1985,

ii. a labor share of output of 63%, which is the average labor share of non-farm business sector output between 1980 and 1985 calculated by the Bureau of Labor Statistics,

iii. a ratio of liabilities plus equity in the non-financial sector to non-financial private sector output of 0.88,[21]

iv. a population share of entrepreneurs of 7.8%, which is the fraction of entrepreneurs calculated from the PSID in 1985,

v. a population share of high-skill entrepreneurs of 4.2%, which is the fraction of entrepreneurs with a college degree or more calculated from the PSID in 1985,

vi. a share of households transitioning from being wage workers to being entrepreneurs of 2.4%, which is the fraction of wage workers transitioning to entrepreneurship calculated from the PSID for 1985,

vii. and a share of new entrepreneurs of 23%, which is the fraction of households in the PSID that switched to entrepreneurship in 1985 over the total number of entrepreneurs in 1985.

Panel B of Table I reports the parameters chosen jointly with the equilibrium of the model, and Panel C of Table I shows the data targets and the model-generated moments. The model closely matches the population share of entrepreneurs, the population share of entrepreneurs that are high skill, and the skill premium, all of which are key for my quantitative exercise. However, the share of new entrepreneurs and the transition rate of workers into entrepreneurship implied by the model are higher than the corresponding values calculated from the data.

The model also generates substantial wealth inequality, although the parameterization did not target any particular moment of the wealth distribution. As reported by Bricker, Henriques, Krimmel and Sabelhaus (2016), the Gini coefficient on wealth in 1989 was 0.84, whereas the Gini coefficient implied by the model for the same year is 0.83. Similarly, the share of wealth accrued by the top 1% of the population was 32% in 1989; in the model, the top 1% accrued 34% of the wealth in the same year.[22] Similarly, the model generates a realistic distribution of employment across entrepreneurs, both in the aggregate and within skill groups (see Figure A.3 in Appendix C.1), with the vast majority of entrepreneurs managing firms of 50 employees or less.

[21] The ratio of liabilities plus equity of the non-financial sector is the sum of the total liabilities of the non-financial non-corporate sector as reported by FRED (time series NNBTILQ027S) plus total liabilities plus equity of the non financial corporate sector (time series NCBLEYQ027S) divided by the total nominal output of the private non financial sector as reported by the BEA. See Appendix B.3 for additional details.

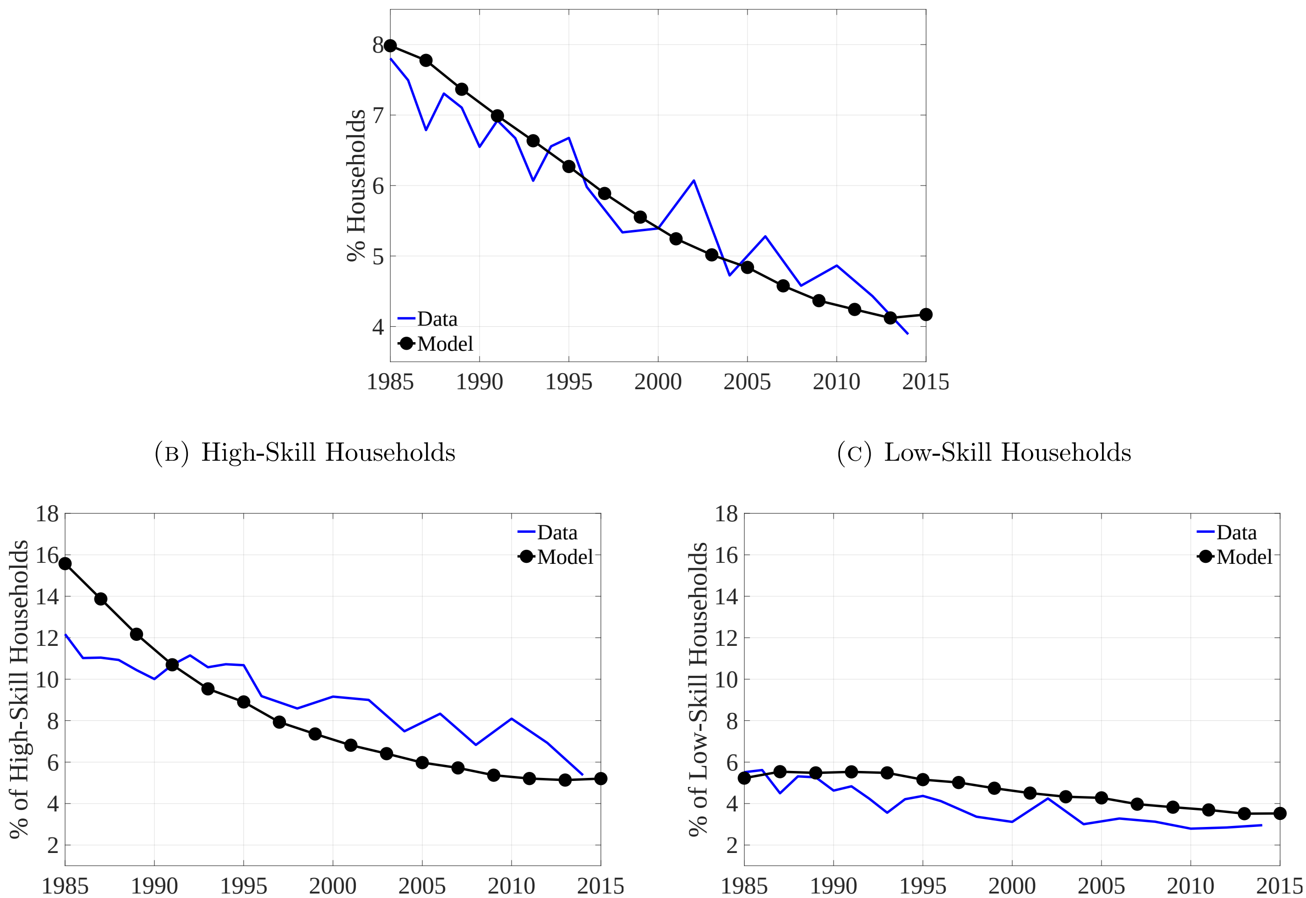
[22] The moments reported by Bricker *et al.* (2016) start in 1989. Hence, the model moments are taken from the fourth year of the transition generated by the model, which corresponds to 1989. For 1985, the model generates a Gini coefficient of 0.84 and a share of wealth of 33.2% for the top 1% of the distribution.

Figure 6 – Evolution of the Share of Entrepreneurs in Model and Data

(a) All Households

(b) High-Skill Households

(c) Low-Skill Households



Note: Panel A Figure 6 shows the evolution of the share of entrepreneurs as calculated from the PSID data (blue solid line) and the share of entrepreneurs implied by the model (black line with circles). Panels B and C show the same statistics within skill groups. High-skill households in the data are those with a college degree or more; low-skill households are those with a high school degree or less.

5 Results

5.1 Decline in the Share of Entrepreneurs

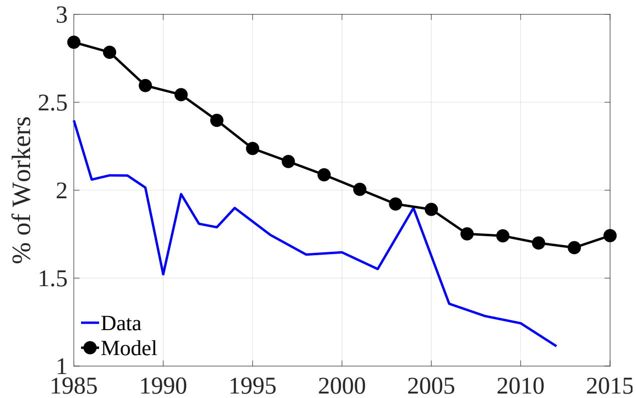
I now turn to the main quantitative results of my model. The economy is assumed to be at a stationary equilibrium in 1985. Then, in 1985, individuals learn about the future path of the three aggregate time series (the price of capital goods, p_t^k, the share of skilled workers, H_t, and the relative productivity of high-skill workers, A_t^H) and have perfect foresight about these variables thereafter. Given these aggregates trends and the initial steady state, the model endogenously determines the evolution of the share of entrepreneurs along the transition path.[23]

Panel A of Figure 6 shows the evolution of the fraction of entrepreneurs in the data (solid

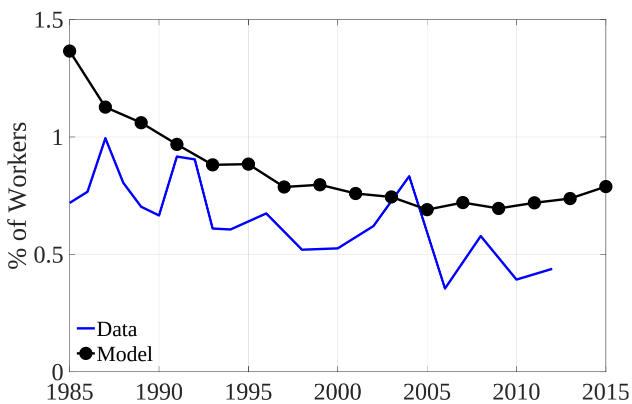
[23] I choose 1985 as my starting point because of data availability. However, as I show in Appendix F, my main quantitative results do not change substantially if I assume that the economy was at steady state in 1970.

Figure 7 – Transition Rate of Workers to Entrepreneurship

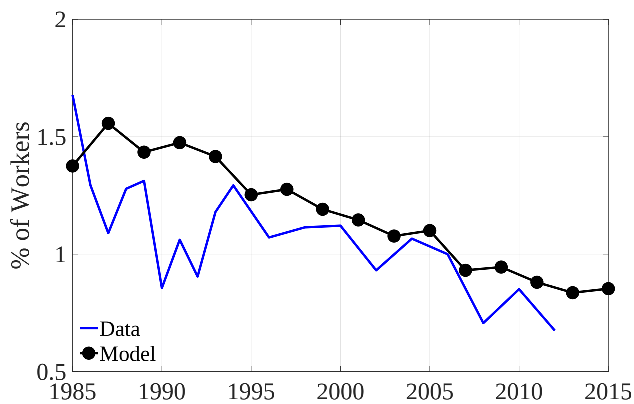
(a) All Workers



(b) High-Skill Workers



(c) Low-Skill Workers



Note: Figure 7 shows the evolution of the transition rate into entrepreneurship as calculated from the PSID data (blue solid line) and the transition rate implied by the model (black line with circles). To accommodate the biannual waves of the PSID after 1997, I calculate the transition rate as the share of households that were not entrepreneurs in period t but transitioned to entrepreneurship in period $t+2$.

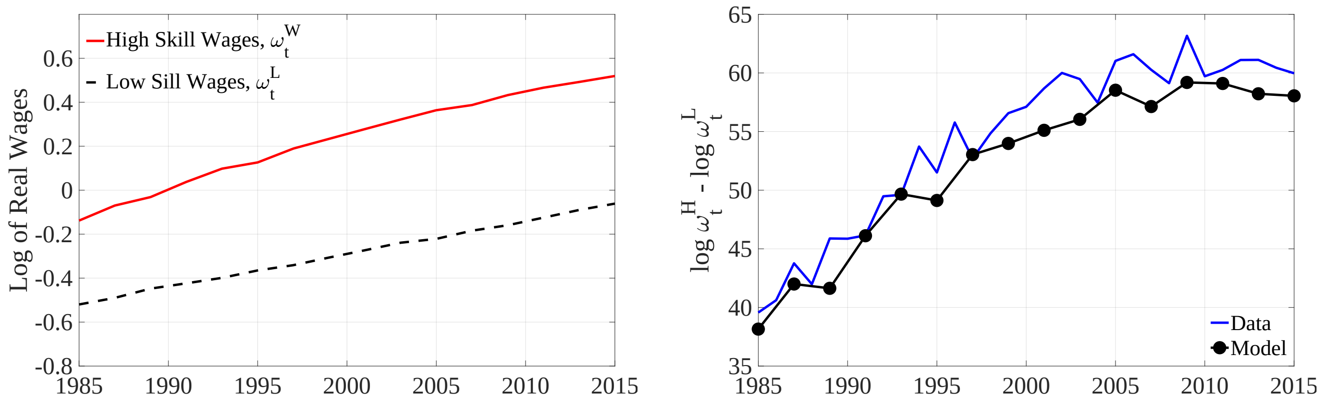
line) and in the model (line with circles). The performance of the model in accounting for the decline in the population share of entrepreneurs is surprisingly good. In the model, the fraction of entrepreneurs drops 3.8 percentage points between 1985 and 2014, accounting for almost all of the 3.9 percentage points decline observed in the data. The model is also consistent with the decline in the share of entrepreneurs among high- and low-skill household, as shown in panels B and C of Figure 6. In the model, the decline in the population share of high-skill entrepreneurs is faster than the decline observed in the data, especially between 1985 to 1995 (panel B of Figure 6). In contrast, the model closely matches the evolution of the population share of low-skill entrepreneurs (panel C).

The model is also consistent with the decline in the entry rate into entrepreneurship observed in the US economy over the last 30 years. To see this, Figure 7 displays the share of workers that transition into entrepreneurship in the data (solid line) and in the model (line with circles). Although the model implies a higher share of the population of workers starting a new firm, it

Figure 8 – Wages and Skill Premium

(a) Wages in the Model

(b) Skill Premium in Model and Data



Note: Panel A Figure 8 shows the evolution of the (log) wages implied by the model. Panel B shows the skill premium in the data and in the model. The college premium in the data is calculated from the CPS as described in Section 4.3.

is reassuring to see that the it delivers a declining trend in the entry rate of entrepreneurs in population (panel A) and within skill groups (panels B and C) much like the trend observed in the data.

In the model, individuals decide in each period whether to run a firm or work for a wage, after comparing the utility value of each of these options. Intuitively, an increase in wages will reduce the incentives to start a firm, more so for those individuals for whom the value of being a worker grows faster. Since both the decrease in the price of capital goods and the increase in the productivity of high-skill workers, increase the marginal productivity of labor the productivity threshold that makes individuals indifferent between working for someone else or running a firm also increases, reducing the share of entrepreneurs in the economy. Panel A of Figure 8 shows the log level of wages of high- and low-skill workers generated by the model. Both are increasing, reducing the share of high- and low-skill entrepreneurs. However, since the wages of high-skill workers rise faster, generating the increase in the skill premium displayed in Panel B of Figure 8, the share of entrepreneurs declines more within the group of high-skill workers.

Taken together, the results of my model indicate that the same technological forces that have been found important in accounting for the increase in the differences in labor earnings between high- and low-skill workers observed in the United States since the mid-1980s can also account for the decline in the share of entrepreneurs and in the formation of new businesses observed over the same period.

5.2 Decomposing the Decline in Entrepreneurship

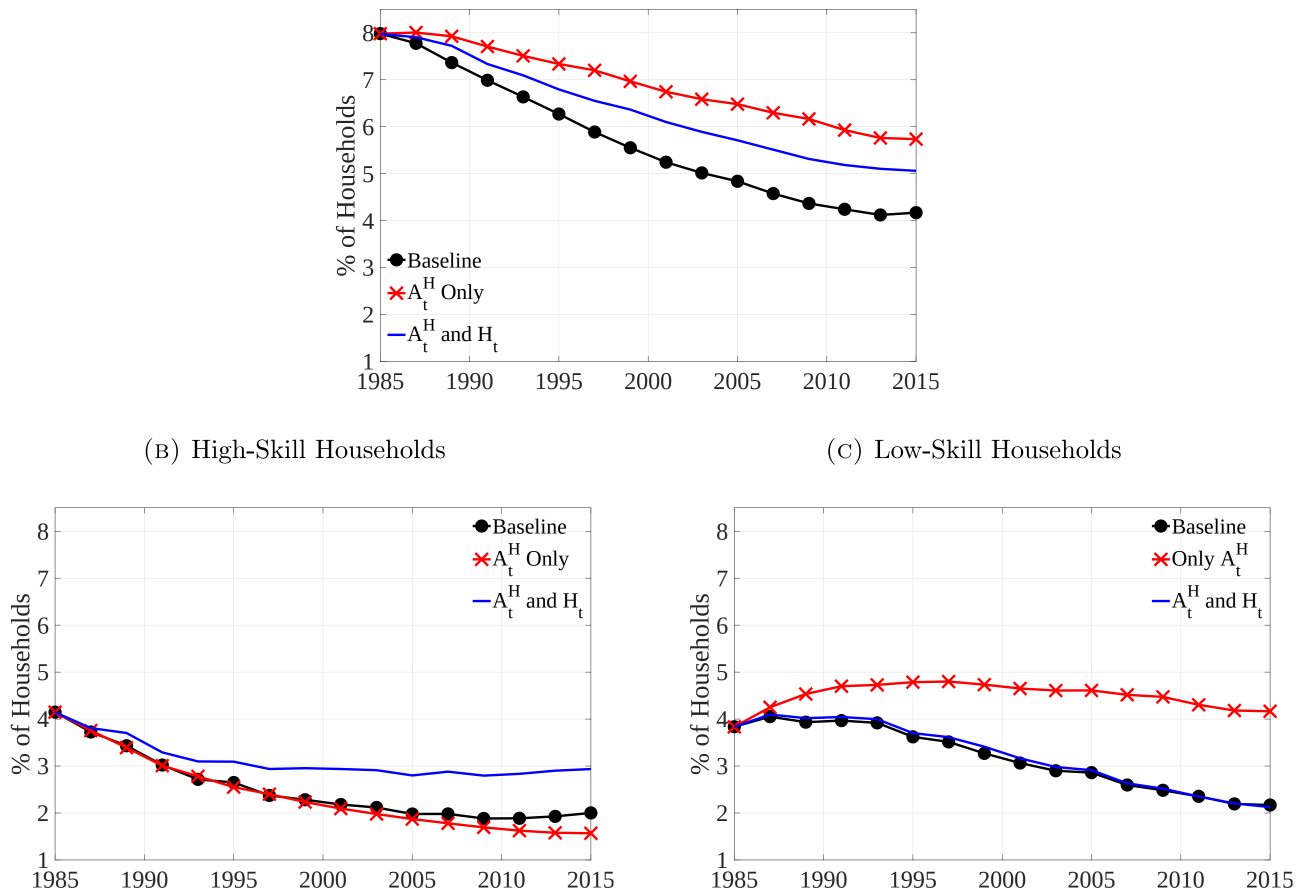
What is the relative contribution of each of the exogenous trends to the decline in the share of entrepreneurs? To answer this question, I study the evolution of the fraction of entrepreneurs by including the effect of each of the aggregate trends one by one, starting with the skill-biased technical change, A_t^H. In this case, I consider the same values of A_t^H used in my baseline exercise, but I fix the values of p_t^k and H_t to their 1985 levels (the initial stationary equilibrium). The evolution of the population share of entrepreneurs is shown in panel A of Figure 9. The black line with circles shows the population share of entrepreneurs implied by the model in the baseline case, whereas the red line with x symbols shows the population share of entrepreneurs for the case in which only A_t^H moves. This exercise can be thought of as measuring the direct effect of the skill-biased technological change on the population share of entrepreneurs. In this case, the proportion of entrepreneurs drops by 2.1 percentage points between 1985 and 2015, or 55% of the overall decline implied by the model (and 53% of the decline in the data).

The discrepancy between my baseline results and this case is explained by the differences in the response of high- and low-skill households. Panel B of Figure 9 shows that an increase in A_t^H reduces the share of high-skill entrepreneurs slightly more than in the baseline case (compare the black line with circles and the red line with x symbols). This is because an increase in A_t^H, coupled with the relative scarcity of high-skill workers in the economy, causes the wage for this group to increase more than in the baseline case, decreasing the incentives for high-skill workers to become entrepreneurs. In contrast, although low-skill workers are relatively less able as entrepreneurs (recall that $\theta_H > \theta_L$), they experience an increase in their profits as the high-skill workers that they hire become increasingly more productive. Moreover, the relative abundance of low-skill workers (H_t is fixed at its 1985 level) implies that the wage of this group does not increase as much compared with my baseline results. Consequently, the share of low-skill entrepreneurs increases, as the Panel C of Figure 9 shows.

Next, I consider the evolution of the share of entrepreneurs implied by my model when both A_t^H and H_t change over time. In this case, the share of entrepreneurs in the population declines even further, as shown by the solid line in panel A of Figure 9. This is because an increase in the relative supply of high-skill workers has two opposite effects that, ultimately, decrease the share of low-skill entrepreneurs more than it increase the share of high-skill entrepreneurs. First, it depresses the wage of high-skill workers, increasing the incentives of individuals in this group to become entrepreneurs. Moreover, since high-skill individuals are more productive than low-skill individuals as entrepreneurs, the total effect is an increase in the share of high-skill entrepreneurs in the economy, as shown by the solid line in panel B of Figure 9. Second, the surge in the demand for labor (due to the increase in A_t^H) and the decreasing share of low-skill workers push the wages of low-skill workers up, decreasing the incentives for low-skill households to become entrepreneurs. In fact, the decline in the share of low-skill entrepreneurs in this case is almost the same as in the baseline results (compare the solid line with the line with circles in panel C of Figure 9). Then, because low-skill workers represent the largest share of the population, the overall proportion of entrepreneurs declines. The increase in the productivity of high-skill workers, A_t^H, and the increase in the supply of high-skill labor, H_t, together account for 75% of the decline

Figure 9 – Model Decomposition of the Decline in the Share of Entrepreneurs

(a) All Households



Note: Figure 9 shows the time series of the population share of entrepreneurs implied by the model. The black line with circles shows the share for the baseline case, the red line with x symbols shows the results in the case that only A_t^H changes over time, and the blue line shows the results in the case that A_t^H and H_t change over time.

in the share of entrepreneurship implied by the model.

Finally, adding in the decline in the relative price of capital, p_t^k, accounts for the difference between the solid line to the line with circles (the baseline case) in Panel A of Figure 9. Because of the complementarity between capital and high-skill workers, a decrease in the price of capital goods increases the demand for high-skill workers, increasing their wage and reducing the incentive to become entrepreneurs. This further reduces the share of high-skill individuals that decide to become an entrepreneur while keeping the share of low-skill entrepreneurs in the economy almost unchanged.[24]

Similarly to the results on the population share of entrepreneurs, the skill-biased technological change explains about half of the overall decline in the entry and exit rates from entrepreneurship

[24] Varying the order of the shocks in this decomposition does not alter the proportion explained by each of the exogenous trends that I consider. For instance, Appendix Figure A.4 shows a decomposition in which I first let A_t^H vary over time, then p_t^k, and finally, H_t. In such a case, the first two exogenous processes explain three-quarters of the total decline in the share of entrepreneurs implied by the model.

generated by the model (Appendix Figures A.5 and A.6, respectively).

5.3 Robustness

I now briefly discuss the robustness of my results to changes in five critical assumptions made in my quantitative exercise. Further details of each of these exercises can be found in Appendix F. First, I consider a case in which households do not have perfect foresight about the evolution of the aggregate time series, but they are perfectly *myopic* in that they are surprised in every period by the change in the aggregate conditions. Relative to my baseline case, I find almost no change in terms of the decline in the share in entrepreneurs implied by the model (Panel A of Figure A.25).

Second, in my baseline results I have considered that the aggregate trends remain fixed after 2015. This is an extreme assumption which impacts individuals' decisions since they have perfect foresight of all aggregate variables. To evaluate the important of this assumption, I consider an alternative case in which the price of capital, p_t^k, keeps decreasing and the share of high-skill workers, H_t, keeps increasing at a constant rate until 2050. The results are shown in Panel B of Figure A.25. Again, I find almost no change in the implied evolution of the share of entrepreneurs over the 1985-to-2015 period. My results suggest that the population share of entrepreneurs would stabilize at around 4% of the households in the economy.

Third, I study a case in which the interest rate is solved in general equilibrium along with the wages for high- and low-skill workers. The results are show in Panel C of Figure A.25. Using the same parameter values as in my baseline case, the model implies a decrease in the share of entrepreneurs that is half of the decline observed in the data. The difference between these results and my baseline case stems from the evolution of the equilibrium interest rate that tends to increase along the transition path.

Fourth, the empirical evidence shows that the relative price of capital has been declining since the 1970s (Krusell *et al.*, 2000). Hence, to study the predictions of my model before 1985, I consider a case in which the economy is at its stationary equilibrium in 1970. As in the baseline case, I take the values of p_t^k and H_t from the data, but I calibrate the value of A_t^H to match the skill premium observed in 1970. My results—show in Panel D of Figure A.25—indicate a small increase in the share of entrepreneurs during the 1970s and then a rapid decline starting in the early 1980s, which coincides with the rapid increase in the skill premium. Although the empirical evidence presented in Section 2 begins in 1985, the increase in the share of entrepreneurs during the 1970s and the posterior decline is consistent with with the evolution of the share of self-employed in the CPS, as shown in Appendix Figure A.12.

Finally, I compare my baseline results with two alternative potential explanations for the decline in the share of entrepreneurs: an increase in the cost of firm creation, κ, and a tightening of the borrowing constraint, λ. I find that changes of neither of these parameters is likely to account for the decline in entrepreneurship in the population and within skill groups. For instance, I find that if the cost of creating a firm, κ, would have increased by a factor of 7 over the last 30 years, the share of entrepreneurs in the economy would have remained almost constant (Figure A.21). Similarly, I find that a tightening of the borrowing—modeled by reducing the value of λ by a third of is value in the initial steady state—has almost no effect in the aggregate share of entrepreneurs (Figure A.22).

6 Subsidizing Firm Creation

Several researchers and policymakers have considered the decline in firm creation and overall dynamism as a negative development in the US economy (see, for instance, Davis and Haltiwanger (2014) and Yellen (2016)). In my model, however, the decline in firm creation is the efficient equilibrium response to technological improvements, conditional, of course, on taking the borrowing constraint as exogenous. That is not to say, however, that there is no room for policy intervention since the entrepreneurs in my model face a borrowing constraint that prevents entrepreneur with little wealth from reaching their optimal scale. Hence, in this section, I study the aggregate response of the economy to a subsidy aimed at increasing the rate of entry of new entrepreneurs to its 1985 level, conditional on the parameter values in 2015.[25]

In particular, consider a policy reform that relaxes the borrowing constraint of the entrepreneurs. I assume that the government gives a subsidy of ι_t to finance the cost of inputs to every entrepreneur in the economy. Hence, entrepreneurs face a collateral constraint given by

$$(1-\iota_t)\left(p_t^k k_{i,t} + \omega_t^H(\Theta_t,\mu_t)\, n_{i,t}^H + \omega_t^L(\Theta_t,\mu_t)\, n_{i,t}^L\right) \leq \lambda a_{i,t}.$$

Although this subsidy affects every entrepreneur, it has a larger impact on small and new entrepreneurs, who typically have less wealth than established entrepreneurs who are managing large firms. I assume that the government collects revenues using a linear tax on workers' and entrepreneurs' income denoted by τ_g. Then, the government budget constraint is given by

$$\sum_{s\in H,L}\int \tau_g\left(\mathbb{I}_{(d_{i,t}=w)} y_{i,t}\omega_t^s + \mathbb{I}_{(d_{i,t}=e)}\pi_{i,t}\left(a_{i,t}, z_{i,t}\right)\right)\mu_t^s =$$
$$\sum_{s\in H,L}\int \left(\left(p_t^k k_{i,t} + \omega_t^H(\Theta_t,\mu_t)\, n_{i,t}^H + \omega_t^L(\Theta_t,\mu_t)\, n_{i,t}^L\right)\right)\iota_t \mathbb{I}_{(d_{i,t}=e)} d\mu_t^s.$$

The definition of the recursive competitive equilibrium for this case is similar to the definition in Section 4.2, with the additional condition that the government must balance the budget in every period.

Using this simple policy, I consider the following experiment. I start as if the economy is in a

[25] This policy intervention is akin to the subsidized loan programs implemented, by the Small Business Administration in the United States, that allows small business to obtain loans at a lower cost.

Table II – Steady-State Comparison of a Subsidy to Firm Costs

	(1) Baseline	(2) 1985-level Level	(3) 1985-level Δ	(4) Optimal Subsidy Level	(5) Optimal Subsidy Δ
Tax (% of GDP)	-	3.16		2.58	
Entry Rate (%)	1.55	2.40		2.35	0.80
Aggregate Output	1.50	1.56	4.0%	1.56	4.0%
Total Factor Productivity	0.87	0.95	9.2%	0.94	8.0%
Entrepreneurs All (%)	3.68	6.10	2.42	5.85	2.17
High Skill (%)	2.41	3.96	1.55	3.77	1.36
Low Skill (%)	1.26	2.14	0.88	2.08	1.08
High-Skill Entrepreneurs (%)	6.34	10.30		9.80	
Low-Skill Entrepreneurs (%)	2.03	3.48		3.38	

Note: Table II compares the macroeconomic aggregates of different stationary economies. Column (1) shows the results for the baseline stationary economy if the parameters were as in 2015 and remain constant for the infinite future. Column (2) uses the same set of parameters but introduces a subsidy to finance the production costs of the entrepreneurs financed with linear tax for all individuals in the economy. The subsidy level is $\iota_t = 6.5\%$ of the total cost of production. Column (4) shows the same statistics under the assumption that the government implements the subsidy that maximizes the average welfare of the stationary economy given the parameter values in 2015. The value of the subsidy is $\iota_t = 5.73\%$.

stationary equilibrium conditional on the parameter values of 2015, and I compare this economy to a new stationary economy in which the subsidy is such that the entry rate of new entrepreneurs is equal to 2.4%, which is the transition rate from workers into entrepreneurship observed in 1985. Columns (1) and (2) of Table II compare aggregate output, total factor productivity (TFP), the tax burden as a percentage of output, and other aggregates at the stationary equilibrium of both economies.[26] To match an entry rate of entrepreneurs to that in 1985, the government imposes a tax that generates revenues equivalent to 3.16% of aggregate output. The increase in the entry rate induces a rise in the fraction of entrepreneurs in the population of 2.42 percentage points and an increase in aggregate output of 4.0%. TFP increases 9.2% in the new steady state. This happens for two reasons. First, on the extensive margin, some production factors are reallocated from the non-entrepreneurial sector to the new entrepreneurs that are, on average, more productive than the firms in the non-entrepreneurial sector. Second, on the intensive margin, already existing entrepreneurs run firms closer to their optimal, unrestricted scale.

The subsidy also generates higher welfare, measured in consumption equivalents. In particular, the average consumption equivalent required to make individuals indifferent between the baseline steady state and the steady state with a subsidy to firms is 0.04; that is, individuals are willing to give up some consumption to live in an economy where the subsidy is in place.[27] The welfare gains, however, are not distributed equally across the population. High-skill individuals experience

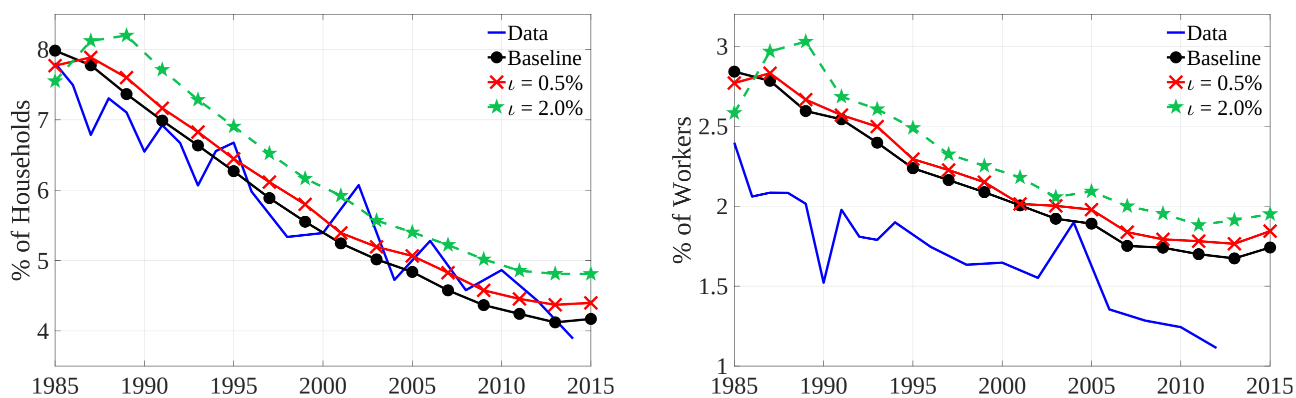
[26] TFP is defined as $Y\left(K^{0.33}L^{0.67}\right)^{-1}$. Here, Y is aggregate output, K is the sum of the capital utilized by all the entrepreneurs and the non-entrepreneurial sector, and L is the size of the labor force, which is normalized to 1.

[27] The average consumption equivalent is the equally weighted average of the value $\lambda(\Omega)$ that solves $(1+\lambda_s(\Omega))^{1-\sigma} V^*_{i,t}(\Omega) = \tilde{V}_{i,t}(\Omega)$ where $V^*_{i,t}(\Omega)$ is the value of an individual in the original stationary equilibrium without subsidies and $\tilde{V}_{i,t}(\Omega)$ is the value at the new stationary equilibrium, both conditional on the same idiosyncratic states, Ω.

Figure 10 – Entrepreneurs and Transition for Different Subsidies

(a) Share of Entrepreneurs

(b) Entry Rate into Entrepreneurship



Note: Panel A of Figure 10 shows the time series of the share of entrepreneurs in the data (solid line) and the model-implied time series for three different levels of input subsidies (the baseline case consider has a subsidy equal to 0). Panel B shows the transition rates into entrepreneurship.

a larger increase in welfare because they are able to run larger firms. Low-skill workers also enjoy an increase in welfare as their wages go up because of the increase in labor demand. Low-skill entrepreneurs experience the lowest increase in welfare because, although they receive a subsidy that relaxes their borrowing constraint, the tax is large and pushes down their consumption, and hence welfare, although not enough to reduce it below the level of the unsubsidized economy. In fact, the subsidy is much more effective in inducing high-skill workers to become entrepreneurs than it is for low-skill workers. The fraction of high-skill individuals that are entrepreneurs increases 1.56 percentage points, from 2.41% to 3.96%, whereas the fraction of low-skill entrepreneurs rises 0.88 percentage points, from 1.26% to 2.14%.

Alternatively, the government could impose a tax that maximizes the welfare of the economy. If the government considers an equally weighted average of utility across the individuals in the economy, the maximum level of utility is reached with a tax of 2.58% of GDP, as column (4) in Table II shows. Output, productivity, and the share of entrepreneurs also increase in this case. I conclude that a policy that aims to subsidize firms through a credit line that relaxes the borrowing constraint with the goal of increasing the entry rate of entrepreneurs to its level in 1985 would generate substantial benefits to the economy.

What would the evolution of the share of entrepreneurs have looked like if the subsidy had been implemented in 1985? Figure 10 shows the time series of the share of entrepreneurs both in the data, for my baseline results, and for different levels of the subsidy. As in the steady-state comparison, a positive subsidy generates an increase in the share of entrepreneurs in each year of the transition; however, it does not change the slope of the time series. In other words, although a *fixed* subsidy is effective in generating a larger share of entrepreneurs, it is unable to undo the impacts of the technological changes affecting the economy that have led to an equilibrium decline in the share of entrepreneurs and the entry rate to entrepreneurship.

7 Conclusion

In this paper, I have documented a decline in the share of entrepreneurs among US households and argued that the same technological forces that have given rise to the increase in returns to high-skill workers are, in part, responsible for the decline in the share of entrepreneurs and the formation of new business observed in the United States over the last three decades.

In the first part of the paper, I provide new evidence on the fall in the share of households participating in entrepreneurial activities and on the share of households transitioning into entrepreneurship. I also show that the decline in the proportion of entrepreneurs has been concentrated among individuals with high levels of educational attainment. Additional empirical evidence suggests that the skill level of new entrepreneurs has increased over time, which is consistent with an increase in the selection of individuals with higher managerial abilities.

Building on this evidence, I study an entrepreneurial choice model where the decrease in the share of entrepreneurs is the equilibrium outcome of the interplay of three exogenous trends—namely, the decrease in the price of capital goods, the increase in the supply of skilled labor, and the increase in the productivity of high-skill workers—and their joint impact on wages and entrepreneurial profits. In my baseline exercise, the model generates a decline of 3.8 percentage points in the share of entrepreneurs, which is almost all of the decline of 3.9 percentage points experienced in the United States over the last 30 years. Hence, viewed through the lens of my model, the decline in entrepreneurship, firm creation, and overall "dynamism" of the US economy should not be cause for concern as it is the equilibrium response to aggregate technological forces.

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Supplemental Online Appendix

NOT FOR PUBLICATION

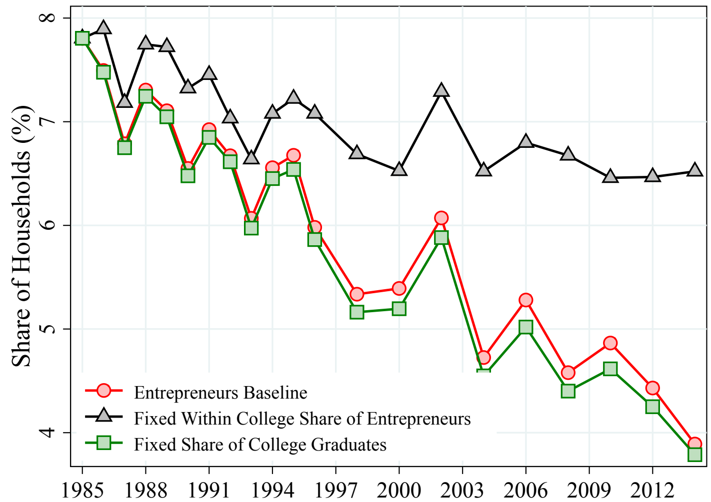
A Appendix Figures

Table A.1 – Sample Characteristics

	Wage Workers	Bus. Owners	Active Bus. Owners	Self-Emp. Bus. Owners	Entrepreneurs
Obs. per year	2,922	609	526	372	203
Fam. Income (M)	69.2	123.3	124.4	134.8	161.2
Age (mean)	39.8	43.1	43.2	44.0	44.3
Males (%)	70.7	89.7	90.0	91.7	92.9
Drop Outs (%)	7.4	2.8	2.8	2.8	1.4
High School (%)	31.1	24.3	25.0	25.9	18.3
Some College (%)	26.4	25.4	25.9	25.5	22.4
College and More (%)	35.2	47.5	46.4	45.8	57.9
White (%)	87.2	95.5	95.6	96.0	96.3
10th Pct. Wealth (M)	-7.8	5.5	6.2	15.2	39.2
50th Pct. Wealth (M)	39.0	267.0	278.9	358.9	493.0
90th Pct. Wealth (M)	414.2	1,605.0	1,729.2	2,068.5	2,601.3
95th Pct. Wealth (M)	684.9	2,750.0	2,959.4	3,497.8	4,326.6

Note: Table A.1 reports statics of a sample of heads of households between 22 and 60 years old. See Appendix B.1 for additional details on the sample selection. Each statistic is the sample average across all the survey waves between 1985 and 2015. Business owners are individuals that declare owning a business. Active business are individuals that own a business and declare have worked in the business in a given year. Self-employed business owners are active business owners that are self-employed. Entrepreneurs are the subset of individuals in the previous group that declare to have a managerial or professional occupation. All monetary values are deflated by the PCE index and expressed in 2012 US dollars. Household wealth is defined as the sum of savings and checking accounts, bonds, stocks, IRA, housing equity, other real state, and vehicles, minus total debt including mortgages. All statistics, with the exception of the number of observation, were calculated using sample weights.

Figure A.1 – Share of Entrepreneurs and Counterfactual Exercises

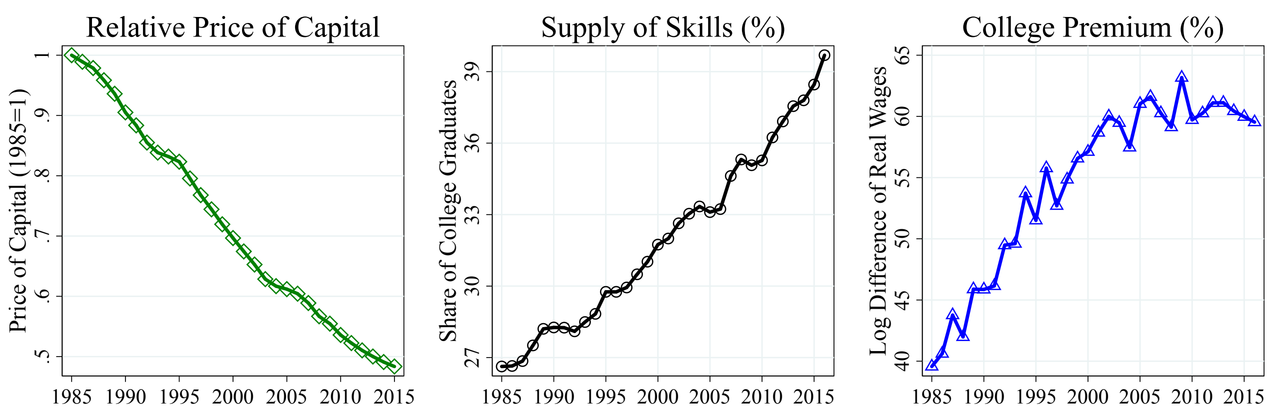


Note: Figure A.1 shows a simple accounting decomposition of the share of entrepreneurs under two alternative scenarios. The first keeps the share of entrepreneurs within the college graduates as its value in 1985 (line with circles). The second keeps the share of college graduates constant (line with triangles). This decomposition is calculated as follows. Denote the aggregate share of entrepreneurs by e_t, the share of entrepreneurs within college graduates as e_t^C and high school graduates as e_t^H. Then, if the population share of college graduates is C_t/T_t and high school graduates is H_t/T_t, where T_t is the total population, we can write e_t as

$$e_t = e_t^C + e_t^H = \frac{C_t^e}{T_t} + \frac{H_t^e}{T_t} = \frac{C_t^e}{T_t}\frac{C_t}{C_t} + \frac{H_t^e}{T_t}\frac{H_t}{H_t} = \frac{C_t}{T_t}e_t^C + \frac{H_t}{T_t}e_t^H.$$

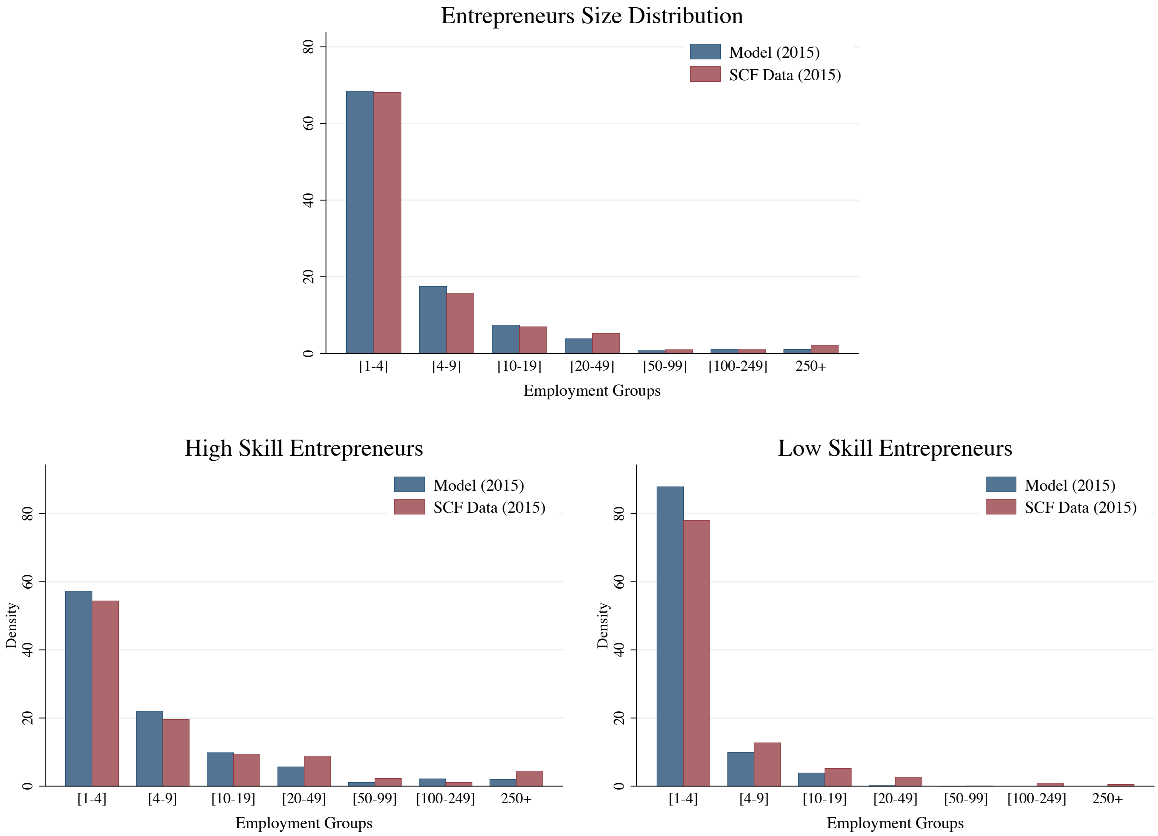
Using this expression one can obtain a simple "counterfactual" decline in the share of entrepreneurs.

Figure A.2 – Aggregate Processes



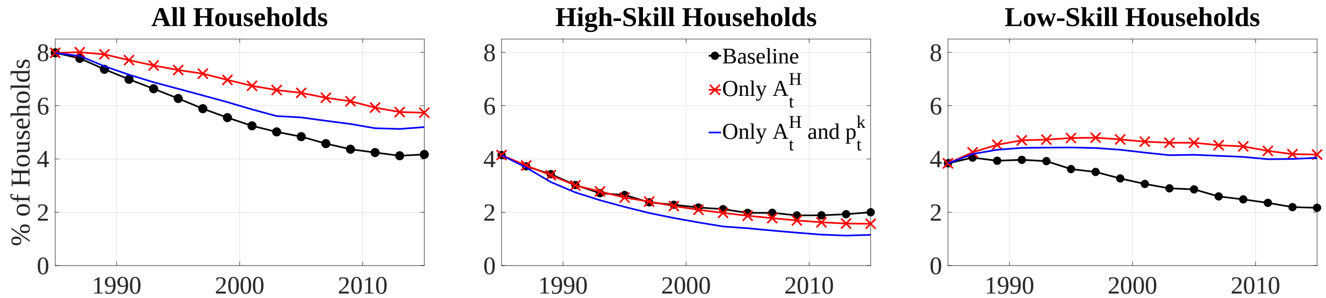
Note: Figure A.2 displays the time series of the relative price of capital goods (left panel), the share of college graduates in the population (center panel), and the college premium (right panel). The relative price of capital goods (calculated by DiCecio (2009)) is normalized to 1 in 1985. The supply of college graduates is calculated over a sample of heads of household drawn from the CPS. The supply of college graduates in each year is the share of heads of household between ages 22 and 60 that have a college degree. The college premium is calculated as the difference between the average of the log of real wages of heads of household with a college degree or more and the average of the log of the real wages of heads of household that have a high school degree over a sample of wage workers. See Appendix B.2 for additional details on the calculation of the supply of college graduates and the college premium.

Figure A.3 – Employment Size Distribution for Entrepreneurs



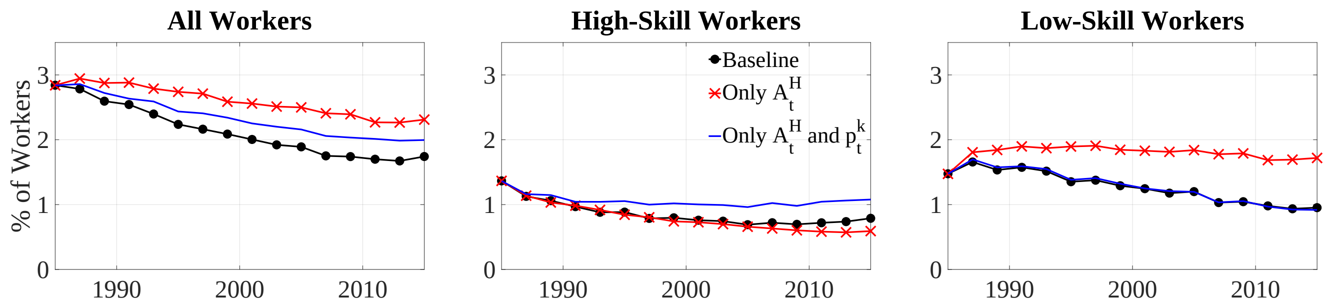
Note: The Figure A.3 shows the share of employment accounted for by entrepreneurs managing firms of different sizes. Model results are obtained from the 30th year of the simulate path. High skill workers in the data are those with a college degree or more; Low-skill are those workers with a high school degree or dropouts. Appendix C.1 discussed the SCF sample and moment calculations.

Figure A.4 – Alternative Decomposition of Decline in Entrepreneurship



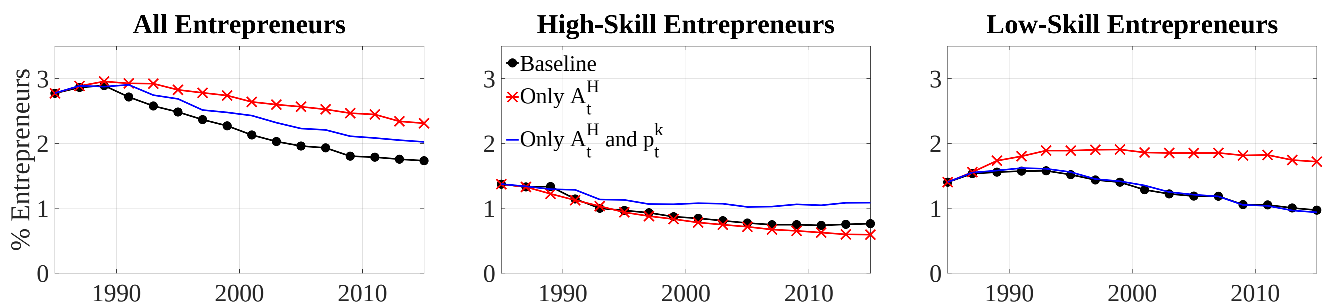
Note: Figure A.4 shows the time series of the transition rate out from entrepreneurship implied by the model. The black line with circles shows the results in the baseline case, the red line with x symbols shows the results in the case that only A_t^H changes over time, and the blue line shows the results in the case that A_t^H and H_t change over time.

Figure A.5 – Decomposition of the Transition Rate



Note: Figure A.5 shows the time series of the transition rate out from entrepreneurship implied by the model. The black line with circles shows the results in the baseline case, the red line with x symbols shows the results in the case that only A_t^H changes over time, and the blue line shows the results in the case that A_t^H and H_t change over time.

Figure A.6 – Decomposition of the Exit Rate



Note: Figure A.6 shows the time series of the transition rate out from entrepreneurship implied by the model. The black line with circles shows the results in the baseline case, the red line with x symbols shows the results in the case that only A_t^H changes over time, and the blue line shows the results in the case that A_t^H and H_t change over time.

B Data Appendix

B.1 The PSID Sample

Sample Selection and Definitions of Entrepreneurship

The PSID sample used for studying the time series of the share of entrepreneurs was constructed as follows. From the raw data (accessed through https://psidonline.isr.umich.edu/), I extract a sample of heads of household from the SRC sample (I do not consider information of the SEO, Immigrants, or Latino Samples) from the waves going from 1970 and 2015. Some individuals have missing observations in employment status or were registered as "refusing to answer". In those cases, I replace the employment status variable by the code corresponding to "no working for money" (code 3). Only 107 observations were replaced in this way. The variable defining the age of the head of the household has several inconsistencies that are necessary to fix. In particular, for those individuals whose age jumps up for more than 3 years, or jumps down, I imputed an increase in age based on the first reliable age. Similar to age, the education variables has many inconsistencies. Because in this paper I focus on the education as a measure of skill, I create a new variable that considers the highest educational attainment of the individual as a measure of education. All monetary variables (income, wealth, etc.) were deflated using the Personal Consumption Expenditure index from the Bureau of Economic Analysis. The baseline sample considers households whose head is between 22 and 60 years old, both ends included. This yields a sample of 112,283 year-household observations with an average of 3,118 observations per year. For the period in which I focus my study, that is 1985 to 2015, the number of observations is 75,031 with an average of 5,573 observations per year. All statistics were calculated using PSID sample weights.

The PSID provides several questions that can be used to classify individuals by their entrepreneurial status. In my analysis, I use four of these questions. The first question is, "Did you (or anyone else in the family there) own a business at any time in (year) or have a financial interest in any business enterprise?" The second is, "On your main job, are you (head) self-employed, are you employed by someone else, or what?" Third, starting in 1985, the heads of household are asked, "Did you (head) put in any work time for this business in (year)?" In the model I discuss in the following section, entrepreneurs work in their own firms, so this last question is crucial to defining who an entrepreneur is. Hence, I focus my analysis on the period in which this question is available. Fourth, heads of households are asked about their occupation, and I use these answers to identify individuals in managerial or professional occupations.

Income Process

To calculate the parameters of the income process used in the model, I measure earnings as the real value of total labor income of individual i in year t. Total labor includes wages and salaries, tips, commissions, and bonuses. However, the results are quite similar if one uses only wages and salaries as measure of labor income. Then, in each year t I drop all observations of individuals that are self-employed business owners in either period t or $t-1$. Given these restrictions, estimate the process of labor income on a sample of 6,303 individuals and 58,094 observations. The value of ρ_w is 0.73 with and standard error of .0028. The adjusted R^2 of the regression is 0.55. The standard error of the residuals 0.53 so I set σ_y to this value. Estimating the income process only for individuals with college or more generates a slightly lower value for ρ_w equal to 0.70 (0.72 for individuals with high school or less). Nevertheless, the standard error of the residuals is quite similar and equal to 0.53.

B.2 CPS Data, Supply of Skills, and College Premium

In this section, I describe how I constructed the share of college graduates (which is equated to the share of high skill workers in the model) and the college premium (which is the skill premium in the model). To calculate both time series, I draw a sample of individuals from the March CPS data (accessed through IPUMS) from 1970 to 2015. To keep the sample selection as close as possible to the PSID sample, I keep individuals that are head of the household aged between 22 and 60 years (both ends included) which are in the labor force and have valid education information. Individuals in the armed force or with negative weights are excluded from the sample. The baseline sample consists of 1.7 million individual-year observations.

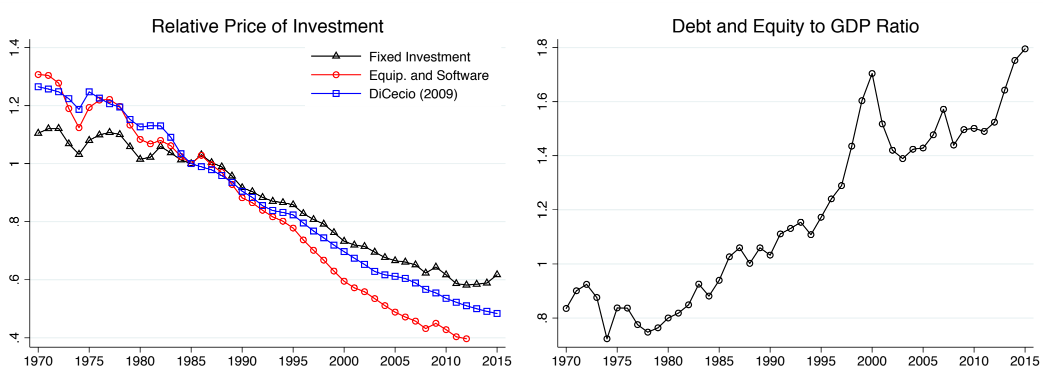
The share of high skill workers is the weighted share of individuals with a college degree or more. The skill premium is calculated over a subsample of wage workers only. This is because both in the model and in the literature, the skill premium is the relative wage of high skill workers to low skill workers. To avoid issues related to the differences in labor supply of college graduates versus non-college graduated, I consider a sample of wage workers (not self-employed) that worked more than 40 weeks, and more than 35 hours per week (which is the definition of full time workers in Acemoglu and Autor (2011)). This leave yields a sample of 1.2 million observations. Then, the college premium is the difference between the weighted average of log-real wage for college graduates and the weighted average of log-real wage for high school graduates.

B.3 Additional Macro Aggregates

I take the measure of the relative price of investment from DiCecio (2009) estimates available in the Federal Reserve Bank of St. Louis website (FRED time series PIRIC). Alternatively, one could calculate the relative price of investment as the ratio of the price index of non residential investment calculated by the BEA (FRED time series A008RD3Q086SBEA) divided by the price index of non durable consumption (FRED series CUUR0000SAN). A third alternative is to use a more refined measure of investment that only considers equipment and software (FRED time series A010RD3A086NBEA) relative to the price index of non durable consumption. The left panel of Figure A.7 shows the evolution of each of these series re scaled to 1985. The three time series show a similar declining pattern although the measure of the price of investment that considers equipment and software shows a sharper decline: relative to 1985, the measure that considers all investment declined 40%, DiCecio (2009) measure declined a 55%, and the measure that considers equipment and software declined 60%. This makes the choice of the quality adjusted time series calculated by DiCecio (2009)'s a conservative option, right in the middle of these different measures.

For the ratio of debt and equity to business GDP that serves as one of the targets in my quantitative exercise I consider four different time series. From the Flow of Funds, I consider the Non Financial Non Corporate Businesses Total Liabilities (FRED time series NNBTILQ027S) and the Non Financial Corporate Businesses Total Liabilities and Equity (FRED time series NCBLEYQ027S). Both series are aggregated averaging the quarterly data to annual levels. Then, I add these annual series to have a measure of the total liabilities of the non financial business sector. The measure of GDP comes from BEA sectoral measures of GDP from which I add up the annual nominal GDP across all private industries with the exception of Finance and Insurance. The right panel of Figure A.7 shows the resulting time series.

Figure A.7 – Price of Investment and Debt-to-GDP ratio



Note: The left panel of Figure A.7 shows the time series of the relative price of investment for three different measures. The right panel shows the debt and equity of non financial businesses to non financial businesses GDP ratio.

C Additional Evidence on the Decline in the Share of Entrepreneurs

In this Appendix, I show additional results on the decline in the share of entrepreneurs in the US economy. For doing that I draw from the Survey of Consumer Finance (SCF) and the Current Population Survey (CPS). Both surveys have strengths and weaknesses in terms of coverage and representativeness. Both surveys provide cross sectional data that precludes analyzing the transition of individual in and out of entrepreneurship. Still, both surveys suggest the same general picture in terms of the evolution of the share of entrepreneurs over the last 30 years in the United States.

C.1 SFC Sample

C.1.1 Sample Selection

The SCF is a nationally representative survey conducted every three years by the Federal Reserve Board of Governors. The SCF oversample rich individuals which are more likely to be entrepreneurs. I take data from over the period 1989 to 2016. The raw sample contains 238,880 individual-year observations. For comparability to the results on the PSID, I consider a sample of heads of households between 22 and 60 which are in the labor force with valid information on education. Following Cagetti and De Nardi (2006) and Michelacci and Schivardi (2016)I classify an individual as an entrepreneur if she is self-employed in his primary job (variable X4106 in the SCF) and she has an active management role in at least one privately owned business (variable X3104 in the SCF). I further divide the sample on individuals with a high school degree or less and those with some college studies or more (variable X5901 in the SCF for the period 1989 to 2013 and X5931 for 2016). Finally, I drop all those individuals that do not work for a pay (variable X4106 in SCF). This leave us with a sample of 173,066 individual-year observations. For all the calculations I use the sample weights (variable X42001).

C.1.2 Share of Entrepreneurs

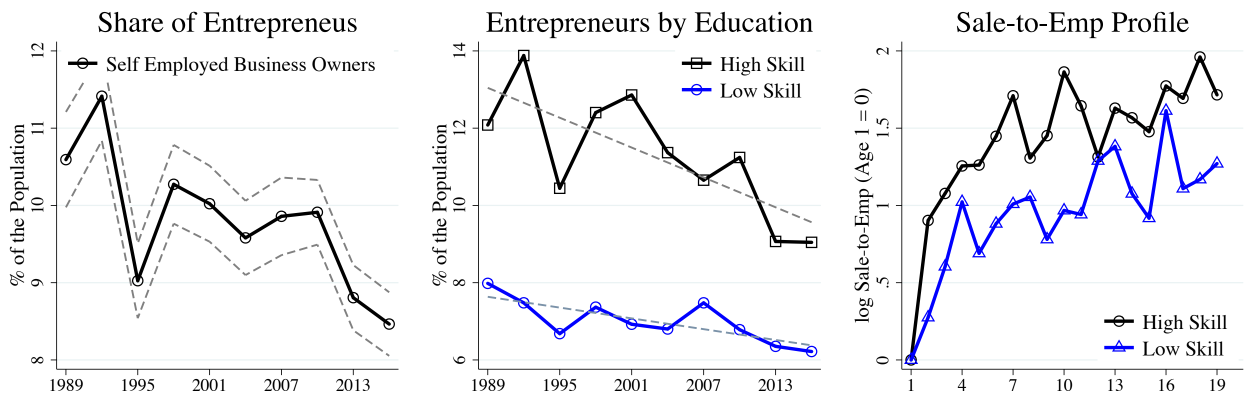
In this subsection, I present additional evidence on the decline in the share of entrepreneurs in the United States using information from the Survey of Consumer Finances. The SCF is a nationally representative survey conducted every three years since 1983. The SCF over samples wealthy households, which are more likely to be entrepreneurs (Cagetti and De Nardi, 2006), allowing for a more precise measure of the share of entrepreneurs in the population. Besides collecting information on household assets and business ownership, the SCF asks whether the head or another member of the family has an active management role in any of the businesses he or she owns. The main disadvantage of the SCF is that it does not follow individuals over time.

I use information from the SCF from 1989 to 2016. Following the definitions described in the main text, I define as self-employed business owners those households whose head or spouse has an active management role in a business owned by the family and whose head is self-employed.[28] These households represented an average of 9.2% of the total population between 1989 and 2016. The left panel of Figure A.8 shows that the share of self-employed business owners in the SCF declines over time, from 10.1 in 1989 to 7.8 in 2016. Separating the sample by education groups, I find that the decrease in the share of entrepreneurs is concentrated among households whose head has at least some college education (center panel of Figure A.8).[29]

[28] See Appendix C.1 for additional details on the construction of the SCF sample.

[29] Michelacci and Schivardi (2016) also use the SCF and suggest that the share of entrepreneurs is stable between 1989 and 2013. The difference is mainly due to the sample selection. Similar to Hurst and Lusardi (2004), I consider individuals between 22 and 60 years old, whereas Michelacci and Schivardi (2016) consider the entire sample of heads of household, independent of their age. Appendix Figure A.10 shows the share of entrepreneurs with and without this age restriction (left panel) and within each age group (center panel). The share of entrepreneurs within the group of individuals of more than 60 years old has increased over time. Since this group has increased its

Figure A.8 – SCF: Characteristics of Entrepreneurs



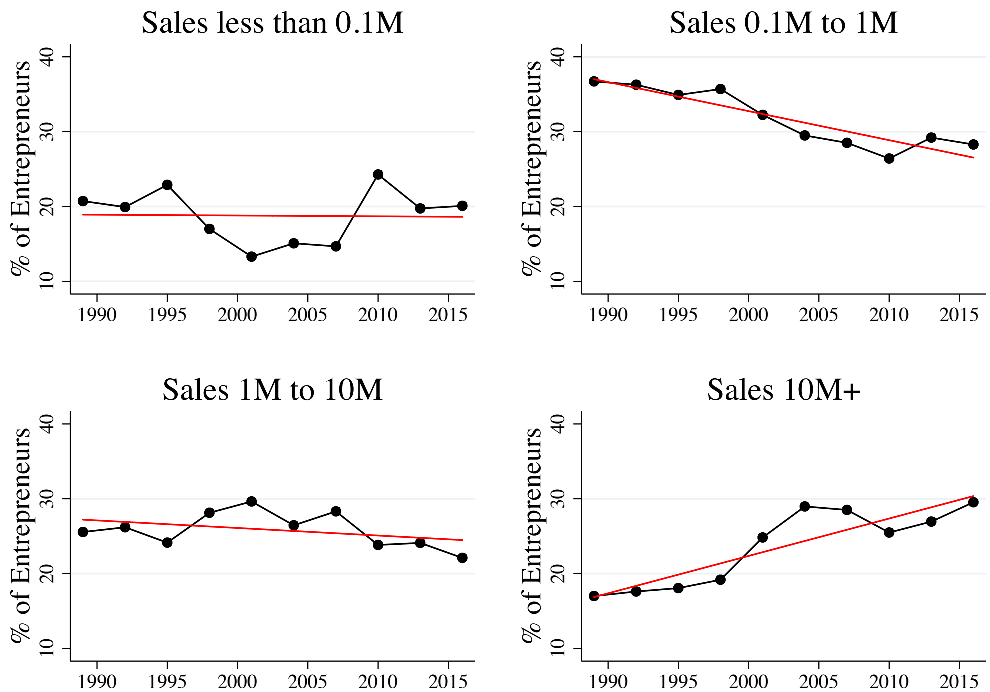
Note: The left and center panels of Figure A.8 display the time series of the share of self-employed business owners in the SCF. High skill entrepreneurs are heads of household with some college studies or more. Low skill entrepreneurs are heads of households with a high school diploma or less. Self-employed business owners are households that own a business, declare having an active management role, and whose head is self-employed. The slopes in the center plot are statistically different at the 5% level. The right panel shows the average sales-to-employment ratio. Each point is the value of the age fixed effect on a regression of the log sales-to-employment on industry, year, and gender fixed effects, and a quadratic in the age of the entrepreneur. All monetary values are expressed in 2012 US dollars. See Appendix C.1 for additional details on the construction of the SCF sample.

The firms of high skill entrepreneurs are more profitable than the firms of low skill entrepreneurs. The right panel of Figure A.8 displays the (average) age profile of the log real sales-to-employment ratio after controlling for industry fixed effects, year fixed effects, and by the gender and age of the entrepreneur. To facilitate the comparison comparison, I have normalized each profile by the sales-to-employment ratio in the first year. The firms of high and low skill entrepreneurs generate a similar amount of dollars per worker in their first year of operation (an average of \$16,400 per employee in the case of high skill entrepreneurs relative to \$15,500 for low skill entrepreneurs), but the firms of high skill entrepreneurs grow much faster than the firms of low skill entrepreneurs. The average sales-per-employee ratio of the firms managed by low skill entrepreneurs grows by 21% in the second year of operation and grows by 80% when the firm has reached the age of five. This increase is more substantial among the firms managed by high skill entrepreneurs: in the second year, these entrepreneurs are selling 80% more per worker than in their first year, and after five years of operation, the sales-to-employment ratio is 150% higher than in the first year. The differences are also economically significant. The median high skill entrepreneur running a firm that has been operating for five years generates \$77,812 per worker, while a firm of the same age but owned by a low skill entrepreneur generates \$28,874 per worker. I do not find important differences between average employment size of firms of high and low skill entrepreneurs after I have controlled for industry.

Using the SCF one also can study in more detail the changing characteristics of entrepreneurs and their firms. For instance, one would like to know whether the decline in the share of entrepreneurs is concentrated among those managing small, medium, or large firms. This would give us a sense of how important is the decrease in the share of entrepreneurs. To see this, I separate the sample of entrepreneurs in the SCF into four size categories, measured by the amount of sales (expressed in 2012 dollars). I consider three cut-offs, one at 0.1 million dollars, a second at 1 million dollars, and the third at 10 million. Then, I calculate the share of entrepreneurs within each of these groups. Figure A.9 shows that the decline of

population share, it is not surprising to find that the share of entrepreneurs is more stable if these individuals are considered in the sample: between 1989 and 2016, the share of entrepreneurs declines 1.55 percentage points among individuals between 22 and 60, but only 0.5 percentage points considering the entire sample. In this paper, I focus on the 22 to 60 range because these individuals are more likely to switch between workers and entrepreneurs and are more inclined to start new businesses. The right panel of Appendix Figure A.10 shows that the share of startup entrepreneurs (entrepreneurs whose main business is one year old or less) among individuals 22 and 60 averages 17% between 1989 and 2016 and has been declining over time, much like the evidence presented by Pugsley and Sahin (2014) using firm-level data, whereas the share of startups within the group of entrepreneurs older than 60 is smaller (average of 5%) and has increased over the last 25 years.

Figure A.9 – Size Distribution of Entrepreneurs



Note: The Figure A.9 shows the evolution of the share of entrepreneurs for different size classifications. All monetary values are expressed in 2012 US dollars. See Appendix C.1 for additional details on the construction of the SCF sample.

the proportion of entrepreneurs has been accompanied by a shift in entrepreneurs' size distribution. In particular, the share of the smallest group has stayed constant over the years, the share of middle-sized entrepreneurs, with sales between 0.1M and 1M, has declined, whereas the group of entrepreneurs selling more than 10 million has increased substantially over time. Importantly, this change in the sales-size distribution of entrepreneurs is mostly explained by changes in the distribution of high skill entrepreneurs, which represent a disproportionate share of the group or large entrepreneurs: high skill entrepreneurs represent 80% of all entrepreneurs selling more than 10M dollars per year, but less than 20% in the group of entrepreneurs selling less than 0.1M. Furthermore, the sales-size distribution among low skill entrepreneurs almost did not change over the sample period as shown in Appendix Figure A.11.[30]

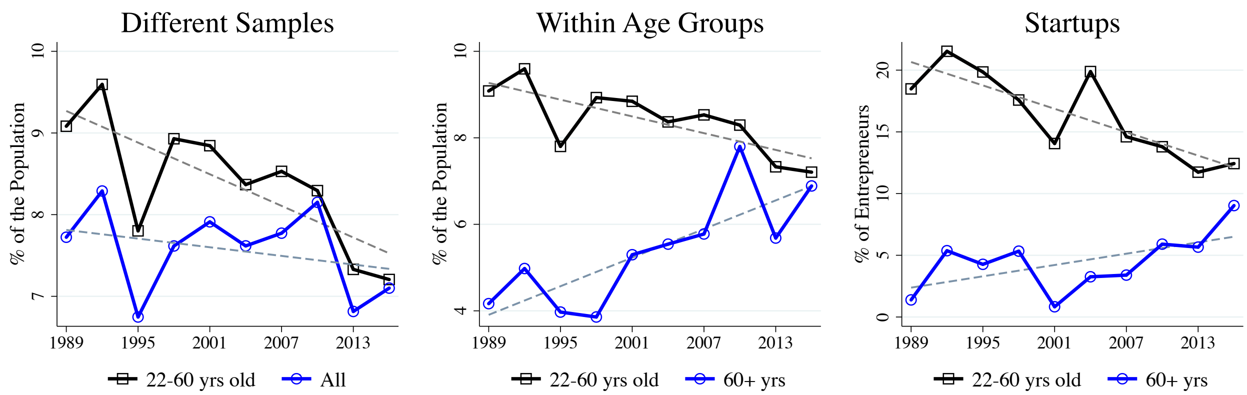
C.1.3 Robustness

Here I discuss two additional issues. First, Michelacci and Schivardi (2016) use the SCF to study the returns to entrepreneurs and he suggests that the share of entrepreneurs has been stable from 1989 to 2013. The difference between my conclusions and theirs steams from the sample selection. Given their focus on entrepreneurial returns Michelacci and Schivardi (2016) consider the entire population sample while I focus on 22 to 60 years old individuals which are more likely to switch occupations between workers and entrepreneurs. The left panel of Figure A.10 shows the share of entrepreneurs in the SCF with and without the group of individuals that are over 60 years old. In the second case, the share of entrepreneurs is more or less stable over the sample period. This is because within the group of over 60 years old, the share of entrepreneurs is either flat or increasing as the center panel of Figure A.10 shows. This, coupled with an increasing share of this group in the US population, pushes the share of entrepreneurs up, keep the population share more or less constant. In contrast to Michelacci and Schivardi (2016), I focus on individuals that might transit into entrepreneurship and weigh the costs and benefits of starting a new

[30]This results are robust to other classification in terms of sales size and if I use employment instead of sales as a measure of entrepreneur's firm size.

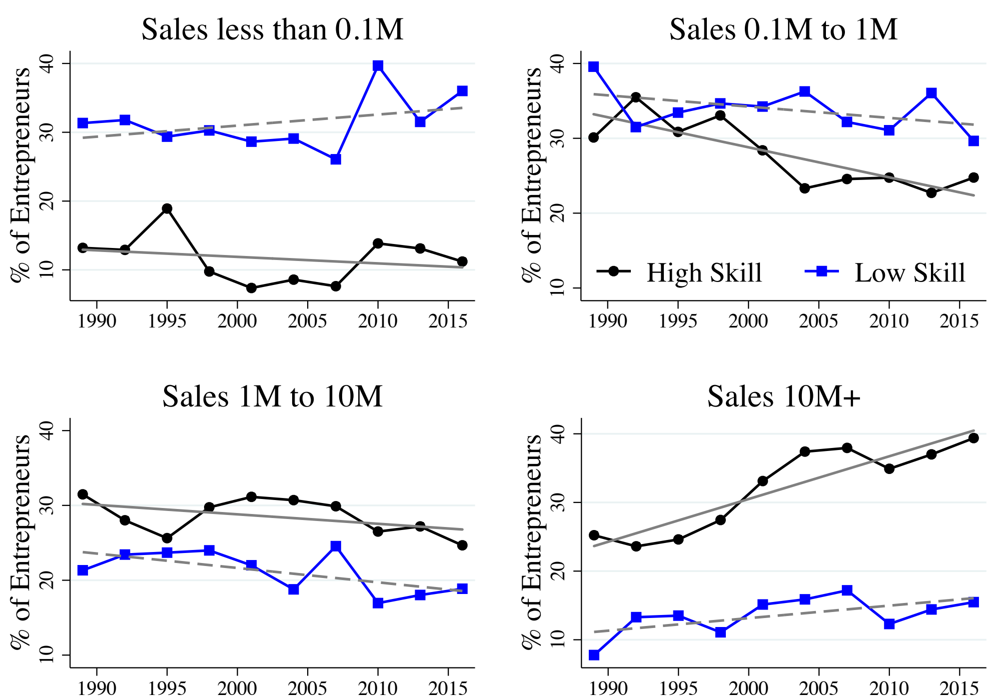
firm. Importantly, for the group of entrepreneurs that are between 22 and 60 years old, the share of startups entrepreneurs, that is, the fraction of entrepreneurs whose primary firm is one year old or less, shows an step decline during the sample period while this share is smaller and increasing within the group of entrepreneurs older than 60 years (right panel of Figure A.10).

Figure A.10 – Share of Entrepreneurs and Startups in the SCF



Note: Figure A.10 shows the share of entrepreneurs within different population groups and for different definitions of entrepreneurs. The left panel shows the share of entrepreneurs in the baseline sample (individuals between 22 and 60 years old) and considering the entire sample (individuals of 22 years or more). The center panel shows the share of entrepreneurs within age groups. The right panel shows the share of startups entrepreneurs within age groups. Startup entrepreneurs are entrepreneurs that actively manage at most two firms and one of them has at most 1 year old.

Figure A.11 – Size Distribution: High and Low Skill Entrepreneurs



Note: The Figure A.11 shows the evolution of the share of entrepreneurs for different size classifications within high and low skill entrepreneurs. All monetary values were deflated using the PCE and expressed in 2012 dollars.

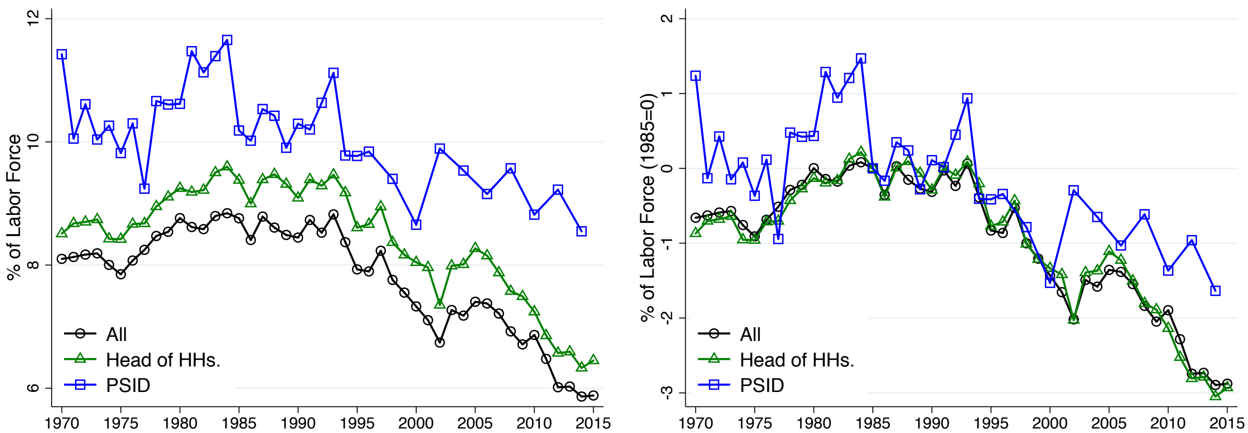
C.2 Evidence from the CPS

The decline in the share of entrepreneurs documented in Section 2 of the main text comes from a small, although nationally representative, sample of household. Hence, one might wonder whether the results presented here using the PSID can also be observed in other data sets. For this reason, in this Appendix a draw a sample of household from the Current Population Survey (CPS) from 1970 to 2015. The CPS is a nationally representative survey collected by the US Census Bureau. Here, I use the March supplement that collects information on employment status, income, industry, and occupation, to analyze if the patters found in the PSID are also present using a much larger data set. As much as possible, I keep the same sample selection used in the previous section. The main drawback of using the CPS is that the definition of what constitutes an entrepreneur can be based only on few questions that mostly refer to whether or not the individual is self-employed, and therefore, the sample could be skewed to individuals that work for themselves and do not hire any other employees. This is important for two reasons. First, most of the evidence presented by Haltiwanger *et al.* (2015), Decker *et al.* (2016), and others refer to employee firms and therefore self-employed individuals that do not hire other workers are not considered. Secondly, new empirical evidence suggests that alternative works agreements (contractors, part time workers, etc.) are in a rise in the US economy (Katz and Krueger, 2016). To the extent that there is overlap between self-employed individuals and workers in alternative work agreements, analyzing trends of the share of self-employed might be misleading. With these caveats in mind, I consider two measures of entrepreneurship. The first is the proportion of individuals that are self-employed over the entire population, and second, to have a closer definition to the one used in PSID, I consider the fraction of self-employed head of households.

The left panel of Figure A.12 shows that the share of self-employed in the population has steadily declined since the early 1980s and such decline has accelerated since the mid 1990s. For better comparison with my previous results, here I also show the proportion of self-employed head of households from the PSID. The levels are somewhat different, with a larger proportion of self-employed in the PSID, but the decline is similar in both data set, as it is shown in the right panel of A.12. Figures A.13 and A.14 complement these results showing the decline in the share of self-employed within education and age groups.

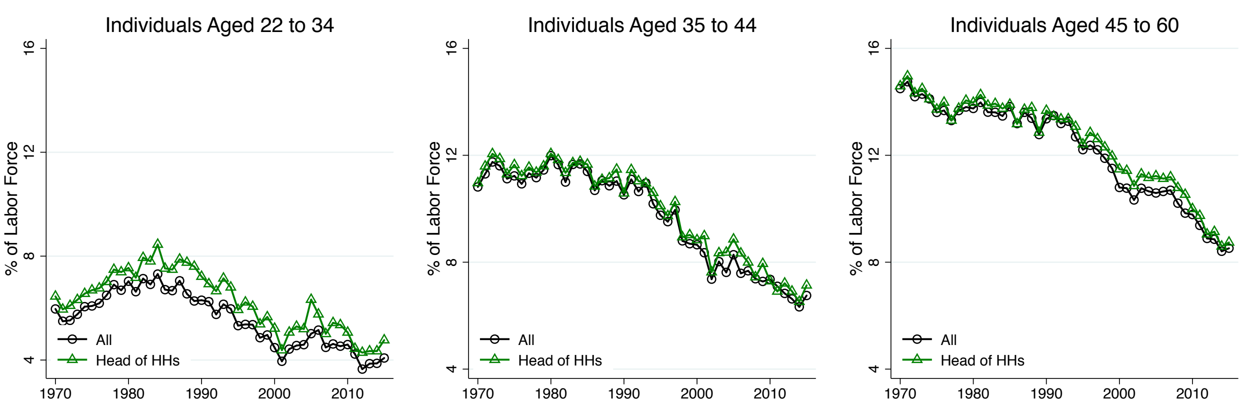
Because the CPS is a much larger sample, we can go one step further and study in which which industries the decline in the share of self-employed is stronger. For doing that, I calculate the share of self-employed individuals within 14 two-digit SIC groups. The employment share accounted for self-employed is quite different across industries, as one can expect from the large disparities in the scale of production. For instance, the share of total employment account for by self-employed workers in services is around 15%, while in manufacturing it is 1.5%. To have a better comparison across sectors, Figure A.15 shows the share of self-employed workers within each industry rescaled to its value in 1985. With the exception of manufacturing, the decline in the share of self-employed is quite evident in almost all sectors. Interestingly, the decline in self employment is not circumscribed to sectors such as retail and whole sale trade (see upper right panel) which has been increasingly dominated by big retail stores, but it is also present in construction or even within growing sectors, such as Services (see the upper left panel).

Figure A.12 – Share of Self-employed in the Population



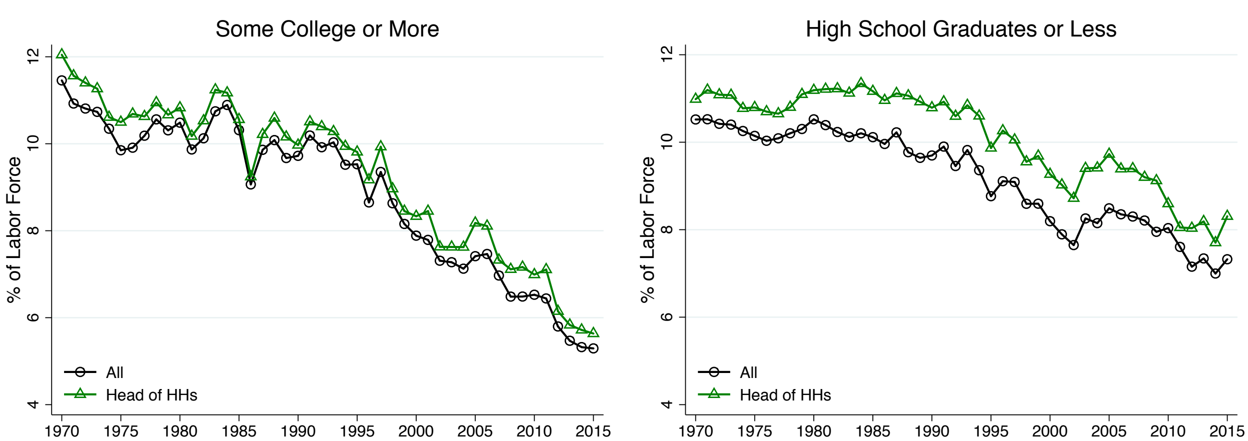
Note: Figure A.12 shows the proportion of self-employed individuals aged between 22 and 60 years old. Individuals which are not in the labor force (students, disable) or are in the military are excluded. The share of self-employed head of households is the ratio to all the head of households that are self-employed over the population of head of households.

Figure A.13 – CPS: Proportion of Self-employed by Age



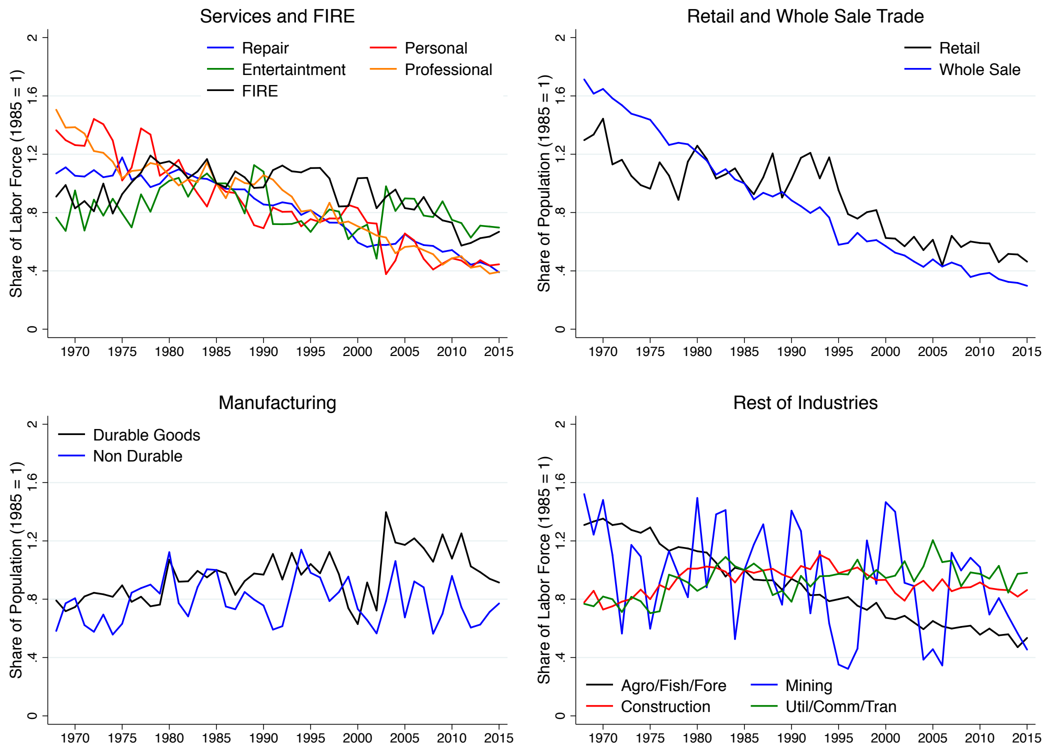
Note: Figure A.13 shows the proportion of self-employed individuals within age groups. Individuals which are not in the labor force (students, disable) or are in the military are excluded. The share of self-employed head of households is the ratio to all the head of households that are self-employed over the population of head of households within each age group.

Figure A.14 – CPS: Proportion of Entrepreneurs by Education



Note: Figure A.14 shows the proportion of self-employed individuals within education groups. Individuals which are not in the labor force (students, disable) or are in the military are excluded. The share of self-employed head of households is the ratio to all the head of households that are self-employed over the population of head of households within each education group.

Figure A.15 – CPS: Proportion of Self-Employed by Industry



Note: Figure A.15 shows the proportion of self-employed individuals within industry sectors. Individuals which are not in the labor force (students, disable) or are in the military are excluded. The share of self-employed head of households is the ratio to all the head of households that are self-employed over the population of head of households within each industry.

C.3 Entrepreneurship and Labor Earnings in the Cross Section

So far, I have presented descriptive evidence on the decline in the share of entrepreneurs in the United States over the population and within education groups, without discussing the potential causes of such decline. In this section, I discuss a first set of results that link the decline in the share of entrepreneurs to the rapid increase in wages for high-skill workers using cross-state data.

To evaluate the contribution of the observed changes of the wages of high- and low- skill workers to the decline in the share of entrepreneurs, I run a series of state-level regressions of the form

$$e^s_{j,t} = \beta_0 + \beta_1 w^s_{Coll,t} + \beta_1 w^s_{HighS,t} + X^s_{j,t}\Gamma' + \epsilon^s_{j,t},$$

where $e^s_{j,t}$ is the share of entrepreneurs in state j in the education group s in year t. The main explanatory variables are the average log-real labor earnings for college graduates $\left(w^s_{Coll,t}\right)$ and high school graduates $\left(w^s_{HighS,t}\right)$. The matrix $X^s_{j,t}$ includes a set of aggregate and state-level controls.

In this section, I use the CPS to measure the share of entrepreneurs at the state level. Although the sample size in CPS is much larger than in the PSID, the CPS provides less information about the entrepreneurial status of an individual, and therefore I measure the share of entrepreneurs as the fraction of heads of household that are self-employed. Importantly, the CPS shows the same patterns that I document using the PSID: the share of self-employed is also declining, almost at the same pace as in the PSID, and this decline differs substantially between college and high-school graduates.[31]

Table A.2 shows the regression results. Column (1) presents the correlation between the share of entrepreneurs and the wage for college graduates. The negative and statistically significant coefficient indicates that states in which the wages for workers with a college degree are higher are also states in

[31]See Appendix C for additional evidence on the decline in the share of entrepreneurs in the CPS.

Table A.2 – Lower Share of Entrepreneurs in States with High Labor Income

Dependent variable:	Share of Self-Employed Within State/Year/Education Group					
Population:	College Graduates			Non-College Graduates		
	(1)	(2)	(3)	(4)	(5)	(6)
Wage College	-8.28^{***}	-5.42^{***}	-6.25^{***}			1.86^{***}
	(0.25)	(0.49)	(0.72)			(0.62)
Wage non-College			0.69	-9.85^{***}	-2.30^{***}	-7.0^{***}
			(0.91)	(0.43)	(0.69)	(0.93)
R^2	0.35	0.50	0.60	0.20	0.47	0.59
FE	N	Y	Y	N	Y	Y
$Controls$	N	N	Y	N	N	Y
N	2,053	2,053	2,053	2,053	2,053	2,053

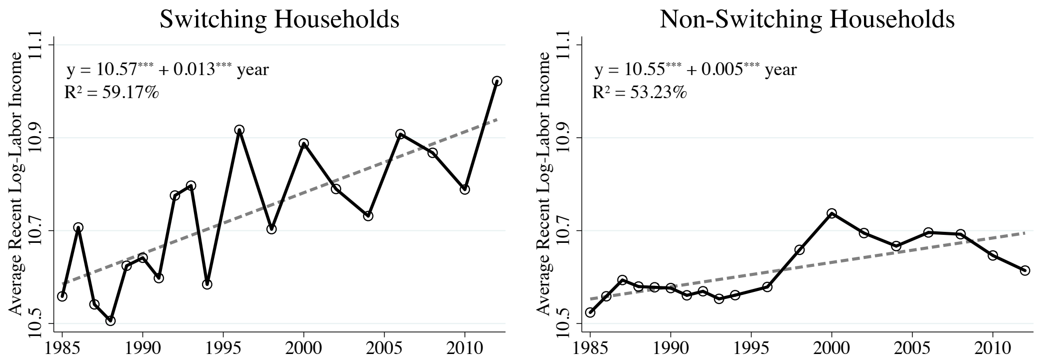
Note: Table A.2 shows the results of a regression of the share of self-employed heads of households within a year/state bin for two education groups—college graduates and high school graduates—using data from the CPS March Supplement from 1970 to 2015. In column (2) and (5) I control for a state-level fixed effect and a linear trend. Columns (3) and (6) include a set of controls such as the within-state working age population, the share of heads of households between ages 25 and 35, the share of households between ages 35 and 45, and the average log-earnings for college and non-college self-employed. Standard errors in parentheses are clustered at the state level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

which the share of self-employed is lower. This raw correlation, however, captures fixed differences across states and other aggregate factors that can account for the decline in the share of self-employed. Hence, in column (2) I add state-level fixed effects and a linear trend, which controls, for instance, for fixed differences in regulation across states and aggregate trends affecting all states simultaneously. Furthermore, to account for the decline in labor supply and the continuous aging in the population, both of which have been found to be relevant in explaining the decline in firm creation in the United States, column (3) incorporates several controls such as the state-level labor force, a measure of the within-state age distribution, and the within-state average business income among the self-employed. The main coefficient of interest—the elasticity of the share of entrepreneurs with respect to the wage of college graduates—remains statistically and economically significant across the three specifications, indicating that the observed changes in wages can, in part, account for the decline in entrepreneurship observed in the United States over the last three decades.

In terms of magnitudes, the coefficient in column (3) suggests that the observed rise in the wages of high-skill workers (which increased 37% between 1985 and 2015 in the CPS) is associated with a decline of 2.3 percentage points in the share of self-employed among college graduates, which is half of the overall decline since 1985 within this group. Columns (4) to (6) show similar results for the share of self-employed within the group of workers with a high school degree. In this case, the coefficient of column (6) indicates that the observed change in the average wage of workers with a high-school degree (which increased around 20% between 1985 to 2015) correlates with a decline of 1.5 percentage points in the share of self-employed within this education group.

C.4 Additional PSID Results

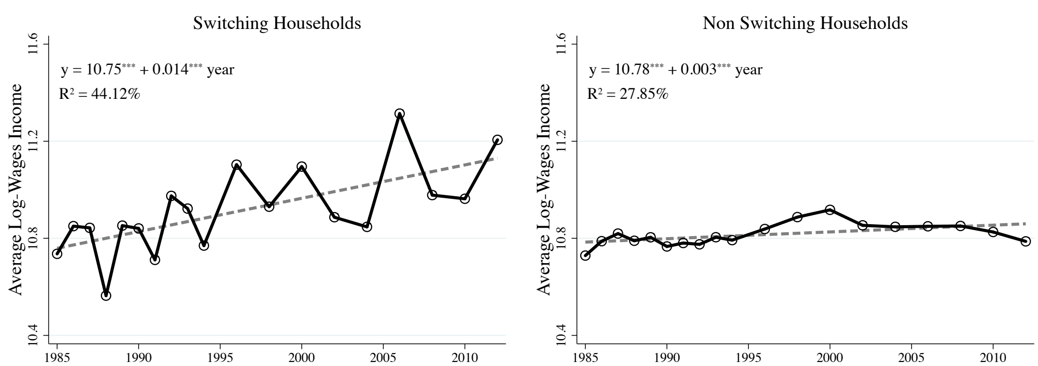
Figure A.16 – Average of Recent Labor Income



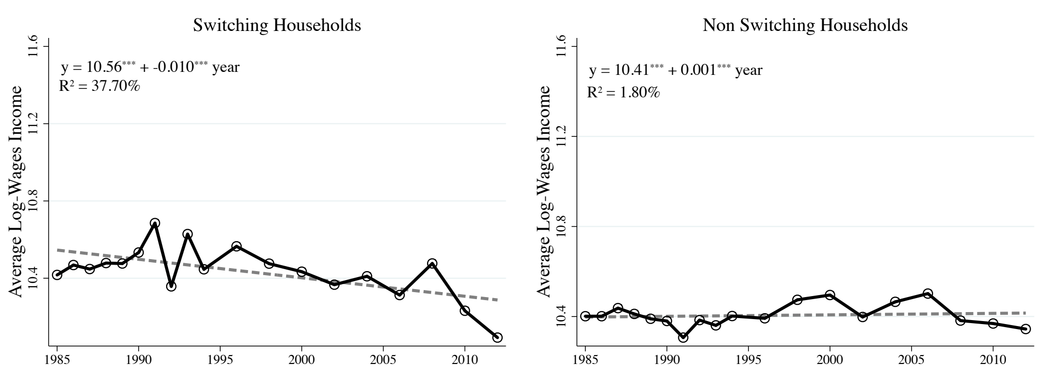
Note: Figure A.16 shows the average (log of) recent labor earnings for a sample of men, heads of household, who are neither a business owner nor self-employed in year t. Recent earnings are defined as the average of the real labor income in periods t, $t-1$, and $t-2$ for years prior 1997 and the average labor income in periods t and $t-2$ after 1997. The left panel shows the average recent earnings within the group of households that become business owners in year $t+2$ while the right panel shows the same statistic for individuals that remain as workers in period $t+2$. The difference in the slope in the left and right panels is statistically significant at 1%.

Figure A.17 – Average Wages and Salaries Income for Workers

(a) Some College or More



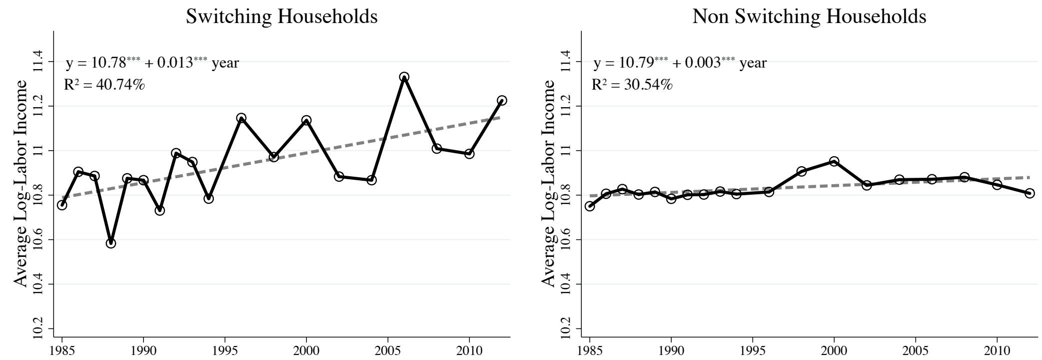
(b) High School Graduates or Less



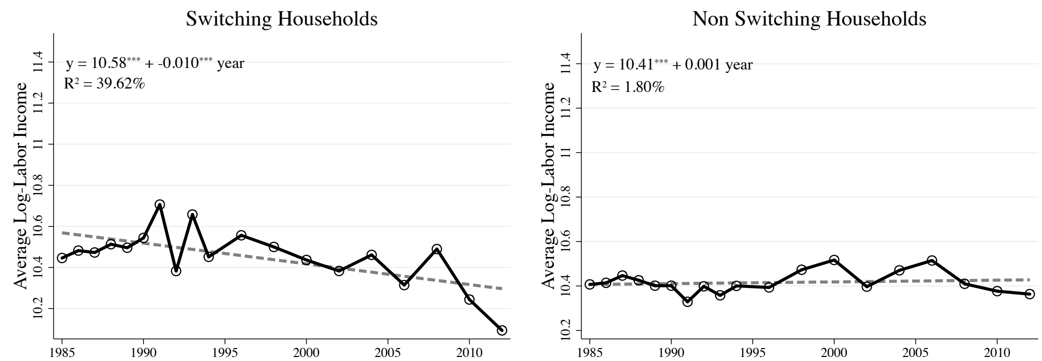
Note: Figure A.17 shows the average log of wages and salaries income of men head household who are neither a business owner nor self-employed in year t from PSID. Top panels show the statistics for college graduates. Bottom panel shows the statistics for workers with some college or less. The left panel shows the average wage within the group of households that become self-employed business owners in year $t+2$ while the right panel shows the same statistic for individuals that remain as workers in period $t+2$.

Figure A.18 – Average Total Labor Earnings for Workers

(a) Some College or More



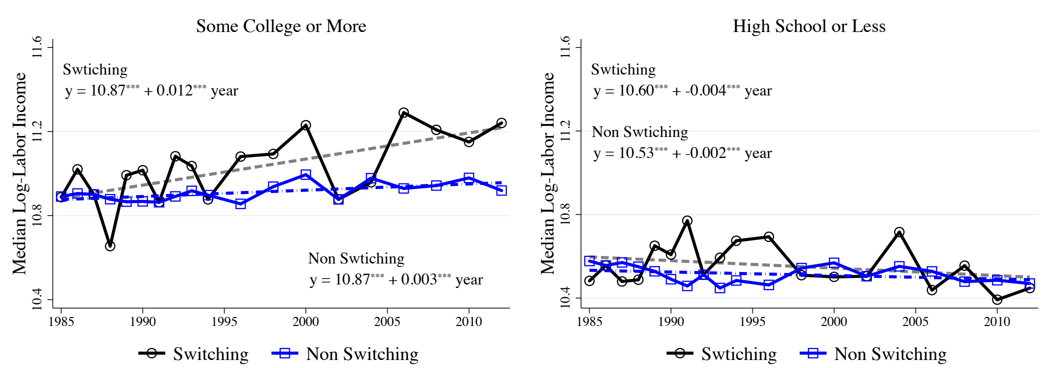
(b) High School Graduates or Less



Note: Figure A.18 shows the average of log labor earnings of men, head household who are neither a business owner nor self-employed in year t from PSID. Recent earnings are defined as the average labor income in periods t, $t-1$, and $t-2$ for years prior 1997 and the average labor income in periods t and $t-2$ after 1997. Top panels show the statistics for college graduates. Bottom panel shows the statistics for workers with some college or less. The left panel shows the average wage within the group of households that become self-employed business owners in year $t+2$ while the right panel shows the same statistic for individuals that remain as workers in period $t+2$.

Figure A.19 – Percentiles of Labor Income For Workers

(a) Median



Note: Figure A.19a shows the median and 90th percentile of log labor earnings of men, head household who are neither a business owner nor self-employed in year t from PSID. Recent earnings are defined as the average labor income in periods t, $t-1$, and $t-2$ for years prior 1997 and the average labor income in periods t and $t-2$ after 1997.

D Static Model

D.1 Model with Capital and Labor

In this Appendix, I discuss the solution of the model of Section 3 which is a simple application of the model of Lucas (1978), extended to consider the effects of a decline in the price of capital and an increase in the productivity of labor.

Lemma 1. *There is a z^* such that $\forall z \geq z^*$ the household becomes an entrepreneur*

Proof. We want to show that the solution of the household's problem implies a z^*-threshold such that for all $z^* \geq z$ the individual becomes an entrepreneur. To show this, consider the first order conditions of the entrepreneurial problem which are given by

$$\begin{aligned}
\frac{\partial \pi}{\partial n} &: z\gamma \left[\left((An)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \right]^{\gamma-1} \frac{1}{\rho} \left((An)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}-1} \rho \left(An \right)^{\rho-1} A - w = 0 \\
\frac{\partial \pi}{\partial k} &: z\gamma \left[\left((An)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \right]^{\gamma-1} \frac{1}{\rho} \left((An)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}-1} \rho k^{\rho-1} - p^k = 0.
\end{aligned}$$

Taking the ratio of the first order conditions we have that

$$\begin{aligned}
\frac{\left((An)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}-1} \left(An \right)^{\rho-1} A}{\left((An)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}-1} k^{\rho-1}} &= \frac{w}{p^k} \\
\frac{k^{\rho-1}}{n^{\rho-1} A^{\rho}} &= \frac{p^k}{w} \\
\frac{k}{n} &= \left(\frac{A^{\rho} p_k}{w} \right)^{\frac{1}{\rho-1}},
\end{aligned}$$

that is, the capital-to-labor ratio, does not depend on the productivity of the entrepreneur, z. Now, we can express $f(n,k) = \left((An)^{\rho} + k^{\rho} \right)^{\rho} \equiv n \left(A^{\rho} + \left(\frac{k}{n} \right)^{\rho} \right)^{1/\rho} \equiv ng(A, k/n)$ and notice that

$$f_k = n g_{k/n} = n \left(A^{\rho} + \left(\frac{k}{n} \right)^{\rho} \right)^{\frac{1}{\rho}-1} \left(\frac{k}{n} \right)^{\rho-1}.$$

and

$$f_n = g(A, k/n) - g_{k/n}(A, k/n) \frac{k}{n}.$$

Then, from the first order condition for capital we have

$$
\begin{aligned}
z\gamma\left[\left((An)^{\rho}+k^{\rho}\right)^{\frac{1}{\rho}}\right]^{\gamma-1}\frac{1}{\rho}\left((An)^{\rho}+k^{\rho}\right)^{\frac{1}{\rho}-1}\rho k^{\rho-1} &= p^{k}\\
\left[\left((An)^{\rho}+k^{\rho}\right)^{\frac{1}{\rho}}\right]^{\gamma-1}\left(n^{\rho}\left(A^{\rho}+\left(\frac{k}{n}\right)^{\rho}\right)\right)^{\frac{1}{\rho}-1}k^{\rho-1} &= \frac{p^{k}}{z\gamma}\\
\left[ng\left(A,k/n\right)\right]^{\gamma-1}\left(n^{\rho}\left(A^{\rho}+\left(\frac{k}{n}\right)^{\rho}\right)\right)^{\frac{1}{\rho}-1}k^{\rho-1} &= \frac{p^{k}}{z\gamma}\\
\left[ng\left(A,k/n\right)\right]^{\gamma-1}\left(A^{\rho}+\left(\frac{k}{n}\right)^{\rho}\right)^{\frac{1}{\rho}-1}n^{1-\rho}k^{\rho-1} &= \frac{p^{k}}{z\gamma}\\
\left[ng\left(A,k/n\right)\right]^{\gamma-1}\left(A^{\rho}+\left(\frac{k}{n}\right)^{\rho}\right)^{\frac{1}{\rho}-1}\left(\frac{k}{n}\right)^{\rho-1} &= \frac{p^{k}}{z\gamma}\\
\left[ng\left(A,k/n\right)\right]^{\gamma-1}g_{k/n} &= \frac{p_{k}}{z\gamma}\\
n &= \frac{1}{g\left(A,k/n\right)}\left(\frac{p_{k}}{z\gamma g_{k/n}}\right)^{\frac{1}{\gamma-1}}.
\end{aligned}
\tag{6}
$$

We can insert expression 6 in the market clearing condition for labor, which is given by

$$
1-G\left(z\right)+\int_{z}^{\infty}n\left(z\right)dG\left(z\right)\leq 1,
$$

which indicates that total labor supply (which is equal to 1), must be less or equal to the fraction of entrepreneurs $(1-G(z))$ and the total demand for labor generated by those entrepreneurs. Replacing 6 we have,

$$
\begin{aligned}
1-G\left(z\right)+\int_{z}^{\infty}n\left(z\right)dG\left(z\right) &= 1\\
\int_{z}^{\infty}\frac{1}{g\left(A,k/n\right)}\left(\frac{p^{k}}{z\gamma g_{k/n}}\right)^{\frac{1}{\gamma-1}}dG\left(z\right) &\leq G\left(z\right)\\
\frac{1}{g\left(A,k/n\right)}\left(\frac{p^{k}}{\gamma g_{k/n}}\right)^{\frac{1}{\gamma-1}}\underbrace{\int_{z}^{\infty}z^{\frac{1}{1-\gamma}}dG\left(z\right)}_{L(z)} &\leq G\left(z\right)\\
\frac{1}{g\left(A,k/n\right)}\left(\frac{p^{k}}{\gamma g_{k/n}}\right)^{\frac{1}{\gamma-1}}L\left(z\right) &\leq G\left(z\right),
\end{aligned}
\tag{7}
$$

which gives an expression for the price of capital,

$$
p_{k}=\frac{1}{\gamma g_{k/n}}\left(g\left(A,k/n\right)\frac{G\left(z\right)}{L\left(z\right)}\right)^{\gamma-1},
\tag{8}
$$

where we have assumed that the labor market clearing condition holds with equality. We can use expression

(8) in the optimal allocation of labor, given by (6), to obtain

$$\begin{aligned}
n &= \frac{1}{g\left(A, k/n\right)} \left(\frac{\frac{1}{\gamma g_{k/n}} \left(g\left(A, k/n\right) \frac{G(z)}{L(z)} \right)^{\gamma - 1}}{z \gamma g_{k/n}} \right)^{\frac{1}{\gamma - 1}} \\
n\left(z\right) &= \left(\frac{1}{z} \right)^{\frac{1}{\gamma - 1}} \left(\frac{G\left(z\right)}{L\left(z\right)} \right), \qquad (9)
\end{aligned}$$

which implies that the optimal labor demand for the entrepreneur of type z does not depend on $g\left(A, k/n\right)$, depends positively on z, and $n\left(z\right) = 0$ since $\gamma < 1$.

We can re-write the profits of the entrepreneur using the first order conditions of labor and capital as follows. First, notice that nw is given by

$$z\gamma \left[\left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \right]^{\gamma - 1} \frac{1}{\rho} \left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho} - 1} \rho \left(An\right)^{\rho - 1} An = wn$$

$$z\gamma \left[\left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \right]^{\gamma - 1} \frac{1}{\rho} \left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \left(\left(An\right)^{\rho} + k^{\rho} \right)^{-1} \rho \left(An\right)^{\rho} = wn$$

$$z\gamma \left[\left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \right]^{\gamma - 1} \left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \left(\left(An\right)^{\rho} + k^{\rho} \right)^{-1} \left(An\right)^{\rho} = wn$$

$$\gamma Y \frac{\left(An\right)^{\rho}}{\left(\left(An\right)^{\rho} + k^{\rho} \right)} = wn. \qquad (10)$$

Second, we can express $p_k k$ as

$$z\gamma \left[\left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \right]^{\gamma - 1} \frac{1}{\rho} \left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho} - 1} \rho k^{\rho - 1} k = p^k k$$

$$z\gamma \left[\left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \right]^{\gamma - 1} \left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho} - 1} k^{\rho} = p^k r k$$

$$z\gamma \left[\left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \right]^{\gamma - 1} \left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \left(\left(An\right)^{\rho} + k^{\rho} \right)^{-1} k^{\rho} = p^k k$$

$$z\gamma \left[\left(\left(An\right)^{\rho} + k^{\rho} \right)^{\frac{1}{\rho}} \right]^{\gamma} \frac{k^{\rho}}{\left(\left(An\right)^{\rho} + k^{\rho} \right)} = p^k k$$

$$\gamma Y \frac{k^{\rho}}{\left(\left(An\right)^{\rho} + k^{\rho} \right)} = p^k k. \qquad (11)$$

We can replace Equations (10) and (11) in the profits of the entrepreneur to obtain

$$\begin{aligned}
\pi\left(z\right) &= z \left[\left(An\right)^{\rho} + k^{\rho} \right]^{\gamma} - \gamma Y \frac{\left(An\right)^{\rho}}{\left(\left(An\right)^{\rho} + k^{\rho} \right)} - \gamma Y \frac{k^{\rho}}{\left(\left(An\right)^{\rho} + k^{\rho} \right)}, \\
\pi\left(z\right) &= z \left[\left(An\right)^{\rho} + k^{\rho} \right]^{\gamma} - \gamma Y \frac{\left(An\right)^{\rho} + k^{\rho}}{\left(\left(An\right)^{\rho} + k^{\rho} \right)}, \\
\pi\left(z\right) &= Y - \gamma Y, \\
\pi\left(z\right) &= \left(1 - \gamma\right) Y,
\end{aligned}$$

and using $g\left(A, k/n\right)$ we have,

$$\pi\left(z\right) = \left(1 - \gamma\right) z \left[n \left(A^{\rho} + \left(k/n\right)^{\rho} \right)^{1/\rho} \right]^{\gamma}. \qquad (12)$$

Using the expression for profits given by (12) and the fact that wages must be equal to the marginal productivity of labor we have, that i

$$z\gamma\left[\left((An)^{\rho}+k^{\rho}\right)^{\frac{1}{\rho}}\right]^{\gamma-1}\frac{1}{\rho}\left((An)^{\rho}+k^{\rho}\right)^{\frac{1}{\rho}-1}\rho\,(An)^{\rho-1}A=w,$$

we can define a function $J(z,A,k/n)$ as

$$\begin{aligned}
J(z,A,k/n) &= (1-\gamma)\,z\left[n\left(A^{\rho}+(k/n)^{\rho}\right)^{1/\rho}\right]^{\gamma}-w\\
&= (1-\gamma)\,z\left[n(z)\,g(A,k/n)\right]^{\gamma}-z\gamma\left[\left((An)^{\rho}+k^{\rho}\right)^{\frac{1}{\rho}}\right]^{\gamma-1}\left((An)^{\rho}+k^{\rho}\right)^{\frac{1}{\rho}-1}(An)^{\rho-1}A \quad (13)\\
&= (1-\gamma)\,z\left[n(z)\,g(A,k/n)\right]^{\gamma}-z\gamma g(A,k/n)^{\gamma-1}\left(g(A,k/n)-g_{k/n}(A,k/n)\frac{k}{n}\right)A\\
&= (1-\gamma)\left[n(z)\,g(A,k/n)\right]^{\gamma}-\gamma g(A,k/n)^{\gamma-1}\left(g(A,k/n)-g_{k/n}(A,k/n)\frac{k}{n}\right)A, \quad (14)
\end{aligned}$$

which is the difference between the value of being an entrepreneur (that receives profits) and the value of being a worker (that receives wages). In the last line, we have rescaled both terms by from $1/z$ which is without loss of generality. Then, since the first term is increasing in z, whereas the second term is constant, standard arguments imply that there is a z^* such that $J(z,A,k/n)\equiv 0$, and for every $z\geq z^*$, the profits are larger than the equilibrium wage in the economy and the household decides to be an entrepreneur. $\square$

Theorem 2. *A decrease in the price of capital p_k, increases z^* if $\rho<0$, reducing the share of entrepreneurs.*

Proof. We want show that z^* increases when p_k decreases. To see this is the case, first notice that a decrease in p_k increases k/n if $\rho<1$ since

$$\frac{\partial k/n}{\partial p^k} = \left(\frac{A^{\rho}}{w}\right)^{\frac{1}{\rho-1}}\frac{1}{\rho-1}\left(p^k\right)^{\frac{1}{\rho-1}-1}$$

which is negative if $\rho<1$. Knowing this, it is sufficient to show that the derivative of z^* with respect to p_k is positive. Consider that for the marginal entrepreneur, the value of $J(z^*,A,k/n)=0$, and can be further simplified to get

$$\begin{aligned}
J(z^*,A,k/n) &= (1-\gamma)\left[n(z^*)\,g(A,k/n)\right]^{\gamma}-\gamma g(A,k/n)^{\gamma-1}\left(g(A,k/n)-g_{k/n}(A,k/n)\frac{k}{n}\right)A\\
&= (1-\gamma)\,n(z^*)^{\gamma}-\frac{\left(g(A,k/n)-g_{k/n}(A,k/n)\frac{k}{n}\right)}{g(A,k/n)}A\\
&= (1-\gamma)\,n(z^*)^{\gamma}-\left(1-\frac{g_{k/n}(A,k/n)\frac{k}{n}}{g(A,k/n)}\right)A.
\end{aligned}$$

Using $g(A,k/n)=\left(A^{\rho}+\left(\frac{k}{n}\right)^{\rho}\right)^{1/\rho}$ we have that the ratio in the second term can be written as

$$\frac{g_{k/n}(A,k/n)\frac{k}{n}}{g(A,k/n)}=\frac{\frac{1}{\rho}\left(A^{\rho}+\left(\frac{k}{n}\right)^{\rho}\right)^{1/\rho-1}\rho\left(\frac{k}{n}\right)^{\rho-1}\frac{k}{n}}{\left(A^{\rho}+\left(\frac{k}{n}\right)^{\rho}\right)^{1/\rho}}=\frac{\frac{k}{n}^{\rho}}{A^{\rho}+\left(\frac{k}{n}\right)^{\rho}},$$

which can be replaced back to get,

$$J\left(z^{*},A,k/n\right) \quad = \quad \left(1-\gamma\right)n\left(z^{*}\right)^{\gamma}-\gamma\left(1-\frac{\frac{k}{n}^{\rho}}{A^{\rho}+\left(\frac{k}{n}\right)^{\rho}}\right)A=0.$$

Then, taking the implicit derivative of z^{*} with respect to k/n we have that

$$\left(1-\gamma\right)\gamma n\left(z^{*}\right)^{\gamma-1}n'\left(z^{*}\right)\frac{\partial z^{*}}{\partial k/n}+\gamma\left(\frac{\rho\frac{k}{n}^{\rho-1}\left(A^{\rho}+\left(\frac{k}{n}\right)^{\rho}\right)-\frac{k}{n}^{\rho}\rho\left(\frac{k}{n}\right)^{\rho-1}}{\left(A^{\rho}+\left(\frac{k}{n}\right)^{\rho}\right)^{2}}\right)A=0$$

$$\frac{\partial z^{*}}{\partial k/n}=-\frac{1}{1-\gamma}\frac{1}{n\left(z^{*}\right)^{\gamma-1}n'\left(z^{*}\right)}\left(\frac{\frac{k}{n}^{\rho-1}A^{\rho}}{\left(A^{\rho}+\left(\frac{k}{n}\right)^{\rho}\right)^{2}}\right)\rho A,$$

which is positive if $\rho<0$. Then, a decrease in p^{k} increases k/n which in turn increases z^{*} decreasing the share of entrepreneurs in the economy. □

Corollary 3. *If $\rho<0$, an increase in A, decreases the share of entrepreneurs in the economy.*

Proof. First, notice that an increase in A increases the capital-to-labor ratio if $\rho<0$ since,

$$\begin{aligned} k/n &= A^{\frac{\rho}{\rho-1}}\left(\frac{p_{k}}{w}\right)^{\frac{1}{\rho-1}}, \\ \partial k/n/\partial A &= \frac{\rho}{\rho-1}A^{\frac{\rho}{\rho-1}-1}\left(\frac{p_{k}}{w}\right)^{\frac{1}{\rho-1}}. \end{aligned}$$

But since $\partial z^{*}/\partial k/n>0$, then an increase in A increases k/n, increasing z^{*} and reducing the share of entrepreneurs in the economy. □

D.2 Model with Capital and Two Labor Skills

A main difference between the model presented in Section 3 and the quantitative model discussed in Section 4 is the presence of heterogeneity on workers skills. In this Appendix, I show that the intuitions from the simple model carry over a case with two skill groups and are in line with the results of the quantitative model, in that a decline in the price of capital, or an increase in productivity that is biased towards the highly skill workers, reduces the population share of entrepreneurs.

I modify the model of Section 3 as follows. Consider a unit mass of workers $H+L=1$ where H and L are the proportions of high- and low- skill workers. This skill applies to their ability to work in the firm and is independent of their entrepreneurial ability, z. Entrepreneurial ability is used to produce an homogeneous good, using a CES production function and individuals choose between being an entrepreneur or being a worker. Workers supply one unit of labor inelastically.

Individuals that decide to be entrepreneur solve the following static problem,

$$\pi\left(z\right) \quad = \quad \max_{n^{H},n^{L},k}\left\{z\left[\left[\left(\left(An^{H}\right)^{\rho}+k^{\rho}\right)^{\frac{\alpha}{\rho}}+\left(n^{L}\right)^{\alpha}\right]^{\frac{1}{\alpha}}\right]^{\gamma}-w^{H}n^{H}-w^{L}n^{L}-p^{k}k\right\}, \qquad (15)$$

where n^{H} and n^{L} are the demand for high and low skill labor respectively, k is the demand for capital, and $\left\{w^{H},w^{L},k\right\}$ are the corresponding prices (the price of the homogeneous good is the numerarie). The first order conditions of the problem in (15) are given by,

$$\begin{aligned}
\frac{\partial \pi}{\partial n^H} &: z\gamma\left[\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}}\right]^{\gamma-1}\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}-1} \\
&\quad \left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}-1}\left(An^H\right)^{\rho-1} A - w^H = 0 \\
\frac{\partial \pi}{\partial n^L} &: z\gamma\left[\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}}\right]^{\gamma-1}\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}-1}\left(n^L\right)^{\alpha-1} - w^L = 0 \\
\frac{\partial \pi}{\partial k} &: z\gamma\left[\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}}\right]^{\gamma-1}\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}-1} \\
&\quad \left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}-1} k^{\rho-1} - p^k = 0.
\end{aligned}$$

Using these conditions, we can show that the ratio of k/n^H and n^H/n^L are independent of z. Taking the first order conditions for k and n^H we get,

$$\frac{z\gamma\left[\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}}\right]^{\gamma-1}\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}-1}\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}-1}\left(An^H\right)^{\rho-1} A}{z\gamma\left[\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}}\right]^{\gamma-1}\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}-1}\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}-1} k^{\rho-1}} = \frac{w^H}{p^k}$$

$$\frac{\left(An^H\right)^{\rho-1} A}{k^{\rho-1}} = \frac{w^H}{p^k}$$

$$\frac{k}{n^H} = \left(\frac{A^\rho p_k}{w^H}\right)^{\frac{1}{\rho-1}}, \tag{16}$$

hence, the capital-to-high skill labor ratio does not depend on the entrepreneur's ability. Similarly, we can take the first order conditions for n^H and n^L to obtain,

$$\frac{z\gamma\left[\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}}\right]^{\gamma-1}\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}-1}\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}-1}\left(An^H\right)^{\rho-1} A}{z\gamma\left[\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}}\right]^{\gamma-1}\left[\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L\right)^\alpha\right]^{\frac{1}{\alpha}-1}\left(n^L\right)^{\alpha-1}} = \frac{w^H}{w^L}$$

$$\frac{\left(\left(An^H\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}-1}\left(An^H\right)^{\rho-1} A}{\left(n^L\right)^{\alpha-1}} = \frac{w^H}{w^L}$$

$$\frac{\left(\left(A^\rho + \left(\frac{k}{n^H}\right)^\rho\right)\left(n^H\right)^\rho\right)^{\frac{\alpha}{\rho}-1}\left(An^H\right)^{\rho-1} A}{\left(n^L\right)^{\alpha-1}} = \frac{w^H}{w^L}$$

$$\frac{\left(\left(A^\rho + \left(\frac{k}{n^H}\right)^\rho\right)\right)^{\frac{\alpha}{\rho}-1}\left(n^H\right)^{\alpha-\rho}\left(n^H\right)^{\rho-1} A^\rho}{\left(n^L\right)^{\alpha-1}} = \frac{w^H}{w^L}$$

$$\frac{\left(\left(A^\rho + \left(\frac{k}{n^H}\right)^\rho\right)\right)^{\frac{\alpha}{\rho}-1}\left(n^H\right)^{\alpha-1} A^\rho}{\left(n^L\right)^{\alpha-1}} = \frac{w^H}{w^L}$$

$$\frac{n^H}{n^L} = \left(\frac{1}{A^\rho}\frac{w^H}{w^L}\right)^{\frac{1}{\alpha-1}}\left(\left(A^\rho + \left(\frac{k}{n^H}\right)^\rho\right)\right)^{\frac{\rho-\alpha}{\rho(\alpha-1)}},$$

which is also independent of z. As we will see later, having the ratio expressed as n^H/n^L will be convenient when analyzing the impact of changes in p^k and A.

Similarly to the simple model of Section 3, a increase in p_k (an increase in A), generates an decrease (increase) in k/n^H of $\rho < 0$. To see this, consider,

$$\begin{aligned}\frac{\partial k/n^H}{\partial p^k} &= \frac{1}{\rho-1}\left(\frac{A^\rho p_k}{w^H}\right)^{\frac{1}{\rho-1}-1}\frac{A^\rho}{w^H} \\ &= \frac{1}{\rho-1}\left(\frac{A^\rho}{w^H}\right)^{\frac{1}{\rho-1}}\left(p^k\right)^{\frac{1}{\rho-1}-1}\end{aligned}$$

which is negative if $\rho < 1$. Similarly, $\frac{\partial k/n^H}{\partial A}$ is given by

$$\begin{aligned}\frac{\partial k/n^H}{\partial A} &= \frac{1}{\rho-1}\left(\frac{A^\rho p_k}{w^H}\right)^{\frac{1}{\rho-1}-1}\frac{p^k}{w^H}\rho A^{\rho-1} \\ &= \frac{\rho}{\rho-1}\left(\frac{A^\rho p_k}{w^H}\right)^{\frac{1}{\rho-1}-1}\frac{p^k}{w^H}A^{\rho-1}\end{aligned}$$

which is positive if $p < 0$.

The share of entrepreneurs in the economy

Now we want to show that a decrease in p_k and an increase in A reduces the share of high skill workers. To see this, define the function

$$J^H(z) = (1-\gamma)z\left[\left[\left(\left(An^H(z)\right)^\rho + k^\rho\right)^{\frac{\alpha}{\rho}} + \left(n^L(z)\right)^\alpha\right]^{\frac{1}{\alpha}}\right]^\gamma - w^H = 0, \tag{17}$$

which implicitly defines z^* which is the value of z that makes an individual indifferent between being a worker or an entrepreneurs. We can replace w^H in Equation (17) to obtain,

$$\begin{aligned}J^H(z) &= (1-\gamma)\left(n^H\right)^\gamma - \gamma\left[\left(A^\rho + \left(\frac{k}{n^H}\right)^\rho\right)^{\frac{\alpha}{\rho}} + \left(\frac{n^H}{n^L}\right)^{-\alpha}\right]^{-1}\left(n^H\right)^{\gamma-1}\left(A^\rho + \left(\frac{k}{n^H}\right)^\rho\right)^{\frac{\alpha}{\rho}-1}A^\rho, \\ &= (1-\gamma)n^H - \gamma A^\rho\frac{\left(A^\rho + \left(\frac{k}{n^H}\right)^\rho\right)^{\frac{\alpha}{\rho}-1}}{\left(A^\rho + \left(\frac{k}{n^H}\right)^\rho\right)^{\frac{\alpha}{\rho}} + \left(\frac{n^H}{n^L}\right)^{-\alpha}}. \end{aligned}\tag{18}$$

Since the first term depends increasingly in z and the second terms is independent of z, we have that there is a z^{H*} such that $J^H\left(z^{H*}\right) = 0$. Using a similar argument, we can show that there is a z^{L*} such that $J^L\left(z^{L*}\right) = 0$ and it is given by

$$J^L(z) = (1-\gamma)n^H(z) - \gamma\frac{\left(\frac{n^H}{n^L}\right)^{1-\alpha}}{\left(A^\rho + \left(\frac{k}{n^H}\right)^\rho\right)^{\frac{\alpha}{\rho}} + \left(\frac{n^H}{n^L}\right)^{-\alpha}}.$$

Now we want to show that a decrease in the price of capital and an increase in the productivity of the high skill workers reduces the share of entrepreneurs among the high skill. This is done in Theorem (4)

Theorem 4. *A decrease in the price of capital, p_k, and an increase in the productivity of high skill workers, A, increases z^* if $\rho < 0$, reducing the share of entrepreneurs who are high skill workers.*

Proof. To see this is the case, we can take implicit differentiation of z^* with respect to k/n^H. This is given by

$$\partial z^*/\partial k/n^H \quad = \quad -\frac{\partial J^H\left(z^*\right)/\partial z^*}{\partial J^H\left(z^*\right)/\partial k/n^H}.$$

The numerator is given by

$$\partial J\left(z^*\right)/\partial z^* \quad = \quad \left(1-\gamma\right) n_z^H,$$

which is positive. The denominator is given by

$$\partial J\left(z^*\right)/\partial k/n^H = A^\rho\gamma\frac{\left(\alpha\left(k/n^H\right)^{\rho-1}\left(A^\rho+\left(k/n^H\right)^\rho\right)^{\frac{\alpha}{\rho}-1}+\frac{\alpha\left(k/n^H\right)^{\rho-1}(\alpha-\rho)\left(\frac{\mathrm{wh}}{A^\rho\,\mathrm{wl}}\right)^{\frac{1}{\alpha-1}}}{\left(A^\rho+(k/n^H)^\rho\right)^{\frac{\alpha-\rho}{\rho(\alpha-1)}+1}(\alpha-1)\left(\frac{\left(\frac{w^H}{A^\rho w^L}\right)^{\frac{1}{\alpha-1}}}{\left(A^\rho+(k/n^H)^\rho\right)^{\frac{\alpha-\rho}{\rho(\alpha-1)}}}\right)^{\alpha+1}}\right)}{\left(A^\rho+(k/n^H)^\rho\right)^{-\frac{\alpha}{\rho}+1}\left(\left(\frac{\left(\frac{w^H}{A^\rho w^L}\right)^{\frac{1}{\alpha-1}}}{\left(A^\rho+(k/n^H)^\rho\right)^{\frac{\alpha-\rho}{\rho(\alpha-1)}}}\right)^{-\alpha}+\left(A^\rho+(k/n^H)^\rho\right)^{\alpha/\rho}\right)^2}$$

$$-\frac{A^\rho\gamma\left(k/n^H\right)^{\rho-1}\rho\left(A^\rho+\left(k/n^H\right)^\rho\right)^{\frac{\alpha}{\rho}-2}\left(\frac{\alpha}{\rho}-1\right)}{\frac{1}{\left(\left(A^\rho+(k/n^H)^\rho\right)^{-\frac{\alpha-\rho}{\rho(\alpha-1)}}\left(\frac{w^H}{A^\rho w^L}\right)^{\frac{1}{\alpha-1}}\right)^\alpha}+\left(A^\rho+(k/n^H)^\rho\right)^{\alpha/\rho}},$$

which is negative if $\rho<0$ and $\alpha>0$. Given this, $\partial z^*/\partial k/n^H>0$ which implies that a decrease in p_k, that in turn increases k/n^H, increases z^* hence reducing the share of entrepreneurs among those that are high skill. Similarly, an increase in A which increases k/n^H, increases z^* also reducing the share of entrepreneurs. □

As a corollary of Theorem (4), we can show that the share of entrepreneurs that are low skill also decline.

Corollary 5. *A decrease in the price of capital, p_k, and an increase in the productivity of high skill workers, A, increases z^* if $\rho<0$, reducing the share of entrepreneurs who are low skill workers.*

Proof. The implicit derivative of z^* with respect to k/n^H on $J^L(z)$ is given by $\partial z^*/\partial k/n^H=-\frac{\partial J^L(z^*)/\partial z^*}{\partial J^L(z^*)/\partial k/n^H}$. The numerator positive. The denominator is given by

$$\partial J^L\left(z^*\right)/\partial k/n^H = \frac{\gamma\left(\alpha\left(k/n^H\right)^{\rho-1}\left(A^\rho+\left(k/n^H\right)^\rho\right)^{\frac{\alpha}{\rho}-1}+\frac{\alpha\left(k/n^H\right)^{\rho-1}(\alpha-\rho)\left(\frac{\mathrm{wh}}{A^\rho\mathrm{wl}}\right)^{\frac{1}{\alpha-1}}}{A^\rho+(k/n^H)^\rho{}^{\frac{\alpha-\rho}{\rho(\alpha-1)}+1}(\alpha-1)\left(\frac{\left(\frac{\mathrm{wh}}{A^\rho\mathrm{wl}}\right)^{\frac{1}{\alpha-1}}}{\left(A^\rho+(k/n^H)^\rho\right)^{\frac{\alpha-\rho}{\rho(\alpha-1)}}}\right)^{\alpha+1}}\right)}{\left(\left(\frac{\left(\frac{\mathrm{wh}}{A^\rho\,\mathrm{wl}}\right)^{\frac{1}{\alpha-1}}}{\left(A^\rho+(k/n^H)^\rho\right)^{\frac{\alpha-\rho}{\rho(\alpha-1)}}}\right)^{-\alpha}+\left(A^\rho+(k/n^H)^\rho\right)^{\alpha/\rho}\right)^2\left(\frac{\left(\frac{\mathrm{wh}}{A^\rho\mathrm{wl}}\right)^{\frac{1}{\alpha-1}}}{\left(A^\rho+(k/n^H)^\rho\right)^{\frac{\alpha-\rho}{\rho(\alpha-1)}}}\right)^{\alpha-1}}$$

$$-\frac{\gamma\left(k/n^H\right)^{\rho-1}(\alpha-\rho)\left(\frac{\mathrm{wh}}{A^\rho\mathrm{wl}}\right)^{\frac{1}{\alpha-1}}}{\left(\left(\frac{\left(\frac{\mathrm{wh}}{A^\rho\mathrm{wl}}\right)^{\frac{1}{\alpha-1}}}{\left(A^\rho+(k/n^H)^\rho\right)^{\frac{\alpha-\rho}{\rho(\alpha-1)}}}\right)^{-\alpha}+\left(A^\rho+(k/n^H)^\rho\right)^{\alpha/\rho}\right)\left(A^\rho+(k/n^H)^\rho\right)^{\frac{\alpha-\rho}{\rho(\alpha-1)}+1}\left(\frac{\left(\frac{\mathrm{wh}}{A^\rho\mathrm{wl}}\right)^{\frac{1}{\alpha-1}}}{\left(A^\rho+(k/n^H)^\rho\right)^{\frac{\alpha-\rho}{\rho(\alpha-1)}}}\right)^\alpha},$$

which is negative for $\rho < 0$ and $\alpha > 0$. Given this, $\partial z^*/\partial k/n^H > 0$ which implies that a decrease in p_k, that in turn increases k/n^H, increases z^* hence reducing the share of entrepreneurs among those that are low skill. Similarly, an increase in A which increases k/n^H, increases z^* also reducing the share of entrepreneurs. $\square$

These results indicate that, in partial equilibrium, a decrease in p_k and a increase in A will reduce the total share of entrepreneurs in the economy. The results of the quantitative model, however, indicate that the share of high skill individuals who become entrepreneurs has a large response to changes in p_k and A, and that the responds of low skill individuals is is weaker. In fact, in my quantitative exercise, most of the decline in the share of entrepreneurs who are low skill is driven by the decrease in the share of these individuals in the population, while the changes in p_k and A have little impact on the share of low skill entrepreneurs. We can see this also in the simple model described here. Panel A of Figure A.20 shows the share of entrepreneurs in the population (y-axis) over different levels of p_k (x-axis), and for different levels of A, the lines. In this exercise I used the same set of parameters used in the quantitative model. In particular, $\rho = -0.495$ and $\alpha = 0.401$. Clearly, the increase, lower prices imply a smaller share of entrepreneurs (moving from right to left in the plot). Similarly, low A implies higher share of entrepreneurs in the economy relative.

All this decline is accounted for the share of high skill entrepreneurs, which is shown in Panel B of Figure (A.20). As in the aggregate, a decline in the price of capital, reduces the share of entrepreneurs. An increase in A also reduces the share high skill workers who become entrepreneurs (compare dashed with solid line).

For the low skill individuals—panel C of Figure (A.20)—we find the opposite: higher prices and high productivity increase the share of entrepreneurs. This is because a decrease in prices increases the wages for high entrepreneurs—because of the complementarity between capital and high skill labor—but decreases the wage of low skill individuals. Firms are more profitable with lower prices, which motives more individuals to become entrepreneurs. Similarly, high productivity increases profits, inducing more individuals to become entrepreneurs. This general equilibrium effect pushes more low skill into entrepreneurship. This might seem at odds with the results of the quantitative model. However, an important element is missing of this analysis: the relative decrease in the supply of low skill labor. This balances out the decreases in wages for low skill individuals due to changes in productivity, pushing a larger share of individuals out of entrepreneurship.

E The Algorithm

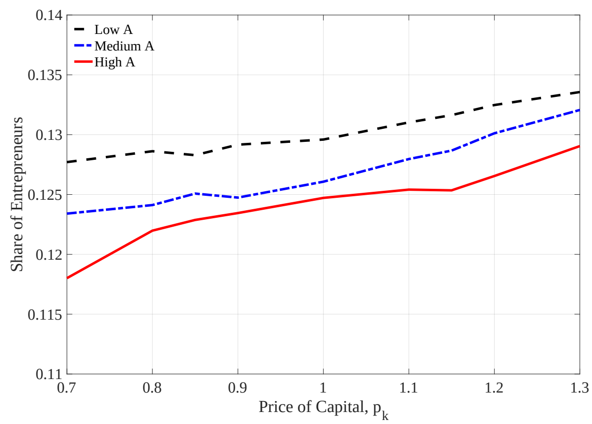
The solution of the model implies calculating an initial and final steady states, and the complete transition path of aggregate states and factor prices, given the exogenous sequences of p_t^k, H_t, and $A_{H,t}$. On top of the well known complications of solving heterogenous agents models, the present model requires finding a combination of three time series of prices that simultaneously clear the markets for capital, high skill labor, and low skill labor. Although in my baseline model I consider a fixed interest rate, here I describe a more general algorithm that solves the model when the interest rate is obtained in general equilibrium Section F.

To solve the steady state of the economy I proceed as follows. Consider that the economy is at the steady state in $t = 0$ and $p_t^k = p_0^{ss} = 1$, $H_t = \overline{H}$, and $A_t^H = 1$. Individuals expect this vector of aggregate states variables to remain constant forever. Then, given this aggregate vector, the algorithm to find the stationary equilibrium is as follows,

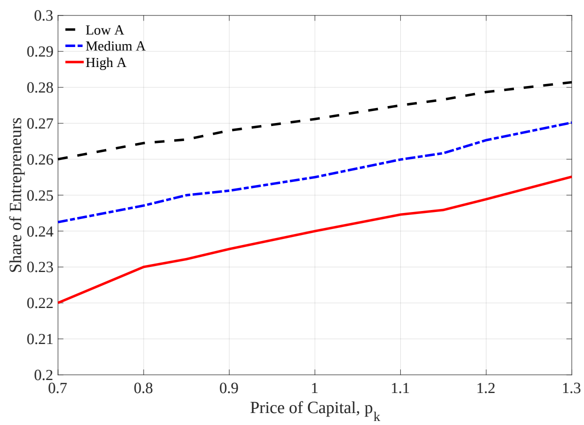
- S0: Guess a vector of prices $\{\tilde{\omega}_H, \tilde{\omega}_L, \tilde{r}\}$ and solve the problem of the households in 2, that is, solve the profit maximization problem of the entrepreneurs, and get the corresponding policy rules and factor demands for the households. To solve the problem of the households I use Value Function Iteration searchings continuously over the asset space.

Figure A.20 – Share of Entrepreneurs and Price of Capital

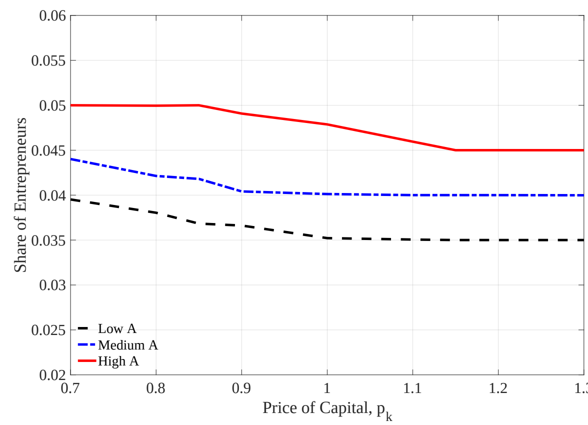
(A) Share of Entrepreneurs



(B) Share of Entrepreneurs Among High Skill



(C) Share of Entrepreneurs Among Low Skill



- S1: Given an initial distribution of individuals over idiosyncratic states, μ_t, iterate until convergence and calculate the aggregate demand of capital, high skill labor, and low skill skilled labor coming from the entrepreneurs. Denote these by $K^{D,e}, N_H^{D,e}$, and $N_L^{D,e}$ respectively. Calculate also the aggregate supplies of capital, and each type of labor, K^S, N_H^S, and N_L^S.

- S2: Calculate the demands of high and low skilled labor of the non-entrepreneurial sector as the residual supply after subtracting the demands for the entrepreneurial sector, that is $N_H = N_H^S - N_H^{D,e}$ and $N_L = N_L^S - N_L^{D,e}$. If these result in negative supplies, go to S0 and guess a new set of prices with a larger value of the wages.

- S3: If the residuals demands of labor are positive in S2, use the first order condition of the problem of the non-entrepreneurial sector to find K, that is, solve the nonlinear expression, $p_{ss,0}\left(\tilde{r}+\delta\right) - F_K\left(N_{H,}, N_L, K^C\right) = 0$.

- S4: Using N_H and N_L from S2 and K^C from S3, check the three following conditions,

  - $\tilde{\omega}_H - F_H\left(N_H, N_L, K\right)$,
  - $\tilde{\omega}_L - F_L\left(N_H, N_L, K\right)$,
  - $K^S - K^C + K^{D,e}$

If the sum of the last three expressions is greater than 10^{-6}, go to $S0$ using a new guess of prices. If not, the equilibrium set of policy functions, value functions, prices, and stationary distribution of individuals over idiosyncratic states has been found.

Notice that we could calculate in S2 the residual demand of capital for the corporate sector, and go to S4 to check $\tilde{r} = F_K\left(N_{H,}, N_L, K^C\right) - \delta$. In practice, I have found that the previous algorithm is much more stable since it avoids iterating over the interest rate. I repeat these same steps both for the initial and final steady states, changing only the value of the aggregates, p_t^k, $A_{H,t}$, and H_t.

To calculate the transition path of the economy between the initial and final steady states requires taking a stand of what do the households know about the evolution of the economy from period 0 to the infinite future. Here, we can take two extremes cases. One can either assume, as in the baseline case, that individuals have perfect foresight about the full equilibrium path of prices and aggregate states, or one can assume that individuals are myopic in the sense that they are surprised by the change of the relative price of investment goods and perceive that such price will remain fixed forever. Here I describe both algorithms in detail.

Perfect Foresight Case. Given a sequence of aggregate states $\Theta_t = \left\{p_t^k, A_t^H, H_t\right\}_{t=0}^T$ and a fixed value of the vector after T periods, $\Theta_T = \left\{p_T^k, A_T^H, H_T\right\}$ for all $t > T$, I proceed as follows,

- P0: take $\Theta_t = \Theta_0$ and $\Theta_t = \Theta_T$ and calculate the corresponding stationary equilibrium recording the equilibrium prices, and value functions. Denote the stationary distribution of the first steady state as $\mu_{ss,1}$.

- P1: Guess a path of prices $\left\{\tilde{\omega}_t^H, \tilde{\omega}_t^L, \tilde{r}_t\right\}_{t=1}^{t=T}$ which is fully observed by the agents at the end of period $t = 0$,

- P2: Starting in period $T-1$, take the continuation values of the problem of the households as given and solve

$$V_{T-1}\left(a_{T-1}, z_{T-1}, y_{T-1}, d_{T-2}\right) = \max_{c_{T-1}, a_T} \left\{ \frac{c_{T-1}^{1-\sigma}}{1-\sigma} + \beta\left[\chi \mathbb{E}_{z'|z,y'|y} V_T^s\left(a_T, z_T, y_T, e_T\right) + (1-\chi) \sum_{j\in\{H,L\}} \zeta_{s,s} \mathbb{E} V_T^s\left(a_T, z_T, y_T, e_T\right)\right]\right\}$$

$$c_{T-1} + a_{T-1} \leq \left(1 + \tilde{r}_{T-1}\right) a_{T-1} + \pi_s\left(z_{T-1}, a_{T-1}\right) - \mathbb{I}\left(d_{T-2} = w\right)\kappa,$$

on a grid of $a's$, $z's$, and $y'z$. Do the same for workers, and record the value functions, V_{T-1}. Notice that, to reduce the notation, I have omitted the i subscript in the endogenous idiosyncratic states.

- P3: Go to period $T-2$, take V_{T-1} as given, and solve the problem entrepreneurs and workers in $T-2$ recording the continuation values. Continue until $t = 1$.

This generates a path of value functions that are consistent with $\left\{\tilde{\omega}_t^H, \tilde{\omega}_t^L, \tilde{r}_t\right\}_{t=1}^{t=T}$. Notice, however, that *these are not the equilibrium prices.* To find the equilibrium prices now we need to iterate forward, taking the initial distribution as given, and solving for the equilibrium prices in every period. Notice that in going forward, we shall not use the guessed set of prices. To iterate forward, I proceed as follows.

- F1: Given $\mu_0 = \mu_{ss,1}$ and the continuation values, V_1^s for $s = \{H, L\}$, solve for a new set of prices $\left\{\omega_1^H, \omega_1^L, r_1\right\}$ that clears the markets and record the resulting μ_1 *without using the guessed sequence of prices*

- F2: To solve the equilibrium in a given period
  - (A) Guess $\{\hat{\omega}_1^H, \hat{\omega}_1^L, \hat{r}_1\}$ and solve the problem of the agents
  - (B) Given μ_0 and the policy functions, calculate the excess demand and check market clearing as in S4
  - (C) If prices clear the markets (tolerance 10^{-5}) stop, record the new equilibrium prices and the results distribution, μ_2 and go to the next period,
  - (D) Otherwise, guess a new set of prices and go to (A)

- F3: Proceed in the same way until period T to generate a new path of *equilibrium prices,* $\{\omega_t^H, \omega_t^L, r_t\}_{t=1}^{t=T}$. Compare them with $\{\tilde{\omega}_t^H, \tilde{\omega}_t^L, \tilde{r}_t\}_{t=1}^{t=T}$ if the maximum distance is greater than 10^{-4}, take a weighted average of the series as a new guess and go to S1, stop other wise

Upon completion, we have found a path of prices, continuation values, policy function, and distributions that are consistent with the equilibrium along the time series of $\{\Theta_t\}_{t=0}^{T}$. Given that the algorithm needs to find a vector of three prices in each period which is consistent with market clearing it requires very good initial conditions. I have found that the standard method of starting with a linear trend of prices between the initial and last steady states works quite poorly. Instead, calculating the stationary equilibrium for several points on the path of $\{\Theta_t\}_{t=0}^{T}$ and using a linear path between these points ensure a faster, more accurate, solution.

Myopic Case. Alternatively, we can assume that individuals are surprised every period by the changes of the exogenous process of Θ_t and every time they see a new aggregate vector, they perceive this as remain fixed for the infinite future. To solve the transition in this case, I proceed as follows.

- M1: Solve the initial steady state of the economy with $\Theta_t = \Theta_0$ and save the steady state distribution, μ_0

- M2: Go to period $t = 1$ with Θ_1 and assume that individuals think that $\Theta_t = \Theta_1$ for all t, and solve for the equilibrium prices as follows, Guess a vector of $\{\hat{\omega}_1^H, \hat{\omega}_1^L, \hat{r}_1\}$, solve the household's problem, and record the policy functions. Here we can use value function iteration because future is perceived as "the same" by the agents.
  - Taking μ_0 and given and the policy functions, check the equilibrium conditions for capital and labor as in S4 above. If they hold, then we have found the equilibrium prices. If not, guess a new set of prices.

- M3: When the prices have been found, update μ_0 to μ_1 and

- M4: Go to period $t = 2$ and start again in point M2, and proceed until the entire transition path is completed.

This generates a new path of equilibrium prices and a distribution of agents over idiosyncratic states.

Some additional details on the numerical implementation of the model are important. The problem of the households is large and contains several state variables that one needs to keep track of. To maintain tractability I choose a coarse grid of 7 points in the labor productivity, y, and a denser grid of 11 points for the entrepreneurial ability, z. Both stochastic processes are discretized using a modified version of the Tauchen (1986) method. In the particular case of z, since most of the action in terms of switching between occupations happen at the upper end of the distribution of z, I place more point in that area of the grid. In other words, I do not choose a equally spaced grid for the z process. Finally, for the grid of assets, I choose a corse grid of 205 points. Because the Value Function has kinks at the points of occupational switching, I solve the problem using Value Function Iteration to ensure the accuracy of the solution. For the same reason, I solve the equilibrium of the model simulating the PDF of the distribution of individuals over the idiosyncratic distribution. The main challenge of solving the model is finding the vector of prices that clear the labor and capital markets. There is no clear guidance to solve such non linear system of equations that involves aggregating the individuals' decisions. Consequently, I trade accuracy for speed. I found that solving first the steady state in each of the transition gives excellent initial conditions for solving the problem along the transition path.

F Model Extensions and Robustness

In this section, I discuss several alternative specification of the quantitative model discussed in the main body of the paper.

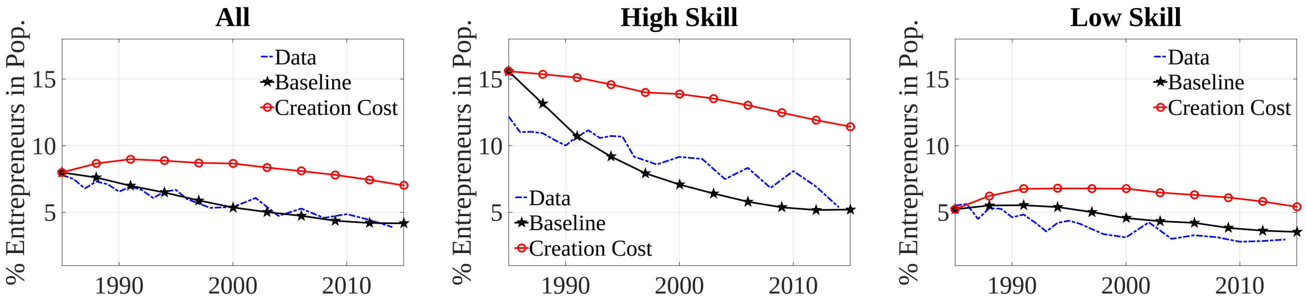
Firm Creation Cost

A possible explanation for the decrease in new business formation is the increasing cost of regulation in the United States, which affects existing and potential entrepreneurs. The cost of regulation is difficult to measure. One proxy for this cost is the number of restrictions in the administrative code. Al-Ubaydli and McLaughlin (2017) provide an estimate of the number of restrictions and words that indicate that a specific action is prohibited or required for firms. Using this dataset, I find that the average number of restrictions within 2-digit NAICS industries grew 75% from 1985 to 2015. Arguably, an increase in the regulatory burden would deter firm creation in a similar way of an increase in the value of κ, the creation cost in the problem of the entrepreneurs, would. Hence, in this section I ask, what is the level of κ that generates the same proportion of entrepreneurs in 2014 conditional on the parameter values and values of the aggregates series as in 1985? I find that the value of κ required to reduce the proportion of entrepreneurs to the level observed in 2014 is almost seven times the value of κ in my baseline exercise. Denote this new level of the entry cost by $\tilde{\kappa}$. Next, I study the model transition generated by a linearly increasing trend of the entry cost. As in my previous exercise, I assume that the economy is at a stationary equilibrium in 1985. Then, the agents learn the entire sequence of κ_t. I assume that κ_t increases between 1985 and 2015 and remains fixed at the value in 2015 for the rest of the transition. For the initial value of κ_t, I take the level used in my baseline calibration, and for the terminal level, I choose $\tilde{\kappa}$.

The left panel of Figure A.21 shows the evolution of the population share of entrepreneurs resulting from an increase in the cost of firm creation. To facilitate the comparison with the baseline results, the Figure A.21 also displays the evolution of the population share of entrepreneurs in my baseline exercise and the population share of entrepreneurs in the data. First, notice that the decline in the share of entrepreneurs implied by an increase in κ_t is more moderate than the decline observed in the data. This is because, in anticipation of higher future costs, some households decide to transition earlier into entrepreneurship, raising the share of entrepreneurs above the original stationary level. The increase in the share of entrepreneurs is mostly explained by the response of low skill individuals as shown in the right panel of Figure A.21. The center panel displays the evolution of the share of high skill entrepreneurs, which is flatter relative to the evolution implied by my baseline exercise. In summary, an increasing cost of regulation, in the form of an increase in the cost of firm creation, generates a small decline in the share of entrepreneurs along the transition and does not seem to account for the rapid decrease in the share of entrepreneurs among high skill individuals.[32]

[32]These results might overestimate the real effect of the increase in the entry cost in my model. If one takes the entry cost as a proxy for the cost of regulation imposed by the tax code and other mandatory rules that firms need to follow, then the entry cost must have increased only 75% based on my calculations using the data collected by Al-Ubaydli and McLaughlin (2017). In such a case, keeping the rest of the parameters as in 1985, my model would predict a decrease of 0.5 percentage point in the share of entrepreneurs, much less than the drop of 3.9 percentage points observed in the data.

Figure A.21 – Effects of an Increase of the Cost of Firm Creation, κ



Note: The left panel of Figure A.21 shows the share of entrepreneurs implied by a linear increase in the cost of creating a firm (κ). The center and right panel show same statistics within the group of low and high skill households.

Borrowing Constraints

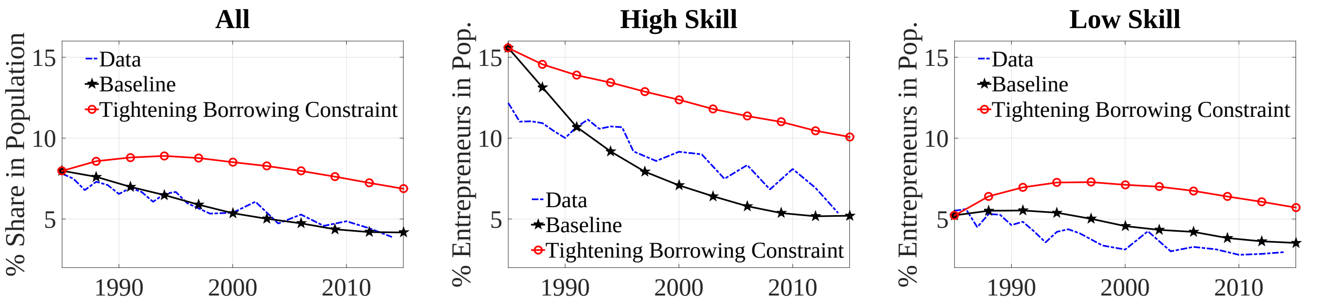
A tightening of the borrowing constraint could also generate a decrease in the share of entrepreneurs. There are at least two possible problems for such channel to be quantitatively relevant. First, given the large increase of house prices observed before the Great Recession, it is unlikely that the borrowing constraints have tightened over time, as many entrepreneurs use their house as a collateral to start a firm. Moreover, if the borrowing constraints have become tighter, then one would expect that the rate at which households and entrepreneurs get rejected by a financial institution when asking for a loan to increase. However, data from the Survey of Consumer Finances (SCF) shows that the rate of rejection has decreased, if anything, across the population in general, and for entrepreneurs in particular. Specifically, the share of households whose head is between 22 and 60 years old that asked for a credit but where rejected has remained constant around 25% since 1989. For entrepreneurs, the rate of rejection declined from 25% in 1992 to less than 15% in 2016. Separating the sample in different age groups or considering heads of households more than 60 year old does not change this result. Alternatively, it is possible that individuals do not get rejected because they never asked for a credit in the first place. The SCF provides information on the share of households (entrepreneurs) that did not ask for a credit because they expected to be reject by the financial institution. Similarly to the rejection rate, the share of households that did not ask for a credit because they expected a rejection has remained constant around 15% (12% within entrepreneurs) between 1989 to 2007, increased during the Great Recession, and then declined again in 2016.

Second, in the context of my model, a tightening of the borrowing constraint is inconsistent with the decrease in the share of low skill entrepreneurs observed in the data. In fact, the model predicts an increase in the share of entrepreneurs within this group following a decline in the value of λ. Figure A.22 shows the time series of the share of entrepreneurs under the assumption that the value of λ decreases by a third between 1985 and 2015, keeping fixed the rest of the parameters as in 1985. In this case, the population share of entrepreneurs declines by half, mostly because of the decrease in the share of high skill entrepreneurs. However, within the group of low skill individuals, the share of entrepreneurs increases over time. This differential response is explained by the differences in managerial ability of high and low skill individuals. Because high skill individuals are relatively more productive as entrepreneurs, they run larger firms that require more resources. Therefore, a tightening of the borrowing constraint affects them the most, whereas the effect for low skill individuals is weaker because they are less able as managers and run smaller firms.

Collateral Constraint

In the baseline version of my model entrepreneurs require working capital to run their firms and they can borrow resources up to a fraction $\lambda > 1$ of their own wealth, a. This assumption was made to have an interesting policy comparison. In this section I consider a more standard assumption. Entrepreneurs are not required to pay workers in advance but borrow to rent capital up to λa_t. The problem of the workers does not change, but the problem of the entrepreneurs changes to

Figure A.22 – Effects of a Tightening of the Borrowing Constraints, λ



Note: The left panel of Figure A.22 shows the share of entrepreneurs implied by a linear decrease in the value of λ. The center and right panel show same statistics within the group of low and high skill households.

$$V^e_{s,t}\left(\Omega_t,\Theta_t,\mu_t\right) = \max_{c_t,a_{t+1}} \left\{ \frac{c_t^{1-\sigma}}{1-\sigma} + \beta \left[\chi \mathbb{E}_{z_{t+1}|z_t,y_{t+1}|y_t} V_{s,t+1}\left(\Omega_{t+1},\Theta_{t+1},\mu_{t+1}\right) + \right.\right.$$
$$\left.\left. (1-\chi)\,\eta \sum_{j\in\{H,L\}} \zeta_{s,j} \mathbb{E} V_{s,t+1}\left(\Omega_{t+1},\Theta_{t+1},\mu_{t+1}\right) \right]\right\}, \quad (19)$$

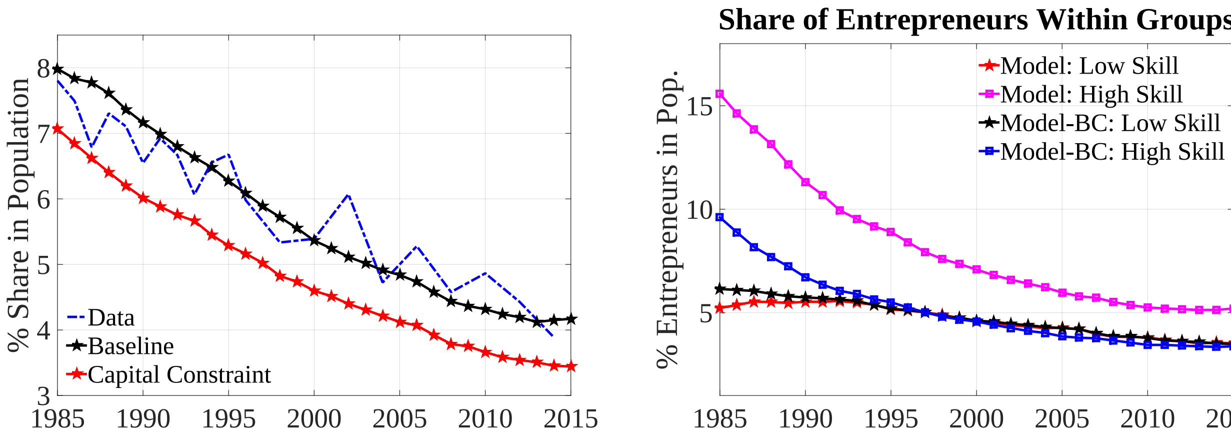
$$\pi_{s,t}\left(z_t,a_t\right) = \max_{n_{H,t},n_{L,t},k_t} \left\{ z_t\theta_s \left[f\left(n_{H,t},n_{L,t},k_t\right)\right]^\gamma - p_{k,t}\left(r+\delta\right)k_t - \right.$$
$$\left. \omega_{H,t}\left(\Theta_t,\mu_t\right)n_{H,t} - \omega_{L,t}\left(\Theta_t,\mu_t\right)n_{L,t} \right\},$$

$$c_t + a_{t+1} \leq \left(1+r\left(\Theta_t,\mu_t\right)\right)a_t + \pi_{s,t}\left(z_t,a_t\right) - \mathbb{I}\left(d_{t-1}=w_{t-1}\right)\kappa,$$
$$p_{k,t}k_t \leq \lambda a_t, a_{t+1} \geq 0,$$

where all the notation follows from the main body of the paper. The first thing to notice is that written in this, the equilibrium of this economy is constrained efficient. Notice this is not the case of the original problem because wages appear in the borrowing constraint. In such case the decentralized equilibrium does not necessarily coincide with planner's solution as the latter internalized the fact that choosing a different allocation, it relaxes the borrowing constraint, moving the economy closer to the efficient optimum. This is not the case with the problem in Equation 19 as the value of $p_{k,t}$ is assumed to be exogenous and therefore is not part of the choice of the planner.

The second thing to notice is that the borrowing constraint relaxes over time as p^k_t decreases. Everything else equal, a decrease in the relative price of capital would induce more individuals to start a firm, increasing the share of entrepreneurs in the economy. Still, because of the general equilibrium effects and the effects of A^H_t and H_t, the decrease in the share of entrepreneurs is quite similar to my baseline results in section 5. The left panel of Figure A.23 shows decline almost does not change in this case relative to the data an and the baseline results. However, because I am using the same set of parameters used in my baseline exercise, the level of the share of entrepreneurs is lower in this case. The right panel shows that the distribution within skill groups changes substantially. Notice also that the share of entrepreneurs declines in this case. This is because, with a more relaxed borrowing constraint, entrepreneurs can operate even closer to their optimal level. General equilibrium will increase even more the wages, reducing the

Figure A.23 – Evolution of the Share of Entrepreneurs



Note: The left panel of Figure A.23 shows the evolution of the share of entrepreneurs as calculated from the PSID data (blue dashed line) and the share of entrepreneurs implied by the baseline model (black-starred line) and by the model with a more standard borrowing constraint $p_{k,t}k_t \leq \lambda a_t$. The right panel shows the share of entrepreneurs within skill group implied by the model. Lines labeled as Baseline correspond to the basic results. Lines labelled as Model-BC consider the modified borrowing constraint.

share of entrepreneurs in the economy.

Myopic Transition

In the baseline case, I have assumed that agents have perfect foresight about the future path of the aggregate state of the economy. Alternatively, one could consider that agents are surprised every period about changes in the aggregate variables and expect that the current state of the economy to remain fixed for the infinite future. In this sense, agents are perfectly *myopic*. This assumption does not change the equilibrium definition, but it does modify the information set available for the agents. Hence, one needs to change the solution algorithm accordingly.[33] The top left panel of Figure A.25 shows the evolution of the fraction of entrepreneurs in this case, along with the time series for the perfect foresight case and the share of entrepreneurs calculated from the data. Overall, the evolution of the share of entrepreneurs is quite similar, both qualitatively and quantitatively. Relative to the perfect foresight case, the overall fall in the share of entrepreneurs and the speed of decline remain basically unchanged if one assumes that entrepreneurs learn every period about the current aggregate state of the economy. Therefore, I conclude that assuming perfectly myopic agents does not affect the results of my model.

Smooth Transition of Aggregates

How would my results change under an alternative assumption about the evolution of the aggregates after 2015? To answer this question, I assume that the price of capital goods, the relative productivity of high skill workers, and the supply of high skill workers all keep a constant growth rate equal to the average growth rate observed during the period 2005-2015. I assume the growth rate of each trend declines geometrically to reach 0 growth in 2035. The upper right panel of Figure A.25 shows that the share of entrepreneurs and the decline implied by the model remain basically the same as in my baseline results.

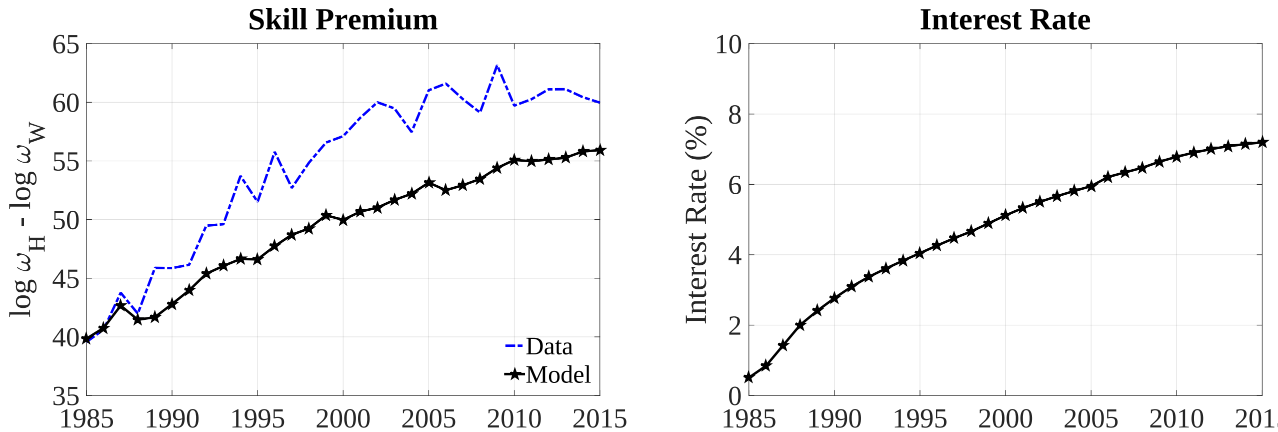
General Equilibrium

In the baseline results, I have assumed a fixed interest rate. This was with the explicit purpose of highlighting the effects of the change in wages on the decision to become an entrepreneur while muting the general equilibrium effect of the change in the interest rate on the production cost and individuals' savings. In this section, I study how my results change if I solve for the equilibrium interest rate along with the wages of high and low skill workers.[34] The bottom left panel of Figure A.25 shows the evolution

[33] Appendix E explains in detail the algorithm used to solve the transition path in this case.

[34] Since this is now a closed economy, one needs to pin down a particular value of capital-to-output ratio at the initial steady state. I do that by choosing value of β to that the capital-to-output ratio is equal to three in the

Figure A.24 – College Premium and Interest Rate in GE



Note: Figure A.24 shows the evolution of the skill premium and interest rate implied by the mode in the general equilibrium case.

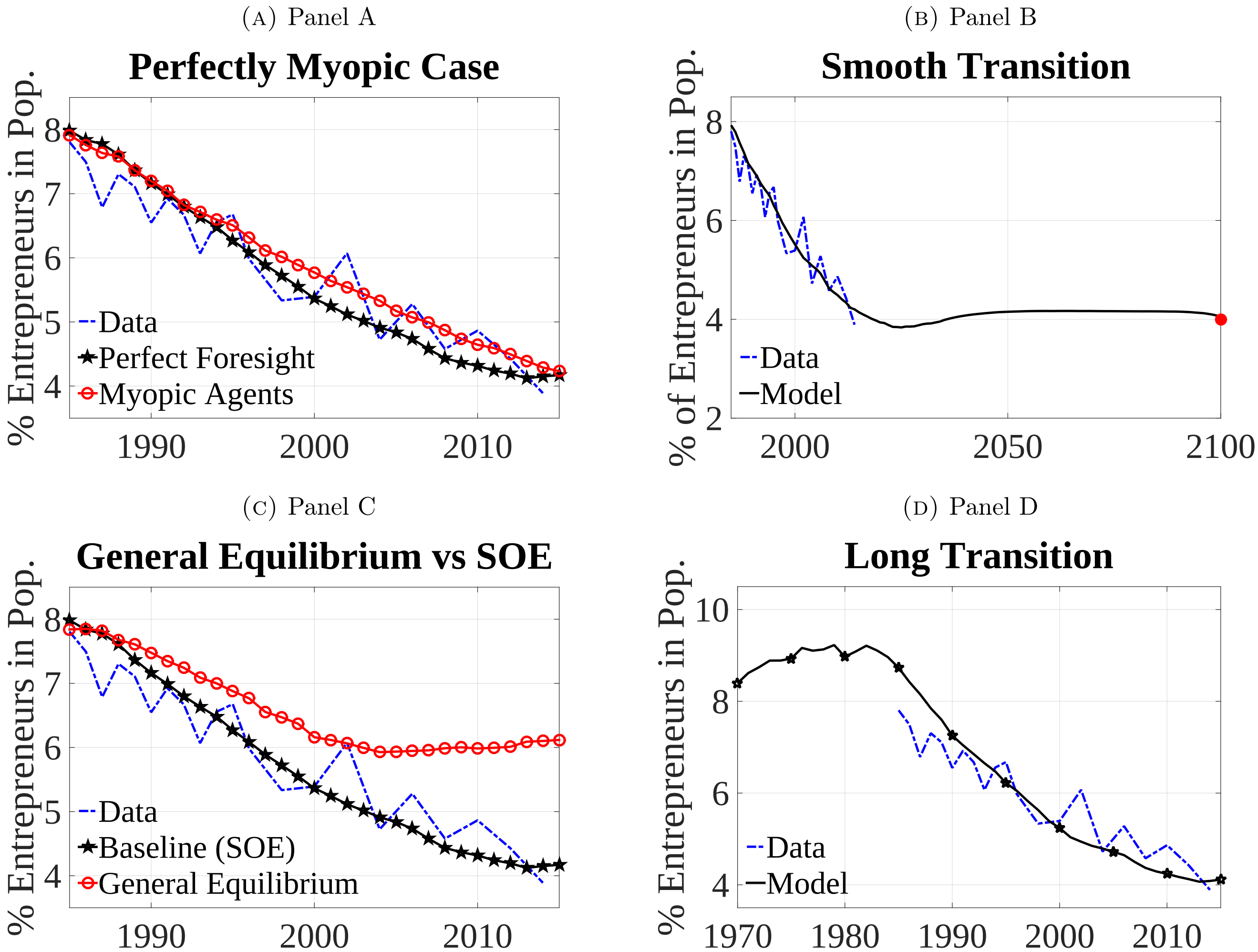
of the share of entrepreneurs in the data, in the benchmark small open economy case and in the general equilibrium case. Appendix Figure A.24 shows the evolution of the skill premium and the interest rate implied by the model. In the latter, the decline in the share of entrepreneurs is half of the decline generated by my benchmark case. This is because the interest rate increases substantially along the transition path, increasing the rate of households's saving. The increase in individuals' savings has two effects on entrepreneurial profits. First, more savings imply more capital for the firms, increasing the profits of entrepreneurs. Second, more wealth relaxes the borrowing constraint, allowing entrepreneurs to operate firms closer to their optimal size. These two effects increase the value of being an entrepreneur. Consequently, the general equilibrium feedback dampens the effects of the changes in the wages on the share of entrepreneurs. Overall, the general equilibrium version of the model predicts a decline of 2.0 percentage points in the share of entrepreneurs, which is about 52% of the decline generated in the fixed interest rate case. Consequently, although considering general equilibrium changes my results quantitatively, the changes in wages and profits induced by the three aggregate trends I consider can account for at least half of the fall in the share of entrepreneurs observed in the data.

A Longer Transition

In my baseline exercise, I have assumed that the economy is in steady state in 1985. Then agents learn about the path of aggregate variables from that year to the infinite future. However, the relative price of investment has shown a declining trend starting several years before 1985, so one might wonder how much my quantitative results depend on the assumption that the economy is at steady state in 1985. To address this concern, here I assume that the economy is at its stationary equilibrium in 1970, and then individuals observe the evolution of the price of capital, the evolution of the productivity of high skill workers, and the supply of high skill labor. As in my previous results, here I take the values of $p_{k,t}$ and H_t from the data, and I change the value of $A_{H,t}$ to reproduce the skill premium observed in 1970. Then, I assume that each exogenous process remains constant after 2015. The bottom right panel of Figure A.25 shows the evolution of the share of entrepreneurs in the data and the model. First, notice that starting the economy in 1970 does not affect the ability of the model to closely follow the decline in the share of entrepreneurs from 1985 on. Second, the model predicts that the share of entrepreneurs was more or less stable between 1970 and the early 1980s, and started its decline in the mid-1980s. The data necessary to construct my preferred definition of entrepreneurs start in 1985. However, one can look at the evolution of the share of self-employed business owners to get a sense of the evolution of the share of entrepreneurs before 1985. This is show by the blue-dashed line in the bottom right plot of Figure A.25. Between 1970

stationary equilibrium at the beginning of my simulation. The corresponding value of β is 0.88, which is what I use in my baseline calibration.

Figure A.25 – Share of Entrepreneurs for Different Robustness Exercises



Note: The upper left panel of Figure A.25 compares the evolution of the share of entrepreneurs in the baseline perfect foresight case with the share of entrepreneurs in the perfectly myopic case. The upper right panel shows the transition path of the share of entrepreneurs under the assumption that aggregate variables grow at a decreasing rate after 2015. The bottom left panel of Figure A.25 compares the baseline, fixed interest rate case with the evolution of the share of entrepreneurs in the general equilibrium case. Finally, the bottom right panel displays the share of entrepreneurs implied by the model under the assumption that the economy was in steady state in 1970.

and 1985, the college premium decreased and then bounced back, explaining why my model predicts a flat share of entrepreneurs in the first years of the transition. Therefore, I conclude that a longer transition starting from 1970 does not change substantially my baseline, post-1985, results.[35]

[35] My results are consistent with the evidence from CPS. As it is show in Appendix Figure A.12, the proportion of self-employed head of households does show a constant share of entrepreneurs between 1970 and the mid 1980s.