Technical Change and Entrepreneurship*

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Abstract

This paper studies the decline in the proportion of entrepreneurs in the US population over recent decades. I provide empirical evidence of the decline of the share of entrepreneurs and observe, importantly, that this decline has been more pronounced among college graduates. Then, I build an occupational choice model in which individuals decide whether to work or become entrepreneurs depending on their skill level, assets, and entrepreneurial ability. In this model, the rapid increase of wages to high skill workers reduces the relative value of becoming an entrepreneur, thereby explaining the decline in the share of entrepreneurs in the population. I find that the increase in the wages of high skill workers accounts for a large fraction of the decline in entrepreneurship experienced by the US economy.

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1 Introduction

Entrepreneurs are widely considered the backbone of the US economy and the engine of growth. They are critical to the formation of new firms, the development of new products, and the pursuit of new business opportunities. However, the fraction of entrepreneurs in the population has declined substantially over the last 30 years: from 7.8% in 1985 to 3.9% in 2014.

In this paper, I relate the decreasing share of entrepreneurs to the rise in income inequality observed in the United States over recent decades. It is well documented that the average real wage of college graduates has increased considerably, much faster than the average wage of workers at lower education levels (Autor, Katz and Kearney, 2008). Intuitively, if the outside option of running a firm is to work for a wage, then an increase in wages will reduce the incentives to and likelihood of starting a new firm. Hence, since we observe a rapid increase in the wages of college graduates and a stagnation of the wages of high school graduates, we would expect the share of entrepreneurs to decline among college graduates but not among high school graduates. Using data from the Panel Study of Income Dynamics (PSID) I corroborate this intuition. Specifically, I find that the decline in the share of entrepreneurs among college graduates has been three times faster than the decline for individuals with at most a high school degree.

Given this evidence, I build a general equilibrium occupational choice model to quantify the impact of the increase in the skill premium on the decline in the share of entrepreneurs in the US population. In the model, a large number of individual households decide each period whether to be a worker or an entrepreneur conditional on their asset level, skill type, and entrepreneurial ability. Entrepreneurs face a collateral constraint stemming from the imperfect enforceability of contracts. I calibrate the model to account for salient features of the US economy in the mid-1980s: most importantly, the share of entrepreneurs, the relative proportion of high and low skill entrepreneurs, and the wage skill premium. Then, I study the transition generated by three exogenous processes: an increase in the productivity of high skill workers, a decrease in the relative price of capital goods, and an increase in the supply of high skill labor. I find that the change in the wages of high skill workers generated by these three trends is critical to explaining the decline in the share of entrepreneurs between 1985 and 2014. Specifically, the model generates a drop of 3.8 percentage points, almost all of the decline observed in the data. Decomposing the contribution of the three aggregate processes considered in the model, I find that the increase in the productivity of high skill workers explains half of the reduction in the share of entrepreneurs in the US population, while the other half is equally explained by the decrease in the price of capital goods and
the increase in the supply of high skill labor.

In the model, the share of entrepreneurs declines despite the fact that profits rise over time as workers become more productive and capital becomes cheaper: it is the increase of wages of high skill workers relative to entrepreneurial profits that generate the decline in the share of entrepreneurs. This mechanism induces an increase in the selection of the most talented individuals into entrepreneurship as only those with high enough entrepreneurial ability decide to run a firm. Using panel data from the PSID I provide evidence of this mechanism. In particular, I show that within the group of college graduates, the average real wage of individuals before transitioning to entrepreneurs – a measure of individual skill – increased 35 log points between 1985 and 2014, while the average wage of college graduates that remained as worker grew 10 log points during the same period.

The slowdown in firm creation has raised concern among researchers and policymakers because of the importance of new businesses to job creation and productivity growth (Decker, Haltiwanger, Jarmin and Miranda, 2014). In my model, the decline in the transition rate to entrepreneurship, i.e. the share households transitioning from wage workers to entrepreneurs, is the equilibrium outcome of an economy experiencing an increase in the wage of high skill workers relative to firm profits. Still, because the borrowing constraint, some households with high entrepreneurial skill remain as workers as they could not run their firms at the optimal scale. Hence, I consider a simple subsidy that aims to bring the rate of new 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 (with parameters as in 2014), the share of entrepreneurs increases 1.79 percentage points, output grows 1.82 percent, and productivity grows 3.53 percent. Welfare also improves, with the group of high skill individuals experiencing the largest increase. Importantly, this positive effect is present regardless of whether the government uses a lump sum tax or a linear tax on earnings to finance the subsidy.

**Literature Review**

This paper relates to the growing literature on the reduction of firm creation in the US economy. Several studies by Pugsley and Sahin (2014), Decker, Haltiwanger, Jarmin and Miranda (2014), Decker, Haltiwanger, Jarmin and Miranda (2016), and others have documented a large decline in the share of activity accounted for by young and small firms. Importantly, these papers show that the contraction of business entry is not bounded to a particular sector or geographical area. This suggests that structural factors are responsible
for the decline in the pace of firm creation experienced by US economy. My research complements these studies by using individual-level data to show that the decline in the firm entry has been accompanied by a fall in the share of entrepreneurs in the population. Moreover, I show that the transition rate to entrepreneurship has also declined over time, mirroring the drop in the startup rate documented by the firm dynamics literature.

Recent papers have postulated that an aging population is responsible for the reduction in firm creation. For instance, Liang, Wang and Lazear (2014) exploit cross-country variation to quantify the importance of differences in the age distribution on the rate of entrepreneurship, and Karahan, Pugsley and Sahin (2016) use differences in population growth across states in the United States to explain the decrease in the formation of new firms. However, the decrease in the proportion of entrepreneurs across all age groups would suggest there are additional factors driving the decline in firm creation. Another possible explanation for the decline in firm entry is the increasing cost of regulation (Davis and Haltiwanger (2014)). My model captures a regulatory burden by imposing a cost to firm creation, which I can use to quantify the effect of an increase in the entry cost on entrepreneurship. Specifically, I ask what is the entry cost necessary to reduce the share of entrepreneurs observed in 1985 to the level in 2014, absent of any other change economy. Comparing these two stationary economies, I find that an entry cost that is 7 times the cost of the initial stationary equilibrium, and represents 2% of the total output, is necessary to generate the drop of entrepreneurship observed in the data. However, a linearly increasing cost of firm creation is not able to reproduce the speed of the decline in entrepreneurship and the contrasting drop in the share of entrepreneurs within high and low skill individuals. Hence, without other mechanisms at place, a simple increase in regulatory costs could not fully explain salient features of the data.

The most related work to my paper is Jian and Sohail (2017), which documents a decline in the transition rate into self-employment using a matched sample of the Current Population Survey (CPS). They show that the decline of the transition rate is stronger among college graduates. Then they study the effects of a skill-biased increase in productivity on the share of entrepreneurs in the context of a static occupational choice model. I depart from these authors at least in three aspects: First, I study the decline of the fraction and the transition into entrepreneurship considering a more comprehensive definition of entrepreneurship. Second, I consider a general equilibrium model that incorporates several degrees of heterogeneity and is consistent with salient features of the data. For instance, my model accounts well for the rise in the skill premium and for the extent of wealth inequality observed in the United States, which is crucial, as the asset holdings are an important determinant of the
transition into entrepreneurship (Cagetti and De Nardi (2006)). Third, in my quantitative exercise I not only consider the direct effect of the increase high skilled workers productivity (skill bias technical change), but also the indirect effect of a decline in the relative price of capital and the increasing share of high skill workers in the population, both of which are absent from Jian and Sohail (2017)’s analysis.

The rest of the paper is organized as follows. Section 2 shows evidence of the decline of the share entrepreneurs in the US population using several definitions and within education and age groups. The evidence of section 2 motivates the occupational choice model that I describe in section 3. Section 4 presents the results of the model and section 5 discussed the policy and welfare analysis. Section 6 concludes.

2 Motivating Facts

In this section, I show that the US economy has experienced a steady decline in the fraction of the population participating in entrepreneurial activities. Moreover, this decline is stronger among individuals with a college degree or more. I also show that the transition rate into entrepreneurship, that is, the share of wage workers that starts a business in the following year, has also fallen in recent decades.

2.1 Data and Definitions

I begin by studying the evolution of the share of entrepreneurs in the population and the transition to entrepreneurship using data from the Panel Study of Income Dynamics (PSID) which is 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 3000 families.\footnote{In this study I focus on the SRC sample, or “core” sample. However, the main conclusions of the empirical section remains almost unaltered if we include the Survey of Economic Opportunities sample and use the proper weights.} My results are based on a sample of heads of household from 1985 to 2015, that are in the labor force, aged between 22 and 60 years old (both ends included), and with information on education attainment and occupation. All statistics presented below are calculated using sample weights. Appendix A describes in full detail the sample selection and variables construction.

There is no consensus in the literature about what households or individuals should be classified as entrepreneurs (see for instance Evans and Leighton (1989), Hurst and Lusardi
(2004), Cagetti and De Nardi (2006)). Henceforth, most of my results of this section refer to four different possible classification of entrepreneurs that encompass the different alternatives considered in the literature. The PSID provides several questions that can be used to classify individuals by their entrepreneurial status. In my analysis, I use mainly four questions. The first 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 question is “On your main job, are you (head) self-employed, are you employed by someone else, or what?” Third, heads of household are asked “Did you (head) put in any work time for this business in (year)?” Finally, I use the occupation of the head of the household. Using this information I separate households in four different groups. The first group considers all the households who are business owners (answer affirmatively to the first question). Between 1985 and 2014, this group represented an average of 16.7% of all the households in the United States. Second, I consider business owners that declare have worked for their businesses during the previous year, denoted as active business owners. These households account, in average, for 14.8% percent of the population. The third group considers households who are 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, those self employed business owners that have a managerial or professional occupation. These households, which are closer to what I will consider an entrepreneur in my model economy, represented an average of 6.0% of the population between 1985 and 2014. Table I reports the average number of household in each class and their average share in the population. Table I also shows the share of entrepreneur at the start and the end of the sample. Notice that independent of the definition used, the share of households participating in entrepreneurial activities has declined between 3.5% and 5% during the last 30 years. Appendix table V reports additional characteristics of the sample and within the different classifications of entrepreneurs.
Table I – Proportion of Entrepreneurs in the Population

<table>
<thead>
<tr>
<th>Years</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1985 – 2014]</td>
<td>3.664</td>
<td>16.73%</td>
<td>14.84%</td>
<td>10.05%</td>
</tr>
<tr>
<td>1985</td>
<td>2.902</td>
<td>17.58%</td>
<td>16.32%</td>
<td>11.69%</td>
</tr>
<tr>
<td>2014</td>
<td>4.140</td>
<td>13.57%</td>
<td>11.33%</td>
<td>7.78%</td>
</tr>
<tr>
<td>Δ(2014 – 1985)</td>
<td>-4.01%</td>
<td>-5.99%</td>
<td>-3.91%</td>
<td>-3.90%</td>
</tr>
</tbody>
</table>

Note: Table I shows the average proportion of entrepreneurial households for four different classifications. Business owners are households whose head declares that he or another member of the household owns a business. Active business owners are households whose head declares have worked for the family business in a given year. Self-employed business owners are households classified as active business owners whose head declares being self-employed in his or her main job. Finally, entrepreneurs are households classified as self-employed business owners whose head has a managerial or professional occupation. The first row shows the average proportion within each group between 1985 and 2014. The second row shows entrepreneurs fractions in 1985 and the third shows entrepreneurs fraction in 2014. The last row shows the change between 1985 and 2014. All differences in the fourth row are statistically significant at the 1%.

2.2 The Declining Share of Entrepreneurs

In this subsection, I document the declining proportion of entrepreneurs in the population and the drop in the share of households transitioning to entrepreneurs between 1985 and 2014. To start, the left panel of figure 1 shows the substantial drop in the share of individuals participating in entrepreneurial activities. For instance, in 1985, 16% of the households in the United States were active business owners, while in 2014 only 12% of the households were classified as such. Similarly, in 1985, 7.8% of all the households are classified as entrepreneurs. This figure was 3.9% in 2014. To better appreciate the decline in the rate of entrepreneurs across different definitions, the right panel of figure 1 shows the times series of the share of entrepreneurial households rescaled by the level in 1985.2 3

2 In this section I calculate the fraction of entrepreneurs on a sample of heads of household that considers those that did and did not work for a wage in the corresponding year. Dropping the later group of observations – mostly unemployed heads of household – changes the level of the share of entrepreneurs in the population (it reduces the denominator). However, the declining trend remains almost the same as I show in appendix figure 16.

3 Appendix figure 17 shows the time series of the fraction of entrepreneurial households considering 95% percent confidence intervals. The decline is statistically significant across all definitions.
The top panels of figure 2 show the time series of the fraction of entrepreneurs separating the population by education groups. Notice that, independent of the definition that one uses, the fraction of entrepreneurs within the group of individuals with some college or more is larger than the fraction of entrepreneurs within the group of households whose head has at most a high school degree. Second, although both groups have experienced a decline in the share of entrepreneurs, the drop is steeper for the group of households with some college studies. This is more clear at the bottom panels of figure 2 that shows the share of entrepreneurial households rescaled to the level in 1985: the group household with some college studies experienced an average decline of 6 percentage points between 1985 and 2014 while the decline for the group with a high school diploma or less is between 1 and 2 percentage points.
Karahan et al. (2016) and Liang et al. (2014) postulate that demographic shifts towards an older population is an important factor in explaining the decline in entrepreneurship. An aging population can impact the share of entrepreneurs since young individuals are more inclined to take risks and start a new businesses, and therefore, a shrinking proportion of young individuals will reduce entrepreneurship.\footnote{Another channel through which an aging population can impact the share of entrepreneurs is affecting the current and future demand for goods. A decline in the population growth might reduce the future returns to investment, affecting the decision to start a business today. The model that I present in the next section abstracts from population growth.} However, the fraction of entrepreneurs has declined within narrow age groups as well. Figure 3 displays the proportion of entrepreneurs for three different age groups normalized by their corresponding value in 1985.\footnote{The share of entrepreneurs across groups is certainly different, with a higher average proportion of entrepreneurs in the group of individuals aged between 35 and 44 as it is shown in appendix figure 19.} Importantly, the fraction of entrepreneurs between 35 and 44 years old, which earlier research has identified...
tified as the age group most likely to start their own firm (Stangler and Marion (2013)), also dropped. This suggests there are other factors driving the decrease in the share of entrepreneurs.

**Figure 3 – Share of Entrepreneurs within Different Age groups**

![Graph showing the share of entrepreneurs within different age groups](image)

Note: Figure 3 shows the fraction of entrepreneurs within three different age groups rescaled to the 1985 level. See notes in table I for additional details.

**Transition to Entrepreneurship**

A declining trend in the share of entrepreneurs might be the result of a drop in the proportion of household starting a new business, an increase in the share of entrepreneurs closing their firms to become workers, or both. To study which of this is more important I calculate the transition rates in and out of entrepreneurship across the population and over the years. In order to have a more direct comparison between the different classifications of entrepreneurial households, I measure the transition rate to entrepreneurship as the share of the population that is neither business owner nor self-employed in year $t$, but transits to either of the classifications in year $t + 2$. Figure 4 shows that the transition rates have declined for each classification since 1985. The drop is substantial: in 1985, 8.1 percent 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 percent in 2014, which implies a decline of 50% of the transition rate. I find a similar drop in the transition rates for the rest of the definitions of entrepreneurial households (see right panel of figure 4). Exit rate out of entrepreneurship, i.e. the share of active entrepreneurs in period $t$ that transited to wage worker in $t + 2$, are quite volatile and did not show any particular trend between 1985 and 2014.

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6I construct two-years transition rates to accommodate the biannual waves of the PSID after 1997.
Next, I use the panel dimension of the PSID to study how the characteristics of the households that start new businesses have changed over time. This may give insight on whether the new cohorts of entrepreneurs come from a more skilled group. Here, I study the wage level of entrepreneurs before they started their business. Arguably, workers with higher wages are more skilled, in a general sense, than workers with lower wages. Therefore, an increase in the wage of the households that transit into entrepreneurship, might be indicative that new entrepreneurs are more skilled and expect higher future profits, as they gave up higher earnings to start their firms. In such case, the decline of 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 men, heads of household, that are neither self-employed nor business owners in year $t$ (wage workers in period $t$). For each individual, I measure recent labor earnings as the average of total labor earnings between years $t$ and $t - 2$. Calculating recent labor earnings reduces business cycle variations which can affect heavily workers at the bottom of the skill distribution.\footnote{Observations of individuals that were entrepreneurs in period $t - 2$ or $t - 1$ are not considered in this calculation as they have no labor income earnings.} For consistency with the previous results, I divide the sample into two groups, those with a high school diploma or less, and those with some college studies or more.\footnote{Including workers with some college in the first group makes my results stronger.} Then, in each group, I calculate the average recent labor earnings within the group of individuals that will become business owners in $t + 2$ (switching households) and within those that will remain as workers (non-switching households).

Figure 5 shows that, within households with some college studies, the average wage of individuals who became entrepreneurs grew faster than the average wage of individuals than
remained as a worker. The difference in the growth rate of earnings is both economically and statistically significant (at the 1%): the average recent earnings of workers that transited into entrepreneurship grew 1.7% percent per year between 1985 and 2014, accumulating more than 35% increase in thirty years. On the other hand, the average earnings for those that remained as workers grew less than 0.4% in average during the same period of time, accumulating roughly 10% of growth. This suggests that new high skill entrepreneurs are increasingly selected from a pool of workers with higher average wages, and therefore, more talented. In contrast, the growth rate of wages did not differ significantly between switching and non-switching worker within the group of individuals with a high school diploma or less. Figure 6 shows that the average recent earnings for households transitioning to entrepreneur decreased during the sample period while for individuals that remained as workers increased less than 0.1% per year.

**Figure 5 – Average Labor Income for Workers with Some College or More**

![Graph showing average recent labor income for Switching and Non-Switching Households.](image)

Note: Figure 5 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 \( t \) and have some college studies or more. 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%.

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9 Figure 15 in appendix C shows the results using a pooled sample of entrepreneurs. In such case, the growth rate of of recent earnings for switching workers grew an average of 1.3% per year between 1985 and 2014 but only 0.5% for non switching worker. In appendix C I also show that these results are quite robust and do not change much if we consider wages and salaries instead of total labor earnings (figure 20), if we consider current labor earnings (figure 21), or if we look at the 50th percentile of total labor earnings distribution (figure 22). The differences in growth rate of earnings between those that switch to business owner and those that remain as worker tend to vanish at higher levels of the recent income distribution. This can be seen in figure 23 that shows the 90th percentile of the recent labor income distribution.
Figure 6 – Average Labor Income for Workers with a High School Diploma or Less

Note: Figure 6 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 \( t \) and have a high school diploma or less. 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 \( t+2 \).

There is no statistical difference between the slopes in the left and right panel.

In summary, I have shown that the US economy has experienced a decline in the proportion of households involved in entrepreneurial activities. The decline is stronger among the households whose head has some college studies. I also find a decline in the transition rate into entrepreneurship and a increasing (positive) selection of entrepreneurs with higher wages. Given this evidence, the next section presents an equilibrium model that is consistent with the decline in the share of entrepreneurs, with the differential reduction in the share of entrepreneurs across education groups, and with the increase in the selection of more talented workers to start new firms.\(^{10}\)

3 The Model

3.1 Households and Production

Demographics

This section describes the general equilibrium model I use to study the impact of the changes in the earnings distribution on the decision of becoming an entrepreneur. Consider an economy with a continuum of individual households of measure one. In each period, there is a proportion \( H_t \) of high skill households, and a proportion \( L_t \) of low skill households.

\(^{10}\)Appendix A.2 presents additional evidence on the declining share of entrepreneurs using a sample from the Current Population Survey.
Individuals die with probability \((1 - \chi)\), in which case, his offspring enters the model. The offspring carries the same skill type of her parents with probability \(\zeta_s\) with \(s \in \{H, L\}\). She also inherits the assets bequeathed by her parent and her parent’s business in the case the parent dies as an entrepreneurs.

Preferences

Each individual values consumption by means of the utility function \(c_t^{1-\sigma} / (1 - \sigma)\) and supply one unit of labor inelastically. They discount future streams of utility at the rate \(\beta < 1\), and discount the utility of their offsprings a proportion \(\beta \eta\) with \(\eta \in [0, 1]\).

Production Technology

In each period, an individual decides whether to work for a wage or run a firm (labor unit is indivisible). If she decides to be a worker, she receives an income of \(\omega_{s,t} y_t\), where \(s \in \{H, L\}\), \(y_t\) is an idiosyncratic, positively autocorrelated shock, and \(\omega_{s,t}\) is the wage of a worker of type \(s\) in period \(t\). A worker cannot borrow, but can save a riskless asset, \(a_t\), that rents \(r_t\).

If the individual chooses to be an entrepreneur, she produces a homogeneous good using four different factors: her own entrepreneurial ability, low skilled labor, \(n_{H,t}\), high skilled labor, \(n_{L,t}\), and capital, \(k_t\). The entrepreneurial ability has two component, a fixed part, denoted by \(\theta_s\) which depends on the skill type of the individual, and an idiosyncratic part, \(z_t\), which is positively autocorrelated and is independent of \(y_t\). Hence, the production technology available to the individual is \(z_t \theta_s [f (n_{H,t}, n_{L,t}, k_t)]^\gamma\), where \(\gamma < 1\) is the span-of-control parameter that determines the degree of decreasing returns to scale, and hence, the returns to entrepreneurial ability \((\text{Lucas Jr} (1978))\). The function \(f (n_{H,t}, n_{L,t}, k_t)\) is given by,

\[
f (n_{H,t}, n_{L,t}, k_t) = \left[\psi (\tau (A_{H,t} n_{H,t})^\rho + (1 - \tau) k_t^\rho) \right]^{\alpha} + (1 - \psi) n_{L,t}^\alpha \right]^{\frac{\alpha}{\rho}}. \tag{1}
\]

In this production function, \(\rho\) controls the elasticity of substitution between high skilled labor and capital, and \(\alpha\) controls the elasticity of substitution between the composite of capital and high skill labor and the low skilled labor input. \(\tau\) determines the output share of capital and \(\psi\) determines the output share of labor. \(A_{H,t}\) captures a skill-biased change in productivity that affects directly the relative contribution of high skill workers to output. There is no fixed cost of production: however, creating a new firm implies a one period cost, \(\kappa\). Notice this cost affects only individuals transiting from wage worker to entrepreneur.
Many firms are not managed by individual households weighting the 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 second sector of production populated by a large number of homogeneous firms operating a constant returns to scale production technology given by,

$$F(N_{H,t}, N_{L,t}, K_t) = A\left[ \psi (\tau (A_{H,t}N_{H,t})^{\rho} + (1-\tau) K_t^{\rho})^{\frac{\sigma}{\rho}} + (1-\psi) N_{L,t}^{\sigma} \right]^{\frac{1}{\alpha}},$$

which I will refer as the non-entrepreneurial sector. Both sectors produce the same good and in both capital depreciates at the rate $\delta$.\(^{11}\)

**Borrowing Constraint**

Similar to Jermann and Quadrini (2012), entrepreneurs need to rent capital and pay wages before revenues are realized. This captures that idea that entrepreneur needs some “working capital” to run their businesses. Then, I assume that entrepreneurs obtain an intra period loan of $p_{k,t}k_t + \omega_{H,t}n_L + \omega_{L,t}m_L$ where $p_{k,t}$ is the price of capital goods in terms of consumption . The maximum amount of the loan is constrained by the wealth of the household. In particular, each entrepreneur faces a simple collateral constraint of the form,

$$p_{k,t}k_t + \omega_{H,t}n_L + \omega_{L,t}m_L \leq \lambda a_t,$$

with $\lambda \geq 1$. This type of borrowing constraint can arise from a limited enforcement problem as in Jermann and Quadrini (2012), and has been used extensively in the literature (e.g. Buera and Shin (2013), Moll (2014), and others).

**Exogenous Aggregate Processes**

The economy is subject to three aggregate exogenous processes: a decrease in the relative price of capital goods, $p_{k,t}$, an increase in the share of high skill workers, $H_t$, and a increase in the productivity of high skill workers, $A_{H,t}$. In my baseline exercise there is no aggregate uncertainty and the time series of each of these processes are fully known by the individuals.\(^{12}\)

\(^{11}\)In this model, the presence of decreasing returns to scale and the borrowing constraints impede the most productive entrepreneur to grow up to the point to use all the resources of the economy. In a model with constant returns to scale and without borrowing constraint, only the most capable entrepreneur is active and is optimal to manage all the most productive individual to manage all the resources.

\(^{12}\)In this model, I assume that the price of capital goods is exogenously given. This is equal to modeling a third sector with a linear production technology that transforms consumption goods into capital goods. A decrease in the relative price of capital would result from an increase of this this sector productivity.
The Problem of the Households

At the beginning of each period an individual is characterized by her fixed skill type, $s \in \{H, L\}$, her asset level, $a_t$, her entrepreneurial ability, $z_t$, her worker ability, $y_t$, and her previous occupation, $d_t$, with $d_t \in \{w_t, e_t\}$ where $w$ stands for worker and $e$ for entrepreneur. To simplify the notation, name the vector of idiosyncratic states by $\mathbf{x}_t \equiv \{a_t, z_t, y_t, d_t\}$, where $w$ stands for worker and $e$ for entrepreneur.

To simplify the notation, name the vector of idiosyncratic states by $\mathbf{x}_t \equiv \{a_t, z_t, y_t, d_t\}$, and the distribution of individuals of type $s$ in period $t$ over idiosyncratic states by $\mu_{s,t}$ with $\mu_t \equiv \{\mu_{H,t}, \mu_{L,t}\}$. Denote the vector of aggregate states by $\mathbf{y}_t \equiv \{p_{k,t}, A_{H,t}, H_t\}$. Then, a $s$ -type individual solves

$$V_{s,t} (\Omega_t, \Theta_t, \mu_t) = \max \{V_{w,s,t} (\Omega_t, \Theta_t, \mu_t), V_{e,s,t} (\Omega_t, \Theta_t, \mu_t)\},$$

where $V_{w,s,t} (\Omega_t, \Theta_t, \mu_t)$ is the value of being a worker in period $t$ and $V_{e,s,t} (\Omega_t, \Theta_t, \mu_t)$ is the value of being an entrepreneur. If an individual decides to be a worker, she solves

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

subject to the laws of motion of $y_t$ and $z_t$, the law of motion of the distribution of individuals over idiosyncratic states, $\mu_{t+1} = \Psi (\Theta_t, \mu_t)$, and the evolution of the aggregate states, $\Theta_{t+1}$. In the problem of the worker described by equation (3), the first expectation is taken over the conditional distributions of $z_{t+1}$ and $y_{t+1}$, and over the next’s period distribution of individuals over idiosyncratic states, while the second expectation is taken over the unconditional distributions of $z_{t+1}$ and $y_{t+1}$ and the next’s period distribution of idiosyncratic states.
On the other hand, if the individual decides to be an entrepreneur, she solves

\[
V^*_{s,t} (\Omega_t, \Theta_t, \mu_t) = \max_{c_t, \alpha_{t+1}} \left\{ \frac{c_t^{1-\sigma}}{1-\sigma} + \beta \left[ \chi \mathbb{E}_{z_{t+1} | z_t, y_{t+1} | y_t} V_{s,t+1} (\Omega_{t+1}, \Theta_{t+1}, \mu_{t+1}) + \right. \right. \\
(1 - \chi) \eta \sum_{j \in \{H,L\}} \zeta_{s,j} \mathbb{E} V_{s,t+1} (\Omega_{t+1}, \Theta_{t+1}, \mu_{t+1}) \left. \right] \right\}, \tag{4}
\]

\[c_t + \alpha_{t+1} \leq (1 + r (\Theta_t, \mu_t)) \alpha_t + \pi_{s,t} (z_t, \alpha_t) - \mathbb{I} (d_{t-1} = w_{t-1}) \kappa,\]

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

\[
p_{k,t} k_t + \omega_{H,t} (\Theta_t, \mu_t) n_{H,t} + \omega_{L,t} (\Theta_t, \mu_t) n_{L,t} \leq \lambda \alpha_t \]

\[\alpha_{t+1} \geq 0,\]

subject to the non-negativity constraints of factor demands, the laws of motion of \( y_t \) and \( z_t \), the law of motion of the distribution of individuals over idiosyncratic states, \( \mu_{t+1} = \Psi (\Theta_t, \mu_t) \), and the law of motion of the aggregate states, \( \Theta_{t+1} \). Here, \( \mathbb{I} (d_{t-1} = w_{t-1}) \) is an indicator function which is equal to 1 if the individual starts the period as worker and is equal to zero otherwise. This function captures the assumption that fixed cost of creating a firm is paid only by those individuals transitioning from wage worker to entrepreneur. The solution of the problem of the household is characterized by a \( z \)–productivity threshold which depends on the individual’s level of assets, the labor productivity, and the previous’ period occupation.
The Problem of the Non-Entrepreneurial Sector

The non-entrepreneurial sector does not face any borrowing constraint and rents the capital at the rate $r_t (\Theta_t, \mu_t)$. Then, the problem of the non-entrepreneurial sector is given by

$$
\pi_{c,t} = \max_{N_{H,t}, N_{L,t}, K_t} \left\{ F(N_{H,t}, N_{L,t}, K_t) - p_{k,t} (r_t (\Theta_t, \mu_t) + \delta) K_t - \right.
$$

$$
\omega_{H,t} (\Theta_t, \mu_t) N_{H,t} - \omega_{L,t} (\Theta_t, \mu_t) N_{L,t},
$$

subject to the non-negativity constraints of factor demands.

3.2 Equilibrium

Given an initial distribution $\mu_0$ and an exogenous path of $\Theta_t = \{p_{k,t}, A_{H,t}, H_t\}_{t=0}^{\infty}$, an equilibrium in this economy is

- A time path for prices, $\{\omega_{H,t} (\Theta_t, \mu_t), \omega_{L,t} (\Theta_t, \mu_t), r_t (\Theta_t, \mu_t)\}_{t=0}^{\infty}$, and a sequence of distributions over idiosyncratic states $\{\mu_{t+1} (\Theta_t, \mu_t)\}_{t=0}^{\infty}$,
- a sequence of households’ policy functions $\{c^s_t (\Omega_t, \Theta_t, \mu_t), a^s_{t+1} (\Omega_t, \Theta_t, \mu_t), d^s_t (\Omega_t, \Theta_t, \mu_t)\}_{t=0}^{\infty}$, with $\{V_{s,t} (\Omega_t, \Theta_t, \mu_t)\}_{t=0}^{\infty}$, the associated value functions and $s \in \{H, L\}$,
- factor demands for the entrepreneurs, $\{k^s_t (\Omega_t, \Theta_t, \mu_t), n^s_{H,t} (\Omega_t, \Theta_t, \mu_t), n^s_{L,t} (\Omega_t, \Theta_t, \mu_t)\}_{t=0}^{\infty}$,
- demands of the non-entrepreneurial sector, $\{K_t (\Theta_t, \mu_t), N_{H,t} (\Theta_t, \mu_t), N_{L,t} (\Theta_t, \mu_t)\}_{t=0}^{\infty}$,

such that,

- The policy functions, value functions, and factor demands solve the problem of the households given by (3) and (4),
- The factor demands of the non-entrepreneurial sector solve (5),
- Labor markets for high and low skill workers clear,

$$
\int (1 - d^H_t (\Omega_t, \Theta_t, \mu_t)) d\mu^H_t (\Omega_t) = N_{H,t} (\Theta_t, \mu_t) + \sum_{s \in H,L} \int n^s_{H,t} (\Omega_t, \Theta_t, \mu_t) d^s_t (\Omega_t, \Theta_t, \mu_t) d\mu^s_t (\Omega_t),
$$
\[ \int \left(1 - d^L_t (\Omega_t, \Theta_t, \mu_t)\right) d\mu^L_t (\Omega_t) = N_{L,t} (\Theta_t, \mu_t) + \sum_{s \in H,L} \int n^s_{H,t} (\Omega_t, \Theta_t, \mu_t) d\mu^s_t (\Omega_t), \quad (7) \]

- Capital market clears,

\[ \sum_{s \in H,L} \int a^s_t (\Omega_t, \Theta_t, \mu_t) d\mu^s_t (\Omega_t) = p_{k,t} K_t (\Theta_t, \mu_t) + \sum_{s \in H,L} \int \left( p_{k,t} k^s_t (\Omega_t, \Theta_t, \mu_t) + \omega_{H,t} (\Theta_t, \mu_t) n_{H,t} (\Omega_t, \Theta_t, \mu_t) + \omega_{L,t} (\Theta_t, \mu_t) n_{L,t} (\Omega_t, \Theta_t, \mu_t) \right) d\mu^s_t (\Omega_t). \quad (8) \]

A stationary competitive equilibrium is defined in a similar way but over a constant path of \( \Theta_t \) which implies a constant sequence of prices and distributions over idiosyncratic states. The solution of the model requires an initial and final steady states and the complete transition path of aggregate states and factor prices, given an exogenous sequence of \( \Theta_t \). The appendix B describes in detail the algorithm that I use to solve the model.

### 3.3 Calibration

This section describes the quantitative specification of the model. To maintain tractability of the calibration, I choose parameters directly from the literature (e.g. the risk aversion or the depreciation rate), I calculate other parameters directly from the data (e.g. the parameters governing the labor income process), and I choose other parameters such that stationary equilibrium of my model matches salient features of the data. In this section, I also describe the three exogenous time series (the price of capital, the share of high skill workers, and relative productivity of high skill workers) that I will incorporate into the model. In order to highlight the effects of the change in wages on entrepreneurs, I will assume, for the moment, that this is a small open economy and the interest rate constant over time. In the robustness section, I show how my quantitative results change when considering a full-fledged general equilibrium model.
Frequency, Preferences, and Discounting

I set the time period to equal a year. I take a standard value for the coefficient of risk aversion of 2.0. In the baseline case I set $\eta = 1$ so parents are perfectly altruistic. I assume $\beta$ to be 0.88 and a fixed interest rate of 3.0%.

Demographics

I set the value of $\chi$ equal to 0.025 so that the average working life of a household is 40 years. In the baseline calibration I assume when an individual dies, an offspring inherits her parent’s skill type with probability one, so $\zeta_{hh} = \zeta_{ll} = 1$.

Production and Capital Depreciation

I assume that capital is more complementary to skilled than to unskilled workers which implies that $\alpha > \rho$. Hence, I set $\alpha$ equal to 0.401 and $\rho$ equal to -0.495 as in Krusell, Ohanian, Ríos-Rull and Violante (2000). The value of $\gamma$ in the technology of the entrepreneur is equal to 0.88 as is Cagetti and De Nardi (2006), and the capital depreciation rate, $\delta$, is set of an annual value of 0.06.

Labor Income

I assume that the log of $y_t$ is given by $\log y_{t+1} = \rho_y \log y_t + \sigma_y \epsilon_{t+1}$ where $\epsilon_{t+1}$ is a white noise innovation. The values of $\rho_y$ and $\sigma_y$ are estimated using data from PSID for the period 1970 to 1996 on a sample of wage workers.$^{13}$ In the model, all individual households are hit by the same stochastic income process. Therefore, I select a pooled sample of heads of household with valid labor income that work for a wage (non entrepreneurs) in periods $t$ and in $t - 1$. Then, I estimate the following equation,

$$\log w_{i,t} = \beta_0 + \beta_1 A_{i,t} + \beta_2 A_{i,t}^2 + \beta_3 A_{i,t}^3 + \rho_w \log w_{i,t-1} + \nu_{i,t}, \quad (9)$$

where $w_{i,t}$ is the total real labor earnings of the head of the household in period $t$.$^{14}$ The right hand side includes a polynomial in age to control for life-cycle patterns. The estimated

$^{13}$PSID becomes biannual after 1997 and it is not possible to calculate one-year changes.

$^{14}$Here, total labor income includes only wages and salaries, bonuses, tips, and commissions. The labor part of businesses income and the income from farm are excluded as I am considering in the sample individuals that work for a wage only and do not own a businesses neither in period $t$ nor in period $t - 1$. 
autocorrelation of earnings, $\rho_w$, is 0.73, and the standard deviation of $\nu_{i,t}$ is 0.53. Using these values of $\rho_w$ and $\sigma_w$, I discretize the continuous process using the method developed by Tauchen (1986). The sample and additional estimation results are described in appendix A.1.

Exogenous Aggregate Processes

In this section I discuss how I choose the time series of relative price of capital goods, $p_{k,t}$, the increase in the supply of high skill labor, $H_t$, and the increase of the productivity of high skill workers, $A_{H,t}$. The first two have obvious empirical counterparts, while the third needs to be disciplined using additional conditions.

For the time series of $p_{k,t}$ I use the time series of the quality-adjusted relative price of capital goods calculated by DiCecio (2009) normalized to be equal to 1 in 1985. Using this time series, the relative price of capital declined 55% between 1985 and 2015.¹⁵ In my simulation, I will assume that from 2015 on $p_{k,t}$ remains fixed at its 2015 level for the rest of the simulation. This is an extreme case and therefore, in the robustness section, I study how sensitive my results are to different assumptions on the time trend of the price of capital and the rest of exogenous trends 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 aged between 22 to 60 years drawn from the CPS.¹⁶ The share of college graduates in this sample increased from 26% in 1985 to 39% in 2015. In my baseline results I take this time series as given, and I assume that the share of high skill workers remains at its 2015 level for the rest of the transition.

Finally, I need to choose the time series of the skilled-biased technical progress, $A_{H,t}$. Since I cannot observe directly the value of $A_{H,t}$ in the data, I select the time series of $A_{H,t}$ so that the increase in the skill premium implied by the model (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 in the last 30 years in the United States. I measure the college premium observed in the last 30 years in the United States. I measure the college premium observed in the last 30 years in the United States.

¹⁵Alternatively, one could use the measure of the price of capital goods calculated by the Bureau of Economic Analysis (BEA) to compute the relative price of capital goods. Using this measure, the relative price of capital declined 50% between 1985 and 2015. However, as it is shown in Gordon (2007), the BEA understates the improvements in the quality of capital goods and therefore the decline in the price of investment might be understated. See the appendix A.3 for additional details and a comparison of the relative price of investment calculated by DiCecio (2009), the time series using BEA’s data, and an additional measure that only considers equipment and software.

¹⁶I use CPS, instead of PSID, for consistency with the rest of the literature (Acemoglu and Autor (2011)).
premium as the log difference of the real annual labor income over a sample of workers from the CPS. Additional details of the construction of the skill premium are discussed in appendix A.2. Using this sample, the college premium increased from 39\% in 1985 to 60\% in 2015. Because my model economy is subject to two additional aggregate trends (the price of capital and the supply of high skill workers) there is not a clear mapping between the college premium implied by the model and the evolution of $A_{H,t}$. In particular, since high skill workers are more complementary to capital than low skill workers (recall $\alpha > \rho$ in the production function), the decline of $p_{k,t}$ and the rise of $H_t$ will affect the skill premium in opposite directions. To solve this issue I take very simple approach: I fix the value of $A_{H,t}$ in the initial stationary economy to be equal to 1 and select the value of $A_{H,t}$ at the final stationary equilibrium so that my model matches a skill premium of 60\% conditional on the values of $p_{k,t}$ and $H_t$ in 2015. Then, the sequence of $\{A_{H,t}\}_{t=1}^T$ grows linearly between these two fixed points for 30 years. As with the other two exogenous processes, I assume that after 2015 the value of $A_{H,t}$ is fixed for the rest of the transition. Figure 7 shows the times series of the relative price of capital goods, the share of college graduates, and the college premium in the data that I use to discipline the exogenous processes in my model.

**Figure 7 – Aggregate Processes**

Note: Figure 7 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 (left 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 CPS. The supply of college graduates in each year is the share of heads of household between 22 and 60 years old that have a college degree or more. 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 the appendix A.2 for additional details on the calculation of the supply of college graduates and the college premium.
Parameters Determined Jointly in Equilibrium

The parameters that I need to calibrate simultaneously with the equilibrium of the model are the factor shares in the production function, $\tau$ and $\psi$, the borrowing limit, $\lambda$, the switching cost, $\kappa$, and the parameters of the entrepreneurial ability, $\theta_s$ and $z_t$. I normalize $\theta_H$ to 1 and I assume that $\log z_{t+1} = \rho_z \log z_t + \sigma_z \epsilon_{t+1}$ where $\epsilon_{t+1}$ is a white noise innovation. This leaves seven parameters that need to be calibrated jointly with equilibrium of the model. I use these seven parameters to pin down the same number of moments generated by the stationary economy conditional on the values of $p_{k,t}$ and $H_t$ as in 1985. 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 investment, $p_{k,t}$, to 1 in 1985, and I set the share of high skill workers, $H_t$, to 0.26 which is the fraction of head of households with a college degree in the CPS sample in 1985. Conditional on these two fixed values, I choose the rest of the parameters to match:

- a skill premium of 39%, which is the value of the college premium in 1985 as shown in figure 7,
- a labor share of output of 63%, which is the average labor share of the non farm business sector output between 1980 and 1985 calculated by the Bureau of Labor Statistics,
- a ratio of liabilities plus equity of the non financial sector to the non financial private sector output of 0.88,\footnote{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 the Federal Reserve Bank of Saint Louis Economic Data (FRED) – time series NNBTILQ027S – plus the the 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 Bureau of Economic Analysis (BEA). See appendix A.3 for additional details.}
- a share of entrepreneurs in the population of 7.80%, which the fraction calculated from the PSID for 1985,
- a share of entrepreneurs that are high skill of 4.2%, which is the fraction of entrepreneurs with a college degree calculated from the PSID for 1985,
- a share of households transitioning from wage workers to entrepreneurs of 2.4%, which is the fraction of wage workers transitioning to entrepreneurs calculated from the PSID for 1985
- and a share of new entrepreneurs of 23%, which is the fraction of households that transited from wage workers in 1985 over the total number of entrepreneurs in 1985.
Table II – CALIBRATED PARAMETERS IN THE BENCHMARK MODEL

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Share</td>
<td>$\tau$ 0.48</td>
</tr>
<tr>
<td>Labor Share</td>
<td>$\psi$ 0.50</td>
</tr>
<tr>
<td>Borrowing Limit</td>
<td>$\lambda$ 2.5</td>
</tr>
<tr>
<td>Entry Cost</td>
<td>$\kappa$ 0.11</td>
</tr>
<tr>
<td>Relative Productivity of Low Skill Workers</td>
<td>$\theta_L$ 0.94</td>
</tr>
<tr>
<td>Autocorrelation of $z$</td>
<td>$\rho_z$ 0.817</td>
</tr>
<tr>
<td>Standard Deviation of Innovation of $z$</td>
<td>$\sigma_z$ 0.24</td>
</tr>
</tbody>
</table>

Note: Table II reports the set of calibrated parameters and their corresponding values. The data and analogous model generated moments are reported in table III.

Table III – DATA AND MODEL GENERATED MOMENTS

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Model</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skill Premium</td>
<td>0.39</td>
<td>0.39</td>
<td>CPS</td>
</tr>
<tr>
<td>Labor share</td>
<td>0.63</td>
<td>0.63</td>
<td>BLS</td>
</tr>
<tr>
<td>Debt and Equity to GDP</td>
<td>0.88</td>
<td>0.89</td>
<td>Flow of Funds</td>
</tr>
<tr>
<td>Share of Entrepreneurs (%)</td>
<td>7.80</td>
<td>7.82</td>
<td>PSID</td>
</tr>
<tr>
<td>Share High Skill of Entrepreneurs (%)</td>
<td>4.18</td>
<td>4.15</td>
<td>PSID</td>
</tr>
<tr>
<td>Transition Rate (%)</td>
<td>2.40</td>
<td>3.05</td>
<td>PSID</td>
</tr>
<tr>
<td>Share of New Entrepreneurs (%)</td>
<td>23.1</td>
<td>35.0</td>
<td>PSID</td>
</tr>
</tbody>
</table>

Note: Table III shows the set of moments that are targeted to choose the parameters in table II.

Table II reports the parameter calibrated jointly in equilibrium and table III shows the calibration targets and the model generated moments. The model does a good job in matching the share of entrepreneurs, the share of entrepreneurs that are high skill, and the skill premium, all of which are key for my quantitative exercise. The share of new entrepreneurs and the transition rate of workers to entrepreneurs implied by the model are larger than the corresponding values calculated from the data.

4 Results

4.1 Transition

This section shows the main quantitative results of the benchmark model. The economy is assumed to be at a stationary equilibrium in 1985. Then, individuals learn about the future path of the three aggregate time series (the price of investment, the share of skilled workers, and relative productivity of high skill workers), the evolution of the distribution
of individuals over idiosyncratic states, and consequently, factor prices. In other words, individuals have perfect foresight of all the relevant variables from 1985 to the infinite future. In my benchmark exercise, the time series of each of these variables are as shown in figure 7 and remain constant after 2015 for the rest of the transition.\(^{18}\) The left panel of the figure 8 shows the evolution of the fraction of entrepreneurs in the data (blue-dashed line) and in the model (black-starred line). The model accounts well for the decline in the share of entrepreneurs in the population and the speed of the decline. In the model, the fraction of entrepreneurs drops 3.8 percentage points between 1985 and 2014, accounting for almost the 3.9 percentage points decline observed in the data. The model is also able to account for the evolution of the share of entrepreneurs within high and low skill workers, as shown in the right panel of figure 8. In the model, the decline in the share of high skill entrepreneurs is faster than the decline observed in the data (for the group of college graduates) especially in the first years of the transition. The model more closely matches the evolution of the share of low skill workers, although it under predicts the speed of the decline.

**Figure 8 – Evolution of the Share of Entrepreneurs**

The left panel of figure 8 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 model (black starred line). The right panel shows the share of entrepreneurs within skill groups.

The model accounts well for the decline of the share of individuals that transit from wage worker to entrepreneurs in a given period as it is shown in figure 9.

\(^{18}\)The entire transition consists of 300 periods, from 1985 to 2285
4.2 Decomposition

What is the relative contribution of each of the exogenous trends to the decline in the share of entrepreneurs? To answer this, I study the evolution of the fraction of entrepreneurs considering the contribution effect of each of the aggregate shocks, starting from the skilled-biased technological progress, $A_{H,t}$. I consider the same trend of $A_{H,t}$ as in my baseline exercise but fix the levels of $p_{k,t}$ and $H_t$ to their levels in 1985 (the initial stationary equilibrium). The evolution of the share of entrepreneurs in this case is shown in the left panel of figure 10. The black-starred line is the share of entrepreneurs implied by the model in the baseline results while the red-circled line shows the proportion of entrepreneurs for the case in which only $A_{H,t}$ moves. This can be thought of as the direct effect of the skill-biased technical change on the share of entrepreneurs. In this case, the proportion of entrepreneurs drops 2.1 percentage points between 1985 and 2015, or 55% of the overall decline implied by the model (and 53% decline in the data). The discrepancy between my baseline results and this case is the response of the low skill workers. First, the center panel of figure 10 shows an increase in $A_{H,t}$ reduces the share of high skill entrepreneurs, slightly more than in the baseline case. This is because an increase of $A_{H,t}$, coupled with the relative scarcity of the high skill workers in the economy, makes the wages for this group increase very fast, decreasing the incentives for high skill workers to become entrepreneurs. On the other hand, although low skill households are relatively less able as entrepreneurs, they experience an increase in their profits as the high skill workers that they hire are, in fact, more productive. Moreover, the relative abundance of low skill workers implies that their wages do not increase as much compared to my baseline results. Consequently, the share of low skill entrepreneurs
increases, as it is shown by the circled-red line in the rightmost panel of figure 10.

Next, I consider the transition of the economy when \( p_{k,t} \) and \( H_t \) change. In this case, share of entrepreneurs in the economy declines even further as shown by the green-squared line in the left panel of figure 10. An increase in the relative supply of high skill workers has two opposite effects. First, it depresses the wage of the high skill workers, increasing the incentives for this group to become entrepreneurs. Moreover, since high skill individuals are more productive than low skill individuals as entrepreneurs (recall the differences in \( \theta_s \)), the total effect is an increase of the share of high skill entrepreneurs in the economy, as it is shown by the green-squared line in the center panel of figure 10. On the other hand, the surge in the demand of labor and the relative scarcity of low skill workers, push their wages up, decreasing the incentives for low skill workers to become entrepreneurs. Then, because the low skill workers still represent the largest share of the population, the overall proportion of entrepreneurs declines. Taken together, an increase in the productivity of skilled workers and the increase of the supply of high skill labor explains around 75% of the drop in entrepreneurship implied by the model.

Finally, a change in the relative price of capital brings the green-squared line in the left plot of figure 10 to the black-starred line. Due to capital-skill complementarity, a decrease in the price of capital goods boosts the demand for high skill workers, increasing their wages and depressing their incentives to become entrepreneurs bringing down the share of high skilled individuals that decide to run their own firm while holding steady the share of low skill entrepreneurs in the economy. In summary, each of the three trends considered in my baseline exercise explains a important fraction of the decline of entrepreneurship and imply different responses of high and low skill individuals along the transition. The direct effect of the skill bias technical change takes the lion’s share of the overall decline and explains half of the drop in the proportion of entrepreneurs implied by the model.

**Figure 10 – Decomposition of the Decline in Entrepreneurship**

Note: The left panel of figure 10 shows the share of entrepreneurs implied by the model. The black starred line shows the share of entrepreneurs for the baseline case, the red circled line considers only the evolution of \( A_{H,t} \), while the green squared line considers \( A_{H,t} \) and \( H_t \). The center and right panel show similar statistics for high and low skill workers.
4.3 Inspecting the Mechanism

In the model, individuals decide in each period whether to run a firm or to work for a wage 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 workers whose wage grows faster. Since both the decrease in the price of capital goods and the increase in the productivity of high skill workers increases the marginal productivity of of labor, the productivity threshold that makes individuals indifferent between working for a wage or running a firm also increases, shrinking the share of entrepreneurs in the economy. The left panel of figure 11 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 increase faster, generating the increase in the skill premium displayed in the middle panel of figure 11, the share of entrepreneurs declines more within the group of high skill workers. Importantly, only entrepreneurs with high managerial abilities remain active and, consequently, the average value of $z$ rises as the rightmost panel of figure 11 shows. Therefore, in this model, the increase of labor earnings and the differential growth rate of wages experienced by high and low skill workers explain the declining share of entrepreneurs displayed in figures 1 and 2.

**Figure 11 – Wages, Skill Premium, and Productivity**

Note: The left panel of figure 11 shows the evolution the (log) wages in the model. The center panel shows the college premium in the data and the skill premium implied by the model. The right panel shows the evolution of the (log) average skill level of active entrepreneurs calculated as $\zeta_t = \sum_{s \in \{H,S\}} \int z_{i,t} d\zeta_t d\mu_t$.

4.4 Robustness

Increase in the Firm Creation Cost

A possible explanation for the decrease of new businesses formation is the increasing cost of the regulation affecting potential and existing entrepreneurs in the United States. The cost of regulation is difficult to measure. One proxy for this cost is the number of individual restrictions in the administrative code. Al-Ubaydli and McLaughlin (2017) provide an estimate of the
guably, an increase of the regulatory burden would deter new firm creation in a similar way that an increase in the value of $\kappa$, the creation cost in the problem of the entrepreneurs, would. Hence, in this section I ask what is the level of $\kappa$ that generates a proportion of entrepreneurs as in 2014 conditional on the parameter values of 1985. I find that the value of $\kappa$ necessary to reduce the proportion of entrepreneurs to the level observed in 2014 is almost 7 times the value of $\kappa$ in my calibration exercise. Denote this new level of the entry cost by $\tilde{\kappa}$. Next, I study the transitional dynamics generated in the model by a linear 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 $\kappa_t$. I assume that $\kappa_t$ increases linearly between 1985 and 2015 and remains fixed at the value in 2015 for the rest of the transition. For the initial value of $\kappa_t$, I take the level used in my baseline calibration, and for the terminal level I choose $\tilde{\kappa}$.

The left panel of figure 12 shows the evolution of the share of entrepreneurs resulting from an increase in the cost of firm creation. To facilitate the comparison with my previous results, the figure also shows the evolution of the entrepreneurs for my baseline calibration and the share of entrepreneurs in the data. First, notice that the decline in the share of entrepreneurs implied by an increase in the cost of firm creation is more moderate than the decline observed in the data. This is because, in anticipation of the higher future costs, some households decide to transit earlier into entrepreneurship, raising the share of entrepreneurs above the original stationary level. The increase in the share of entrepreneurs is explained by the low skill workers as shown in the right panel of figure 12. Finally, the center panel displays the transition of the high skill entrepreneurs share, which is slower than the transition in the 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 within high skill individuals.\footnote{These results might overestimate the real effect of the increase of 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 risen a 75%. In such case, keeping the rest of the parameters as in the initial stationary economy, my model would predict a decrease of 0.5 percentage points in the share of entrepreneurs, much less than the drop of 3.9 observed in the data.}
Figure 12 – Effects of an Increase of $\kappa$

Note: The left panel of figure 12 shows the share of entrepreneurs implied by a linear increase in the cost of creating a firm ($\kappa$). The center and right panel show same statistics within the group of low and high skill households.

**Myopic Transition**

So far 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 the changes of the aggregates variables and expect that the current level remains the fixed for the infinite future. In this sense, agents are perfectly myopic. This assumption does not change the equilibrium definition but modifies the information set available for the agents. Hence, one needs to change the solution algorithm accordingly. Appendix B explains in detail the algorithm used to solve the transition path in this case. The left panel of figure 13 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 of 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. Then, I conclude that assuming perfectly myopic agents does not affect the results of my model.

**Smooth Transition of Aggregates**

How my results would 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 2010–2015. I assume this constant growth rate lasts 10 years after 2015 and then each growth rate declines geometrically to reach 0 growth in 2050. The center panel of figure 13 shows
that the share of entrepreneurs and the the decline implied by the model remain basically the same as in my baseline results.

**General Equilibrium**

In the benchmark results, I have assumed a fixed interest rate. This was with the explicit purpose to highlight the effects of the change of wages on the decision of becoming an entrepreneur while muting the general equilibrium effect of the change in the interest rate on entrepreneurial cost and individuals’ savings. In this section, I study how my results change if I solve for equilibrium interest rate along with the wages of high and low skill workers. The right panel of figure 13 shows the evolution of the share of entrepreneurs in the data, in the baseline small open economy case, and in the general equilibrium case. In the latter, the share of entrepreneurs decline is half of the benchmark case. This is because the interest rate raises substantially along the transition path increasing the saving rates of the individuals in the economy. The increase of individual’s savings have two complementary 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 operate firms closer to their optimal size. These two effects increase the value of being an entrepreneur. Then, it is not surprising that the feedback of the general equilibrium dampens the effects of the changes in the wages on the share of entrepreneurs. Overall, the general equilibrium version of the model predicts a 2.0 percentage points decline 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, still, the changes in the wage distribution play an important role, and explain at least half of the fall in the share of entrepreneurs observed in the data.

**Figure 13 – Share of Entrepreneurs for Different Robustness Exercises**

Note: The left panel of figure 13 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 center panel show the transition path of the share of entrepreneurs under the assumption that aggregate variables grow at a decreasing rate after 2015. The right panel of figure 13 compares the baseline, fixed interest rate case with the evolution of the share of entrepreneurs in the general equilibrium case.
5 Policy Analysis

Several researchers consider the decline of firm creation as a negative outcome that should be addressed by policy (Haltiwanger, Decker and Jarmin, 2015). In my model, a decline of firm creation is related to a reduction of the transition rate from worker to entrepreneur. Consequently, in this section I study the aggregate response of the economy to a subsidy that intends to increase the rate of entry of new entrepreneurs to the 1985 level conditional on the parameter values in 2015. For doing that I consider a simple policy reform that directly relaxes the borrowing constraint of the entrepreneurs. Specifically, assume that the government gives a subsidy of $\alpha_t$ to finance the cost of inputs to every entrepreneur in the economy. Hence, entrepreneurs face the collateral constraint given by,

$$p_{k,t}k_t + \omega_{H,t} (\Theta_t, \mu_t) n_{H,t} + \omega_{L,t} (\Theta_t, \mu_t) n_{L,t} \leq \lambda a_t - \iota_t.$$  

Notice although this subsidy affects every single entrepreneur, it has a larger impact on small and new entrepreneurs which typically have less wealth than large, established entrepreneurs. In order to highlight the direct effect of the subsidy on entry, here I assume that the government collects revenues using a lump sum tax that affects both workers and entrepreneurs (so the level of the tax does not distort the occupational choice of the individual). Denote this lump sum tax by $\tau_g$. Then, the government budget constraint is given by,

$$\sum_{s \in H,L} \int \tau_g d\mu^*_t (\Omega_t) = \sum_{s \in H,L} \int d^*_s (a_t, z_t, y_t, w_{t-1}, p_{k,t}, \mu_t) \iota_t d\mu^*_t (\Omega_t).$$  \hspace{1cm} (10)

The equilibrium definition for this case is similar to the definition in section 3.2, with the additional restriction that the government must balance the budget in every period. Using this simple policy I run the following experiment. I start as if the economy is in a 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 worker to entrepreneurship in 1985. Columns (1) and (2) of table IV compare aggregate output, Total Factor Productivity (TFP), the tax burden as a percentage of output, and other aggregates in both stationary economies states.\(^{22}\) To reach an entry rate of entrepreneurs as in 1985, the government imposes a lump sum tax equivalent of 1.19% of the aggregate output. The increase in the entry rate

\(^{22}\)TFP is defined as $Y (K^{0.33}L^{0.67})^{-1}$. 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.
induces a rise in the fraction of entrepreneurs in the population of 1.79 percentage points and an increase in aggregate output of 1.82%. TFP increases 3.53% in the new steady state. This happens mainly for two reasons. First, on the extensive margin, some production factors are reallocated from the non-entrepreneurial sector to the new entrepreneurs owners that are, in average, more productive than the firms of non-entrepreneurial sector. Second, on the intensive margin, already existing entrepreneurs can run firms which are closer to their optimal, unrestricted, scale. This policy also induces higher welfare, measured in consumption equivalents. In particular, the average consumption equivalent required to make individuals indifferent between the baseline steady state and the one with a subsidy to firms is 0.04, that is, individuals are willing to give up some consumption to live in an economy where this subsidy is in place.\textsuperscript{23} The welfare gains, however, are not distributed equally across the population. High skill individuals experience the larger increase on welfare as they are able to run larger firms. Low skill workers also enjoy an increase in welfare as their wages go up because of the higher labor demand. The group with the lowest increase of welfare are low skill entrepreneurs. This is because, although they receive a subsidy that relaxes their borrowing constraint, the lump sum tax is large and reduces consumption, and hence, welfare, although not enough to reduce it below the level in the unsubsidized economy. In fact, the subsidy is much more effective in inducing high skill workers to become entrepreneurs than for low skill workers. The fraction of entrepreneurs that are high skill increases 88\% (from 3.27 to 6.20 percent) while the fraction of low skill entrepreneurs raises 52\% from 2.42 to 3.69 percent. Importantly, these results do not vary much regardless of the type of tax, lump sum or linear, used by the Government. To see this, column (3) shows the results of a third stationary equilibrium in which the government finances the subsidy levying a tax equivalent to a fraction $\tau_g$ of the total earnings accrued from labor or profits. In such case, the tax burden goes up to 3.34 percent of the GDP. Nevertheless, aggregate output, productivity, and the share of entrepreneurs also increase in this case. I conclude that a policy that aims to subsidy firms through a credit line that relaxes the borrowing constraint with the goal to rise the entry rate of entrepreneurs to its level in 1985 would generate large benefits for the economy.

\textsuperscript{23}The average consumption equivalent the equally weighted average of the value $\omega(\Omega)$ that solves the equation $(1 + \omega_s(\Omega))^{1-\delta} V_{s,t}^*(\Omega) = \tilde{V}_{s,t}^*(\Omega)$ where $V_{s,t}^*(\Omega)$ is the value of an individual in the original stationary equilibrium without subsidies and $\tilde{V}_{s,t}^*(\Omega)$ is the value at the new stationary equilibrium, both conditional on the same idiosyncratic states, $\Omega$. 

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Table IV – Steady State Comparison of a Subsidy to Firm Costs

<table>
<thead>
<tr>
<th></th>
<th>(1) Baseline</th>
<th>(2) Lump Sum Tax</th>
<th>(3) Linear Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidy (% of GDP)</td>
<td>0</td>
<td>2.82</td>
<td>3.34</td>
</tr>
<tr>
<td>Entry Rate (%)</td>
<td>1.55</td>
<td>2.40</td>
<td>2.40</td>
</tr>
<tr>
<td>Share of Entrepreneurs (%)</td>
<td>3.68</td>
<td>5.47</td>
<td>5.45</td>
</tr>
<tr>
<td>Share of High Skill Entrepreneurs (%)</td>
<td>3.28</td>
<td>6.20</td>
<td>5.71</td>
</tr>
<tr>
<td>Share of High Skill Entrepreneurs (%)</td>
<td>2.42</td>
<td>3.69</td>
<td>3.45</td>
</tr>
<tr>
<td>GDP</td>
<td>1.50</td>
<td>1.53</td>
<td>1.51</td>
</tr>
<tr>
<td>TFP</td>
<td>0.87</td>
<td>0.90</td>
<td>0.89</td>
</tr>
</tbody>
</table>

Note: Table IV compares 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 a lump sum tax for all individuals in the economy. Column (3) shows the results for the case in which the government levies a proportional tax on income from labor or profits.

6 Conclusion

This paper investigates the causes of the decline in the proportion of entrepreneurs in the US population. I provide new evidence on the fall in the proportion of households participating in entrepreneurial activities and in the share of households transitioning to entrepreneurship. Moreover, I show that the decline in the proportion of entrepreneurs has been concentrated among individuals with higher levels of educational attainment. Additional empirical evidence suggests that the skill level of new entrepreneurs has increased over time, which is consistent with a rise of the selection of individuals with higher managerial skills. Intuitively, if the alternative option of running a business is to be a worker, an increase in the later will diminish the incentives to become an entrepreneur and only those that are more able in running a company will decide to start a business. To the extent that a high skill worker is also a good manager, one should observe that the level of recent wages must rise for those that decide to enter into entrepreneurship. The evidence presented in this paper corroborates this intuition. Building on this evidence, I study an occupational choice model where the increase in the wage of high skill workers is the equilibrium outcome of the interplay of three exogenous trends, namely, the decrease in the price of investment, the increase in the supply of skills, and the relative increase in the productivity of high skill workers. My model is able to account for the level and the speed of the decline in the share of entrepreneurs. Moreover, I find that each of the exogenous trends is quantitatively important to explain the
drop in the fraction of entrepreneurs in the economy. In my model, entrepreneurial skill is assumed to be a random process that cannot be affected by individual's decision. Incorporating managerial capital accumulation would allow investigating further the consequences of the decline the fraction of entrepreneurs on aggregate productivity. Equally important is to consider a more realistic tax schedule, taking into account the different tax rules affecting workers and entrepreneurs. I leave these for future research.
References


A Data Appendix

A.1 PSID Sample

The PSID sample used for studying the time series of the share of entrepreneurs and other statistics used in this study was constructed as follows. From the raw data, I extract head of households from the SRC sample (I do not consider information of the SEO, Immigrants, or Latino Sample) 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 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 leave us with 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.

To calculate the parameters of the income process of equation (9) I measure earnings as the real value of total labor income of individual $i$ in period $t$. Total labor includes wages and salaries, tips, commissions, and bonuses. However, the results are quite similar if one uses wages and salaries as measure of labor income. Then, I drop all observations of individuals that are entrepreneurs in either period $t$ or $t - 1$. Given these restrictions, the parameters of equation (9) are calculated on a sample of 6,303 individuals and 58,094 observations. The value of $\rho_w$ 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 $\sigma_y$ to this value. Estimating equation (9) only for individuals with college or more generates a slightly lower estimate of $\rho_w$ 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.
A.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 selection, 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 with in the armed force or with negative weights are also excluded from the sample. Hence, the baseline sample consists on 1.7 million individual-year observations.

The share of high skill workers is the weighted proportion of individuals which are college graduate or more. The center panel of figure 7 shows the corresponding time series from 1980 to 2015. The skill premium, on the other hand, is calculated over a sub sample of wage workers only. This is because both in the model and in the literature, the skill premium only refer to 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, here I consider a sample of individuals which are not self employed that workers 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 is us a sample of 1.2 million observations. Then, the college premium is then 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. The right panel of figure 7 shows the corresponding time series from 1980 to 2015.

A.3 Macroeconomic Aggregates

In this section I show some additional details on the construction of the relative price of investment used in my quantitative exercise, and the measure of debt and equity relative to non financial private sector GDP.

I take the measure of the relative price of investment directly 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 14 shows the evolution of each of these series re scaled to 1985. The three time series show a similar declining pattern although measure of the price of investment that considers equipment and software only 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.

To 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 14 shows the resulting time series.

**Figure 14 – Price of Investment and Debt-to-GDP ratio**

Note: The left panel of figure 14 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. Debt and equity of non financial businesses is the sum of total liabilities and equity of the corporate sector and total liabilities of the non corporate sector from the Flow of Funds. GDP is non financial and non insurance private GPD.

**B  The Algorithm**

The solution of the model implies calculating an initial and final steady state, and the complete transition path of aggregate states and factor prices, given the exogenous sequence
of $p_{k,t}$. On top of the the well known complications of solving an heterogenous agents models, the present model requires finding a combination of three prices that simultaneously clear the markers capital, high skilled labor, and low skilled.

To solve the steady states of the economy I proceed as follows. Consider that the economy is in the steady state in $t = 0$ and $p_{k,t} = p_{ss,0} = 1$, $H_t = P$ and $A_{H,t} = 1$ and individuals expect this vector of aggregate 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.

- **S1:** Given an an initial distribution of individuals over idiosyncratic states, $\mu_t$, 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 $K_{D,e}^S, N_{H}^{D,e},$ 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 this results 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 none linear expression, $p_{ss,0} (\tilde{r} + \delta) - F_K (N_H, N_L, K) = 0$.

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

$$- \tilde{\omega}_H - F_H (N_H, N_L, K),$$

$$- \tilde{\omega}_L - F_L (N_H, N_L, K),$$

$$- K^S - K + K^{D,e}$$

If the sum of the last three expressions is greater than $10^{-6}$, go to S0 using with a new guess of prices. If not, the equilibrium set policy function, value function, prices, and stationary distribution has been found.
Notice that we could calculate in S2 the residual demand of capital for the corporate sector, and go directly to S4 to check \( \tilde{r} = F_K(N_H, N_L, K) \). In practice, I have found that this algorithm is much more stable since 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, \( p_{k,t}, A_{H,t}, \) and \( H_t \).

To calculate the transition path of the economy between an initial and final steady states requires taking an stand of what do the household know about the evolution of the economy from period 0 to the infinite future. Here we can take two extremes cases. One can assume 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.

Given a sequence of aggregate states \( \Theta_t = \{p_{k,t}, A_{H,t}, H_t\}^{T}_{t=0} \) and a fixed value of the vector after \( T \) periods, \( \Theta_T = \{p_{k,T}, A_{H,T}, H_T\} \) for all \( t > T \), I proceed as follows,

- **P0**: take \( \Theta_t = \Theta_0 \) and \( \Theta_t = \Theta_T \) and calculate the corresponding stationary equilibria 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 \( \{\tilde{\omega}_{H,t}, \tilde{\omega}_{L,t}, \tilde{r}_t\}^{t=T}_{t=1} \) 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

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

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

on a grid of \( a's, z's, \) and \( y'z \). Do the same for workers, and record the the value functions, \( V_{T-1}^w \).

- **P3**: Go to period \( T - 2 \), take \( V_{T-1}^h \) 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 \( \{ \tilde{\omega}_{H,t}, \tilde{\omega}_{L,t}, \tilde{r}_t \}_{t=1}^{T} \), but 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, \( V_t^s \) for \( s = \{ H, L \} \), solve for a new set of prices \( \{ \omega_{1,H}, \omega_{1,L}, r_1 \} \) that clears the markets and record the resulting \( \mu_1 \) without using the guessed sequence of prices

- **F2**: To solve the equilibrium in a given period
  
  - (A) Guess \( \{ \tilde{\omega}_{1,H}, \tilde{\omega}_{1,L}, \tilde{r}_1 \} \) and solve the problem of the agents
  
  - (B) Given \( \mu_0 \) and the policy functions, calculate the excess demand and check market clearing as S4
  
  - (C) If prices clear the markets (tolerance \( 10^{-5} \)) stop, record the new equilibrium prices and the results distribution, \( \mu_2 \) 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, \( \{ \omega_{t,H}, \omega_{t,L}, r_t \}_{t=1}^{T} \). Compare them with \( \{ \tilde{\omega}_{t,H}, \tilde{\omega}_{t,L}, \tilde{r}_t \}_{t=1}^{T} \) 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 otherwise

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.

Finally, we can assume that individuals are surprised every period by the changes of the exogenous process of \( \Theta_t \) 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, \( \mu_0 \)
• M2: Go to period $t = 1$ with $\Theta_1$ 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 $\mu_0$ 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 $\mu_0$ to $\mu_1$ 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 need 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 coarse 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 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.
C Appendix Figures

Table V – Sample Characteristics

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Num. obs per year</td>
<td>2,922</td>
<td>609</td>
<td>526</td>
<td>372</td>
<td>203</td>
</tr>
<tr>
<td>Fam. Income (M)</td>
<td>69.2</td>
<td>123.3</td>
<td>124.4</td>
<td>134.8</td>
<td>161.2</td>
</tr>
<tr>
<td>Age (mean)</td>
<td>39.8</td>
<td>43.1</td>
<td>43.2</td>
<td>44.0</td>
<td>44.3</td>
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<tr>
<td>Males (%)</td>
<td>70.7</td>
<td>89.7</td>
<td>90.0</td>
<td>91.7</td>
<td>92.9</td>
</tr>
<tr>
<td>Drop Outs (%)</td>
<td>7.4</td>
<td>2.8</td>
<td>2.8</td>
<td>2.8</td>
<td>1.4</td>
</tr>
<tr>
<td>High School (%)</td>
<td>31.1</td>
<td>24.3</td>
<td>25.0</td>
<td>25.9</td>
<td>18.3</td>
</tr>
<tr>
<td>Some College (%)</td>
<td>26.4</td>
<td>25.4</td>
<td>25.9</td>
<td>25.5</td>
<td>22.4</td>
</tr>
<tr>
<td>College and More (%)</td>
<td>35.2</td>
<td>47.5</td>
<td>46.4</td>
<td>45.8</td>
<td>57.9</td>
</tr>
<tr>
<td>White (%)</td>
<td>87.2</td>
<td>95.5</td>
<td>95.6</td>
<td>96.0</td>
<td>96.3</td>
</tr>
<tr>
<td>10th Pct. Wealth (M)</td>
<td>-7.8</td>
<td>5.5</td>
<td>6,252</td>
<td>15249</td>
<td>39.2</td>
</tr>
<tr>
<td>50th Pct. Wealth (M)</td>
<td>39.0</td>
<td>267.0</td>
<td>278.9</td>
<td>358,9</td>
<td>493.0</td>
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<tr>
<td>90th Pct. Wealth (M)</td>
<td>414.2</td>
<td>1,605.0</td>
<td>1,729.2</td>
<td>2,068.5</td>
<td>2,601.3</td>
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<tr>
<td>95th Pct. Wealth (M)</td>
<td>684.9</td>
<td>2,750.0</td>
<td>2,959.4</td>
<td>3,497.8</td>
<td>4,326.6</td>
</tr>
</tbody>
</table>

Note: Table V reports statics of a sample of heads of households ages between 22 and 60 years old. See appendix A.1 for additional details on the sample selection. Each statistics is the sample average across the waves of 1985 to 2015. Business owners are individuals that declare owning a business. Active business owners declares have a business and have worked for it in a given year. Are active business owners that declare be self employed. Entrepreneurs are the subset of 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 if savings checking accounts, bonds, stocks, IRA, housing equity, other real state, and vehicles, minus total debt. All statistics, with the exception of the number of observation, were calculated using sample weights.
Figure 15 – Average of Recent Labor Income

Note: Figure 15 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 16 – Proportion of Entrepreneurs and Confidence Intervals

Note: Figure 16 shows
**Figure 17 – Proportion of Entrepreneurs and Confidence Intervals**

Note: Figure 17 shows the proportion of entrepreneurial households. Dashed lines show 95% percent bootstrapped Confidence Intervals. See note in table I for more details on the classification of entrepreneurial households.

**Figure 18 – Proportion of Entrepreneurs – Additional Definitions**

Note: Figure 18 shows the proportion of households that are neither business owners nor self employed in period $t$ that are classified as entrepreneurs in period $t + 2$ for different definitions of entrepreneurship. The right panel shows the same statistics rescaled to the corresponding value in 1985.
Figure 19 – Share of Entrepreneurs within Different Age groups

Note: Figure 19 shows the fraction of entrepreneurs within three different age groups. Business owners are households that declare to have some business interest, active business owners are households that own a business and whose head or spouse declares to have worked for the business. Self employed business owners active business owner whose head is self employed. Entrepreneurs are self employed business owners whose head declares to be a manager or a professional.
Figure 20 – Average Wages and Salaries Income for Workers

(a) Some College or More

Switching Households

\[ y = 10.75^{**} + 0.014^{**} \text{ year} \]
\[ R^2 = 44.12\% \]

Non Switching Households

\[ y = 10.78^{**} + 0.003^{**} \text{ year} \]
\[ R^2 = 27.85\% \]

(b) High School Graduates or Less

Switching Households

\[ y = 10.56^{**} - 0.010^{**} \text{ year} \]
\[ R^2 = 37.70\% \]

Non Switching Households

\[ y = 10.41^{**} + 0.001^{**} \text{ year} \]
\[ R^2 = 1.80\% \]

Note: Figure 20 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 21 – Average Total Labor Earnings for Workers

(a) Some College or More

Switching Households

\[ y = 10.78 + 0.013 \text{ year} \]

\[ R^2 = 40.74\% \]

Non Switching Households

\[ y = 10.79 + 0.003 \text{ year} \]

\[ R^2 = 30.54\% \]

(b) High School Graduates or Less

Switching Households

\[ y = 10.58 - 0.010 \text{ year} \]

\[ R^2 = 39.62\% \]

Non Switching Households

\[ y = 10.41 + 0.001 \text{ year} \]

\[ R^2 = 1.80\% \]

Note: Figure 21 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 22 – 50th Percentile of the Labor Income For Workers

Note: Figure 22
**Figure 23 – 90th Percentile of the Labor Income For Workers**

Note: Figure 23

### D Evidence from CPS

The decline of the share of entrepreneurs documented in section 2 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 I 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 patterns 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 overlap, analysis 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 24 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 24. Figures 25 and 26 complement these results showing the decline of 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 sectors the decline of the share of self employed is more evident. For doing that, I calculate the share of self employed individuals within 14 different sectors. 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 27 shows the share of self employed workers within each industry rescaled to its value in 1985. With the exception of manufacturing, the decline of 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 24 – Share of Self Employed in the Population**

![Graph showing the share of self employed in the population over time, with two panels comparing the CPS and PSID data.](image)

Note: Figure 24 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 25 – Proportion of Self Employed by Age Groups – CPS**

Note: Figure 25 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 26 – Proportion of Entrepreneurs within Education Groups – CPS data**

Note: Figure 26 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 27 – Proportion of Self Employed within Industry Sectors – CPS data

Note: Figure 27 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.