Essays on Entrepreneurship

by

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Abstract

It is often argued that borrowing constraints are crucial to the understanding of entrepreneurial activity in the United States. However, portfolio data and calibration exercises raise doubts about the importance of borrowing constraints. This thesis provides three chapters on the subject of entrepreneurship, two study the role of borrowing constraints and another shows that introducing uncertainty about ability in an occupational choice model without financial frictions can generate many patterns that resemble capital market imperfections.

In the first chapter, I model agents who are imperfectly informed about their entrepreneurial ability and whose income provides a signal about their ability. In each period, they observe their income and choose their occupation (worker or entrepreneur) for the next period on the basis of their belief about their ability. I find that such a model produces patterns of wealth, savings, entry into entrepreneurship, and correlations between cash flow and investment that are consistent with the data. While previous work has used these patterns to argue that entrepreneurs face binding borrowing constraints, this paper shows that the same patterns may emerge simply because entrepreneurs are uncertain about their ability and learn slowly about it.

In the second chapter, I use cross-sectional and panel data from the Survey of Consumer Finances across occupations and occupational transition groups. I argue that the evidence on mortgage rates and holdings of stocks and bonds of entrepreneurs are at odds with theories that propose borrowing constraints as the key ingredient in understanding occupational choice and entrepreneurial activity in the United States.

Finally, the last chapter uses a standard general equilibrium model of occupational choice to study the role of financial constraints, finding that borrowing constraints are tighter in the model than in the data. Next, I recalibrate the model to match measures of firm size and slack in the financial constraint given by the real estate equity available for borrowing on the entrepreneur's primary home. Finally, two policy experiments are analyzed for both calibrations, highlighting the equilibrium effects of the differing degrees of tightness in the borrowing constraints.

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Chapter 1

Entrepreneurship, Learning, and Wealth

Abstract

It is often argued that borrowing constraints are crucial to the understanding of entrepreneurial activity in the United States. However, data on the portfolios of entrepreneurs raise doubts about the importance of borrowing constraints: most entrepreneurs are not taking full advantage of the equity in their homes to finance their businesses, and hold positive positions in stocks and bonds. Motivated by this fact, I propose a theory that does not rest on borrowing constraints and nevertheless succeeds in replicating a number of key facts that have been previously used as evidence of capital market imperfections. The core of this theory is a simple learning mechanism. In my model, agents are imperfectly informed about their entrepreneurial ability (their type) and entrepreneurial ability is positively correlated with income. In each period, agents use their income realization to update their belief about their own type. They then choose their occupation (worker or entrepreneur) on the basis of their belief. In the dynamic stationary general equilibrium of the model, the following patterns emerge: 1) positive correlation between cash flow and investment; 2) higher propensity of starting a business for wealthier agents; 3) entrepreneurs are wealthier than workers, even holding income levels constant; 4) upward mobility for workers who enter entrepreneurship, and downward mobility for exiting entrepreneurs; and 5) savings rates that are higher for those entering entrepreneurship and lower for those exiting (compared to those who stay as workers or stay as entrepreneurs). While previous work has used these patterns to argue that entrepreneurs face binding borrowing constraints, this paper shows that the same patterns may emerge simply because entrepreneurs are uncertain about their ability and learn slowly about it.

1.1 Introduction

There is a vast literature interested in whether borrowing constraints are relevant for entrepreneurs in the United States. Such constraints on entrepreneurial activity would indeed have consequences for issues such as wealth accumulation, occupational choice, and optimal taxation policy. One important implication of these models is that entrepreneurs should be investing the marginal dollar of their wealth in their businesses. I first provide evidence on the portfolio of entrepreneurs suggesting that this is not the case. Then, I propose an occupational choice model in which I substitute imperfect information for financial frictions. Finally, I show that such a model can match the stylized facts that have previously been associated with the role of borrowing constraints without generating the unfounded implications for the portfolios of entrepreneurs.

Papers that emphasize the importance of borrowing constraints for entrepreneurial activity stress a handful of stylized facts as supportive evidence of capital market imperfections. Numerous empirical papers study the positive correlations between cash flow and investment. A well known example is Fazzari, Hubbard, and Petersen (1987). They study large publicly-traded manufacturing firms and conclude that a positive correlation between cash flow and investment is evidence of imperfect capital markets. Other papers, such as Petersen and Rajan (1994) and Rauh (2006), have taken a more indirect approach to looking at borrowing constraints through the use of internal versus external funding. Both of these studies show that firms that one would expect *a priori* to be more constrained (lower credit ratings for Rauh and younger firms for Petersen and Rajan), exhibit a stronger sensitivity of investment to internal financing.

Another set of papers study the role of borrowing constraints as a factor in deciding whether to enter entrepreneurship. On one hand, Evans and Jovanovic (1989), Evans and Leighton (1989), Van Praag and Van Ophem (1995) find a positive correlation between net wealth and the probability of starting a business. In the same vein, Blachflower and Oswald (1998) and Holtz-Eakin, Joulfaian, and Rosen (1994a,b) use inheritances as an exogenous instrument of wealth to avoid the endogeneity problem of wealth and entrepreneurial success. However, more recently, Hurst and Lusardi (2004) document that for most of the population the positive wealth-business entry relationship that supports the liquidity constraint literature fails to hold. They find that there is no relationship for most of the wealth distribution, and that the relationship is only present for the top 5% of the income distribution. They provide three reasons for the importance of wealth on entry at the top of the distribution:1) wealthier agents have higher tolerance for risk, 2) successful professionals accumulate high amounts of wealth and become business owners in their professional industries, and 3) echoing Moskowitz and Vissing-Jorgensen (2002), business ownership is a luxury good. The model proposed in this paper is consistent with their second reason, or the idea that successful professionals accumulate high wealth and become business owners themselves. In response to the literature that finds that the probability of starting a business responds strongly to past inheritances, Hurst and Lusardi counter that inheritances are extremely concentrated at the top of the wealth distribution and that they are likely to proxy for more than just liquidity. They find that future inheritances predict current switches into entrepreneurship as well as inheritances received in the past, and conclude that households receiving inheritances have different entrepreneurial propensities –conditional on wealth– than those who do not receive inheritances. In summary, a linear relationship between wealth and entry to enterpreneurship yields a positive correlation, however, a closer look at this relationship reveals that it is only significant at the top of the wealth distribution.

There is another strand of literature that uses numerical simulations to study the decision to become an entrepreneur and the accumulation patterns of entrepreneurs versus workers. In Quadrini (2000), Cagetti-Denardi (2006), and Buera (2007), constrained entrepreneurs have a greater incentive to save than workers in order to escape borrowing constraints and grow their businesses. This leads to wealth allocations and saving patterns that are consistent with the data. In addition, Quadrini (2000) highlights that the upward wealth mobility documented for entrepreneurs can also be reproduced.

I develop an occupational choice model, much like Quadrini (2000) and Cagetti and Denardi (2006), but unlike them I do not impose an ad-hoc financial constraint. In my model, agents are allowed to hold positive or negative amounts of a risk-free asset. The basic ingredient in my model is that agents are imperfectly informed about their ability. Overtime, agents observe their income realization and update their beliefs about their type. In each period, they optimally choose their occupation (worker or entrepreneur), their holdings of the risk-free asset and their investment. A calibrated version of my model generates the following seven predictions:

1. Entrepreneurs are wealthier than workers;
2. Wealth increases the propensity of becoming an entrepreneur for those at the top of the wealth distribution;
3. Entrepreneurs have higher wealth-to-income ratios than workers;
4. There is a positive correlation between cash flow and investment;
5. Transition matrices for family wealth show that entrepreneurs are more upwardly mobile;
6. There is upward mobility for entrepreneurs in terms of wealth-to-income ratios;
7. New entrepreneurs have higher savings rates, followed by continuing entrepreneurs, non-entrepreneurs and entrepreneurs that exit their businesses (which have a negative savings rate).

These predictions are consistent with the data and, while previous work has used these stylized facts as indirect evidence of borrowing constraints, in my model they can be generated without needing this assumption. Whereas the literature studying financial constraints would argue that the propensity to become an entrepreneur increases with wealth because wealthier agents can escape borrowing constraints by self-finance or by providing more collateral, in my model more able workers earn higher incomes, accumulate higher wealth, slowly learn that they are of high ability, and become entrepreneurs.

The argument that imperfect information about ability implies that high cash flows lead to high firm growth was already present in Jovanovic (1982) while studying the evolution of firms within an industry in the context of complete markets. His explanation was that, when cash flows are positively correlated with a firm's ability or efficiency, a high cash flow today leads to higher expected returns on investment and a higher investment today.

By applying Jovanovic's idea to privately-owned businesses, linking a firm with a household, I create a positive correlation between firm cash flow and household income. With incomplete risk-sharing, increases in income imply increases in wealth. Together, this generates a positive correlation between wealth and both the level of investment and occupational choice, allowing the model to replicate the stylized facts listed above.

The rest of the paper is organized as follows. Section 2 describes the empirical motivation of the paper and section 3 lists the stylized facts that are common in the borrowing constraint literature. Section 4 describes and solves a simple partial equilibrium model for entrepreneurs that conveys the basic intuition of the learning mechanism that I am proposing. Section 5 describes the dynamic occupational choice model that is used in the numerical simulations. Section 6 presents the results of the calibration exercise and shows that learning about one's ability over time can qualitatively match the stylized facts. Section 7 concludes.

1.2 Motivation

This section is included for completeness. A more in-depth analysis of what is presented here can be found in the companion paper "Portfolios of entrepreneurs: are borrowing constraints really binding".

I use data from the Survey of Consumer Finances of 2004 to describe the portfolios of entrepreneurs and nonentrepreneurs. The data includes population weights which allow the calculation of population estimates from the sample data. I use these weights in all my calculations. The SCF deals with missing data by providing five replications for each household. Hence, multiple imputation techniques must be taken into account when analyzing the data.

Before analyzing the data, one must choose a definition of entrepreneurship. An entrepreneur could be defined as an agent who holds business assets. This, however, includes agents that do not have an active role in the management of the firm. Another way to distinguish between entrepreneurs and non-entrepreneurs using the SCF is by considering as entrepreneurs those that are self-employed in their main job, whereas workers are paid a wage. On the other hand, this method includes agents that can't find a job and must rely on some sort of self-employment for a living.

First, it is necessary to define an entrepreneur in terms of my data source. I follow the definition used by Cagetti and De Nardi (2006), where entrepreneurs are the intersection of those who are self-employed and those who hold an active management role in a business[1]. Following this method, entrepreneurs make up 6.8% of the U.S. population.

The vast majority of entrepreneur (86.2%) live in a home owned at least in part by themselves or a member of their household, as opposed to renting their home (12% of entrepreneurs) or other more infrequent arrangements. I propose that business owners could access the equity in their homes as a source of finance for their entrepreneurial activity. Even for those entrepreneurs that do not own their homes, roughly half of them report to have positive equity in other types of real estate. Hence, they too could potentially finance their entreprises with mortgages. I focus on primary residences since this affects over six out of seven entrepreneurs.

[1] I also computed the results below taking as entrepreneurs those that are self employed and hold assets of over $5,000 in value in a business in which they have an active management role. The results were not sensitive to this definition change.

Table 1.1: **Ratio of debt secured by primary residence to house value**

	Entrepreneurs	Nonentrepreneurs
Conditional median[a]	54.7	56.4
Ratio of debt to value of home[b]	32.9	35.2
Ratio of debt to value of home by wealth class		
Class 1	65.0	82.0
Class 2	68.2	52.1
Class 3	31.0	26.3

Source: Calculation uses 4,519 households from the 2004 Survey of Consumer Finances.
[a] The conditional median is the median among households with debt secured by their home.
[b] Ratio of total debt secured by primary residence to total value of homes owned by occupation (entrepreneur or nonentrepreneur).

The first two rows of Table 1.1 present alternative measures of debt secured by primary residence as a fraction of house value for both entrepreneurs and workers. The first measure is conditional on having debt secured by primary home, while the second measure is an unconditional average. As can be seen, entrepreneurs and nonentrepreneurs hold similar amounts of debt secured by primary home as a fraction of their home value (this includes mortgages, home equity loans, and home equity lines of credit). Moreover, for those entrepreneurs with debt secured by their home, the median ratio of this debt is of 54.7% of the house value. If we believe that borrowing constraints are important for U.S. entrepreneurs, then this piece of evidence presents a puzzle. Why wouldn't cash-strapped business owners use the equity in their homes as a ready source of financing for their entrepreneurial activity by maxing out their mortgages? Moreover, separating entrepreneurs by wealth classes only compounds the puzzle. I group surveyed agents into three wealth classes, class I being the poorest. Poorer entrepreneurs, who might experience tighter constraints, actually have lower mortgage rates than workers within their class.

At first glance, it may seem relevant to look at total debt holdings, not only mortgage debt, to conclude that entrepreneurs are not obtaining as much external financing as they could.

However, non-mortgage debt is harder to interpret given that total debt-to-asset ratio can be low due to demand or supply considerations. For instance, a low debt ratio may be the result of little need for outside debt or of a binding borrowing constraint that does not allow the business owner to incur in higher debt. Nevertheless, the ratio of total debt to assets is lower for entrepreneurs, even when excluding business assets as can be seen in Table 2.8. Because entrepreneurs are wealthier than workers, the conditional medians of debt for entrepreneurs are higher than that of workers.

Table 1.2: **Debt allocations of entrepreneurs and nonentrepreneurs**

	% with asset[a]	Conditional Median[b]	Portfolio Share[c]	
Entrepreneurs				
Debt secured by primary home	65.2	132,800	5.5	10.0
Other debt	71.5	16,458	2.2	4.0
All debt	85.1	130,666	7.7	14.0
Nonentrepreneurs				
Debt secured by primary home	46.6	91,400	13.5	
Other debt	66.4	10,966	4.3	
All debt	75.8	50,740	17.8	

Source: Calculation uses 4,519 households from the 2004 Survey of Consumer Finances.
[a] Weighted percentage of households with debt holdings of each type by group
[b] Shows the conditional median which is the median debt holding among households with that type of debt by group. Values are in 2004 dollars
[c] The portfolio share is the ratio of the total debt to total assets, by groups. For entrepreneurs there are two columns. The first column is the portfolio share as previously defined and the second column excludes business assets from total assets.

Next, I study the asset holdings of entrepreneurs versus workers. Gentry and Hubbard (2004) find that both types of agents hold, on average, very similar portfolio's aside from active business assets held by entrepreneurs. I focus on financial assets in Table 2.11, because nonfinancial assets of these small entrepreneurs could be associated to the activity of their business (vehicles and real estate that are used for their everyday operations). In the strictest version of the borrowing constraint story, business owners facing binding liquidity would invest as much as possible in their businesses. I find that entrepreneurs are in fact investing as much as workers in financial assets such as stocks and bonds. An important clarification to make is that this holds when excluding holdings in retirement accounts which might prove difficult or costly to use as financing for investing in one's business. Nevertheless, the entrepreneurs' desire to diversify away from their sizeable investments in their businesses might be driving their holdings of financial assets, especially when considering that the portfolio share of business assets to total assets is on average 44.8%.

Table 1.3: **Financial Assets of entrepreneurs and nonentrepreneurs**

	% with asset[a]	Portfolio Share[b]	
Entrepreneurs			
Total financial	99.2	23.4	42.4
Financial minus retirement accounts	99.2	17.4	31.6
Pooled investment funds	25.2	4.0	7.2
Stocks	33.7	4.5	8.3
Bonds	5.3	1.7	3.1
Nonentrepreneurs			
Total financial	93.4	40.5	
Financial minus retirement accounts	92.9	26.9	
Pooled investment funds	14.3	5.7	
Stocks	19.7	6.9	
Bonds	1.5	2.0	

[a] Weighted percentage of households with asset holdings by occupation (entrepreneur or nonentrepreneur).
[b] Ratio of total debt/asset to total assets, by groups. For entrepreneurs, the second column excludes business assets from total assets.

1.3 Stylized Facts

The following stylized facts have been used to argue in favor of binding borrowing constraints for entrepreneurs.

1.3.1 Wealth and Entrepreneurship

Starting a business requires up-front capital. If an agent faces binding borrowing constraints, access to external funding is limited or costly. Hence, the agent's wealth prior to starting a business determines his propensity to become an entrepreneur. There are many papers that argue that wealthier agents are more likely to become entrepreneurs. Evans and Jovanovic (1989), Evans and Leighton (1989), Holtz-Eakin, Joulfaian, and Rosen (1994a,b), Blanchflower and Oswald (1998) are just a few. Hurst and Lusardi (2004) find that repeating the linear specification of these previous papers reveals that an increase in wealth of $100,000 would increase the probability of business ownership by 10%, from roughly 4.5% to 5%. This result is similar to those reported by other authors using different data sets and sample periods. Nevertheless, Hurst and Lusardi's main conclusion is that the relationship between wealth and entrepreneurship is non-linear and driven by households at the top of the 5% of the wealth distribution.

In line with this finding, business households tend to be concentrated in the higher wealth classes. Quadrini (2000) uses the Panel Study of Income Dynamics (1984,89,94) and the Survey of Consumer Finances (1989,92) to show that about three quarters of all families at the top 5% of the wealth distribution are business families. In addition, entrepreneurs are wealthier, even when controlling for income. Quadrini (2000) documents that approximately 14% of all families are business families in the PSID sample; they earn about 22% of total income and own 40% of total wealth. Similar findings are highlighted by Gentry and Hubbard (2004).

The empirical relationship between wealth and entrepreneurship can be summarized as follows:Quadrini(2000) pp.4-7, Gentry-Hubbard (2004) pp.5-9

1. Entrepreneurs are wealthier than workers;

2. Wealth increases the propensity of becoming an entrepreneur for those at the top of the wealth distribution;

3. Entrepreneurs have higher wealth-to-income ratios than workers.

1.3.2 Cash flow and Investment

Perhaps the most notable stylized fact of the borrowing constraint literature is that investment has an excessive sensitivity to cash flows in businesses that cannot borrow from external funds. Fazzari, Hubbard, and Petersen (1987) develop a model for publicly-traded firms in which those firms that retain much of their income are suffering from financing constraints. They group a panel of manufacturing firms into four categories according to their dividend-to-income ratio, finding that the correlation between cash flow and investment increases as firms retain more of their income. They mention in passing that the importance of internal financing is likely to be more dominant for smaller non-publicly traded firms, which typically have less access to external funds. I find that there is in fact a positive correlation between past cash flow and investment using the Survey of Consumer Finances 1984-89. The correlation from the survey data is presented in the results section for comparison with the correlation produced by the model.

Petersen and Rajan (1994), who look at firms and their creditors, find that the older the firm (and the longer its lending relationship) the lower the chance it is late on a payment and the higher the chance it pays suppliers early to get a discount. In turn, Rauh (2006) takes advantage of nonlinear funding rules for defined benefit pension plans to argue that contributions to these plans deplete a firm's internal financial resources and deter investments. Moreover, the drop in capital expenditure when there is a mandatory contribution to the pension plans is larger for firms that are younger, have capital expenditures greater than their cash flows, lower credit ratings, low dividend-to-income ratios, and less cash on their balance sheets. These findings suggests that firms that experience tighter financial constraints *a priori* rely more heavily on internal financing for their day-to-day operations.

In summary, continuing the list started earlier: Fazzari, Hubbard, Petersen pp. 24,26

4. There is a positive correlation between cash flow and investment;

1.3.3 Wealth class mobility

The undertaking of a business activity is a way for households to become wealthier, even when normalizing by income. Quadrini (2000) splits households into three wealth groups and four wealth mobility groups according to their occupational choice: staying workers, workers switching into entrepreneurship, staying entrepreneurs, and entrepreneurs exiting entrepreneurship. He finds that worker families that enter entrepreneurship tend to move to higher wealth groups, while business families that exit entrepreneurship tend to move to lower wealth groups.

The upward mobility of entrepreneurs and entrants and the downward mobility of households that exit entrepreneurship lead Gentry and Hubbard (2004) to look at household savings. They define savings rate as the change in net worth divided by the average income of the two years surveyed divided by six (the number of years between the 1984 and 1989 survey). They report median regressions in which new entrepreneurs save the most out of their income. Entrants to entrepreneurship save 35% more of their average annual income than households that remain as workers. Continuing entrepreneurs also have higher savings rates than workers, while those that exit their businesses have the lowest (and negative) savings rate. Caner (2003) goes a step further, highlighting that entrants into entrepreneurship are the group with the highest wealth increase, even when business assets are excluded from the wealth measure.

In summary, the last set of stylized facts is:Quadrini(2000) pp.6-9; Gentry-Hubbard pp. 27-29, 30-35; Caner (2004) p. 30; Buera (2006)

5. Transition matrices for family wealth show that entrepreneurs are more upwardly mobile;

6. The same pattern exists for wealth-to-income ratios;

7. New entrepreneurs have higher savings rates, followed by continuing entrepreneurs, non-entrepreneurs and entrepreneurs that exit their businesses (which have a negative savings rate).

1.4 Partial Equilibrium Model of Entrepreneurs

Much of the intuition of how imperfect information and learning can affect investment and savings decisions can be conveyed by a simple partial equilibrium model that precludes occupational choice. Business owners have a prior of their own entrepreneurial ability. Every period, they receive a noisy signal of their ability through their income. Overtime, they update their belief and hence refine their perception on how successful their business will be, while reoptimizing their investment decision based on the new information.

Preferences can be specified as follows

$$U_0 = \sum_{t=0}^{\infty} \beta^t u(c_t),$$

where β is the discount rate. Entrepreneurs have a constant absolute risk aversion (CARA) utility given by

$$u(c_t) = -\frac{e^{-\gamma c_t}}{\gamma}.$$

Let c_t, k_{t+1} and b_{t+1} denote the consumption, capital and bond purchases in period t. The budget constraint in period t is given by

$$c_t + k_{t+1} + b_{t+1} = (1+r)b_t + (1 + A_t - \delta)k_t,$$

where $(1+r)b_t$ is financial income and $(1 + A_t - \delta)k_t$ is the sum of capital invested in business in period t and business income net of depreciation. A_t is the sum of two unknown random variables θ and ϵ_t. The time-invariant term θ represents the agent's intrinsic ability and has a mean of $\overline{\theta}$ (the agent's prior) and a variance of σ_θ^2. The time-varying shock ϵ_t has mean zero and a variance of σ^2. The information structure is summarized by:

$$
\begin{aligned}
A_t &= \theta + \epsilon_t \\
\epsilon_t &\sim N(0, \sigma^2) \\
\theta &\sim N(\overline{\theta}, \sigma_\theta^2), \overline{\theta} > 0.
\end{aligned}
$$

Defining a_t as the sum of financial and non-financial assets $a_t \equiv b_t + k_t$, and λ as the per unit cost of capital $\lambda \equiv r + \delta$, the budget constraint can be rewritten for convenience as

$$c_t + a_{t+1} = (1 + r)a_t + (A_t - \lambda)k_t,$$

where the last term is the profit net of cost of capital and is denoted as $z_t \equiv (A_t - \lambda)k_t$. Finally, the right hand side of the budget constraint above can be defined as $x_t \equiv (1+r)a_t + (A_t - \lambda)k_t$, which is the total cash in hand in period t. The budget constraint can be conveniently defined as

$$c_t + a_{t+1} = x_t$$

The timing of the problem is as follows, in every period t, the entrepreneur decides the level of capital k_t based on his belief about A_t. He then observes the realization of A_t and decides how much to consume c_t and how much to invest in assets a_{t+1}.The optimal level of capital can be obtained outside of the dynamic optimization problem that is described later and is given by

$$
\begin{aligned}
k_t^* &= \frac{E_{t-1}(A_t)-\lambda}{\gamma Var_{t-1}(A_t)} = \frac{E_{t-1}(\theta)-\lambda}{\gamma(Var_{t-1}(\theta)+\sigma^2)};\text{ where } k_t=\max(k_t^*,0)\\
E_{t-1}(\theta) &= \frac{(\frac{\sigma^2}{t-1})^{-1}\overline{A}_{t-1}+(\sigma_\theta^2)^{-1}\overline{\theta}}{(\frac{\sigma^2}{t-1})^{-1}+(\sigma_\theta^2)^{-1}},\text{ for } t=2,3...\\
\text{where } \overline{A}_{t-1} &\equiv \frac{1}{t-1}\sum_{i=1}^{t-1}A_i,\text{ for } t=2,3...\text{ and } E_0(\theta)=\overline{\theta}\\
Var_{t-1}(\theta) &= \frac{1}{(\frac{\sigma^2}{t-1})^{-1}+(\sigma_\theta^2)^{-1}}\text{ for } t=2,3...\text{ and } Var_0(\theta)=\sigma_\theta^2\ .
\end{aligned}
$$

Optimal investment depends positively on the expected net return $E_{t-1}(A_t)-\lambda$, and negatively on the risk aversion coefficient γ and the variance of productivity $Var_{t-1}(A_t)$. We get the familiar result that the expected productivity, or posterior mean $E_{t-1}(\theta)$, is the weighted average of the sample mean $\overline{A}_t$ (which is the average of all previously observed productivity levels) and the prior $\overline{\theta}$, with the weights being the reciprocals of $\frac{\sigma^2}{t-1}$ and σ_θ^2 (also known as the precision parameters). Similarly the variance $Var_{t-1}(\theta)$ is the inverse of the sum of the precision parameters.

In this simple case, as t increases the agent will have a better idea of what his productivity level is and he will give more weight to the sample mean $\overline{A}_t$. In the limit, the sample mean will reveal the productivity with certainty, $Var_{t-1}(\theta)$ will shrink to zero, and the risk averse agent will invest more.

The interesting result for my purposes is that this simple model reproduces stylized fact number 4: higher past cash flows are linked to higher current investment levels. High type entrepreneurs, those with high θ, are more likely to have higher cash flows in expectation $E_{t-1}(A_t)$ and will hence choose high k_t levels. However, the mechanism at work here is not financial frictions, but rather the idea that high past cash flows will imply a larger expected productivity for this period, leading entrepreneurs to grow their businesses. This connection was already present in Jovanovic (1982) in the context of growth of firms within an industry. The key added value in this paper is that with imperfect risk-sharing, associating business profits to the entrepreneur's income allows a positive correlation between cash flow and wealth. This is modeled below.

Given the optimal level of capital found above, households choose a_{t+1} and c_t to optimize life-time utility subject to their budget constraint $c_t + a_{t+1} = x_t$. Since idiosyncratic risk is uncorrelated over time, cash in hand x_t fully characterizes the state of the household in time t. The value function $V_t(x)$ satisfies the Bellman equation

$$V_t(x_t) = \max_{(c_t, a_{t+1})} \{u(c_t) + \beta E_t V_{t+1}(x_{t+1})\}.$$

The solution method follows a guess and verify approach, in which I consider a linear consumption rule and an exponential value function typical of the CARA-normal set-up:

$$\begin{aligned} c_t &= m x_t + b, 0 < m < 1 \\ V_t(x_t) &= u(\hat{m} x_t + \hat{b}). \end{aligned}$$

The cash in hand x_{t+1} is Gaussian with conditional mean $E_t x_{t+1} = (1+r)a_{t+1} + E_t A_{t+1} k_{t+1} - \lambda k_{t+1}$, and variance $Var_t x_{t+1} = k_{t+1}^2 Var_t(A_{t+1})$. The value function satisfies

$$E_t V_{t+1}(x_{t+1}) = V_{t+1}(E_t x_{t+1} - \frac{\gamma}{2} Var_t(x_{t+1})).$$

The Euler equation determines the optimal savings and is given by $u'(c_t) = \beta(1+r)E_t u'(c_{t+1})$, or equivalently,

$$E_t c_{t+1} - c_t = \frac{1}{\gamma} \ln \beta(1+r) + \frac{\gamma}{2} Var_t(c_{t+1}).$$

Using the envelope condition and the guess for $V_t(x_t)$ as a function of $\hat{m}$ and $\hat{b}$, it is easy to verify that $m = \hat{m}$ and $b = \hat{b} - \frac{\ln \hat{m}}{\gamma}$. In addition, the budget constraint and the consumption rule imply that $a_{t+1} = (1-m)x_t - b$ or more explicitly

$$a_{t+1} = (1-m)(1+r)a_t + (1-m)(A_t - \lambda)k_t - b.$$

As stated earlier, high type agents are more likely to receive higher cash flows A_t and have on average high investment k_t. Hence, they will, on average, have higher wealth levels a_{t+1}, establishing the positive relationship between firm cash flow and household wealth that is critical for my results[2].

Nevertheless, in order to see if a similar model can generate the remaining stylized facts relating workers to entrepreneurs we would need to model the occupational choice of agents in the economy. This is described in detail in the following section.

1.5 General equilibrium model with occupational choice

I now introduce a richer model that allows agents to choose whether to be workers or entrepreneurs. Aside from studying entrepreneurial income, as the simpler model above, this model also studies labor income. I also introduce standard preferences which couldn't be introduced in the first model because they would have made a closed form solution difficult. This model of an economy with workers and entrepreneurs helps produce the key results for occupational choice, wealth, and savings that the simple model could not address.

There is a continuum of infinitely lived households of measure one. Each household faces idiosyncratic risk but there is no aggregate uncertainty, as in Bewley (1977). Agents have an unknown ability type that changes every period with a positive probability. In each period, they receive a signal of their ability, update their belief accordingly, and choose whether to be an entrepreneur or a worker for the following period.

1.5.1 Preferences

Preferences can be specified as follows

[2]Using the consumption rule, the definition of x_t and the second expression for the Euler equation above, it can be obtained that $m = \frac{r}{1+r}$ and $b = \frac{1}{1+r}[(E_t A_{t+1} - \lambda)k_{t+1} - \frac{1+r}{\gamma r}\ln(\beta(1+r)) - \frac{\gamma}{2}\frac{r}{1+r}Var_t(x_{t+1})]$.

$$U_0 = \sum_{t=0}^{\infty} \beta^t u(c_t)$$

where the agent discounts the future at a rate β. The household's utility of consumption is given by

$$u(c) = \ln(c).$$

I assume an exogenous labor supply of one unit for each agent.

1.5.2 Types

The agent has one of two ability types: high θ_h or low θ_l. The ability type is unknown to the agent and changes each period with a positive probability. That is, if the agent was low (high) type one period he will become high (low) type in the next period with a probability $p_1(p_2)$. In addition, the ability level is positively correlated with income, both labor income y and entrepreneurial income A_e. Every period, the agent observes his income realization and updates his belief about his ability accordingly.

1.5.3 Beliefs

There is Bayesian updating on the belief that the agent is high type given by:

$$\mu' = \begin{cases} M_w(\mu, y|y_{-1}) \text{ for the worker} \\ M_e(\mu, A_e, y|y_{-1}) \text{ for the entrepreneur} \end{cases}$$

The Markov assumption on the income process means that an agent's belief he is of high type in the coming period depends, not only on his belief today and his income realization today, but also on his income yesterday. The reason for this is that yesterday's income realization will yield a set of transition probabilities for today's, and hence it provides extra information on the agent's ability. In the case of the entrepreneur, A_e provides an extra signal of ability.

Both M functions above take into account that an agent's ability can change each period with a probability p_1 if the agent is low type and with probability p_2 if the agent is high type. That is, if we set $\widetilde{\mu}$ to be the belief the agent is of high type after he has received the ability shock, μ' is also given by:

$$\mu' = \widetilde{\mu}(1 - p_2) + (1 - \widetilde{\mu})p_1$$

1.5.4 Technology

As in Quadrini (2000) and Cagetti-Denardi (2006), I model two sectors of production. One referring to the entrepreneurs, who use their labor in their own business, invest in capital, and don't hire outside workers. The second sector of production is the corporate sector, in which firms are not controlled by a single entrepreneur. Unlike Quadrini and Cagetti-Denardi who can motivate this sector by arguing that these firms are not likely to face the same type of financial constraints because they are not controlled by a single agent, in my model these firms deserve special treatment because they do not pose uninsurable idiosyncratic risk on a given agent as opposed to the small firms in the entrepreneurial sector. The corporate sector has a Cobb-Douglas production function

$$Y_c = F(K_c, L) = A_c K_c^{\alpha_C} L^{1-\alpha_C}$$

where K_c and L are the total capital and labor inputs in the corporate sector. A_c is constant and capital depreciates in both sectors at a rate of δ. Capital's share of income in the corporate sector is given by α_c.

The production function in the entrepreneurial sector is given by $A_e k^{\alpha_e}$, where k is the capital invested in the business and α_e is defined as usual. The total factor productivity in the entrepreneurial sector A_e depends on the business owner's type. Both high and low types' ability distributions have the same support $\mathbb{A}_e = \{A_{e,1}, A_{e,2}, A_{e,3}\}$. Nevertheless, the agents with high type will be more likely to get a high draw. In particular, I will assume that

	$A_{e,1}$	$A_{e,2}$	$A_{e,3}$
θ_l	$1-q$	q	0
θ_h	0	q	$1-q$

, where $A_{e,1} < A_{e,2} < A_{e,3}$ and $q > 1/2$.

For both types, the typical draw is $A_{e,2}$. With a probability of $1 - q$ the low types can get a lower draw $A_{e,1}$ and the high types can get a higher draw $A_{e,3}$.

1.5.5 Households

The timeline of the problem is as follows: 1) an entrepreneur picks his optimal capital level given his belief about his ability, 2) both entrepreneurs and workers receive a draw of their ability level and update their beliefs on their type, 3) they then pick their occupation for next period, and choose their asset/debt and consumption level and 4) the agent may switch types.

End of period value functions

The worker's problem For clarity I omit time subscripts from this section, but the timing notation is standard, with primes denoting next period's values. The worker's state variables at the end of the period are his current assets a; his belief that he is a high type μ; and his effective units of labor in that period y. The end of period value function $\widetilde{V}_w$ is

$$\begin{aligned} \widetilde{V}_w(a,\mu,y) &= \max_{(c,a')}\{u(c) + \beta V(a',\mu'|y)\} \\ \text{where } V(a',\mu'|y) &\equiv \max\{V_e(a',\mu'|y), V_w(a',\mu'|y)\}. \end{aligned}$$

V_e and V_w are the beginning of period value functions for the entrepreneur and the worker, respectively, and are defined more explicitly later. They are both conditioned on present income because, as explained later, I assume a Markov process for labor income.

The worker's problem is subject to his budget constraint:

$$c + a' = (1+r)a + wy.$$

The worker's consumption c and assets in the next period a' are equal to his assets this period a times the interests earned $1+r$ plus his labor income wy.

I allow the agent to have positive or negative values of asset a up to the natural debt limit as defined by Schechtman and Escudero (1977). That is, there must be present value budget balance, which is equivalent to requiring the period by period borrowing constraint $a \geq -wy_{\min}/r$. Nevertheless, as is shown in Figure 1, this borrowing constraint is never binding.

The entrepreneur's problem The entrepreneur's end of period value function, $\widetilde{V}_e$, is

$$\begin{aligned} \widetilde{V}_e(a, \mu, A_e, y) &= \max_{(c,a',k)} \{u(c) + \beta V(a', \mu'|y)\} \\ \text{where } V(a', \mu'|y) &\equiv \max\{V_e(a', \mu'|y), V_w(a', \mu'|y)\}. \end{aligned}$$

The entrepreneur maximizes the above subject to his budget constraint:

$$c + a' = (1+r)a + A_e k^{\alpha_e} - (r+\delta)k + wy - \eta$$

where A_e is the entrepreneur's realization of ability, δ is the depreciation rate, and η is a fixed cost of being an entrepreneur. The last two terms in the budget constraint of the entrepreneur are unconventional. However, it is a priori as plausible for business income to be $A_e k^{\alpha_e} + wy$ as it is for it to be only the first of these terms. The important issue here is that the labor earning of entrepreneurs does not impact the marginal product of capital. Hence, changes in the intensive margin of investment k are due to learning about an agent's type.

Beginning of period value functions The beginning-of-period value functions for the worker and the entrepreneur, respectively, can be defined as the expected value of the end-of-period value function, conditional on the information available at the beginning of the current period, that is:

$$
\begin{aligned}
V_w(a', \mu'|y) &= \sum_{i=1}^{I} \widetilde{V}_w(a', \mu', y_i')P(y_i'|y) \\
&= \mu' \sum_{i=1}^{I} \widetilde{V}_w(a', \mu', y_i')P(y_i'|y, \theta_h) + (1-\mu') \sum_{i=1}^{I} \widetilde{V}_w(a', \mu', y_i')P(y_i'|y, \theta_l)
\end{aligned}
$$

$$
\begin{aligned}
V_e(a', \mu'|y) &= \sum_{i=1}^{I} \sum_{j=1}^{J} \widetilde{V}_e(a', \mu', A_j', y_i'|y)P(A_j', y_i'|y) \\
&= \mu' \sum_{i=1}^{I} \sum_{j=1}^{J} \widetilde{V}_e(a', \mu', A_i', y_i'|y)P(A_j'|\theta_h)P(y_i'|y, \theta_h) + \\
&\quad (1-\mu') \sum_{i=1}^{I} \sum_{j=1}^{J} \widetilde{V}_e(a', \mu', A_i', y_i'|y)P(A_j'|\theta_l)P(y_i'|y, \theta_l)
\end{aligned}
$$

Where $P(y_i'|\theta_h, y)$ is the probability that a worker will receive a draw of y_i' given that he is of high type and he received a draw of y in the previous period and $P(A_i|\theta_h)$ is the probability that an entrepreneur will receive a draw of A_i given that he is of high type.

1.5.6 Equilibrium

A steady state equilibrium in this economy is given by the risk-free interest rate r, the wage w, the allocations c, investments k, the beliefs μ,the occupational choices and a constant distribution of people over the state variables (a, μ), such that:

- Beliefs μ adjust according to Bayesian updating.
- The allocations c, a, k and occupational choices maximize the agent's problem as described above;
- Capital and labor markets clear. The total wealth in the economy equals the sum of the total capital employed in the entrepreneurial and corporate sector. Entrepreneurs use their own labor, and the total labor employed by the corporate sector equals the number

of workers in the economy.

- The factor prices w and r are given by the marginal products of each factor and the rate of return of investing in capital in the corporate sector equals the interest rate that clears savings and investment.
- The distribution of workers and entrepreneurs over the state variables (a, μ) is constant.

1.5.7 Calibration

It is necessary to use numerical techniques to find a solution for this model. The calibration strategy in this study is to estimate the least number of parameters as possible. Hence, many of the parameters are taken directly from the literature. The rest of the parameters are calibrated using moments from the data as is specified below. The data source is the 1984-89 panel of the Survey of Consumer Finances, which allows to study exit and entry into entrepreneurship. Data for 1989 in the panel is used whenever data that does not relate to mobility accross occupation is needed. All nominal variables in the calibration are in 1989 dollars.

Preferences The model period is one year and the utility discount factor β is taken to be .95, which is close to the estimated by many, for example King, Plosser and Rebelo (1988). The baseline calibration is performed with log utility.

Types In my model, low and high type refer to the ability of an agent to carry on a profitable entrepreneurial activity. Hence, I fix that 7% of the population in my model to be of high type, which is consistent with the fraction of entrepreneurs in the economy according to my definition. The probability that a low type becomes high type p_1 and the probability that a high type switches to low type in the following period p_2 are part of the set of calibrated parameters.

Technology With respect to the technology of production, the depreciation rate δ is taken from Stokey and Rebelo (1995) and fixed at 6% for both the corporate and entrepreneurial sector. The share of capital in the corporate sector is 33%, consistent with many studies, among others Gollin (2002). The total factor productivity in the corporate sector A_c is normalized to 1.

Most of the parameters of the technology in the entrepreneurial sector are estimated to match moments of the data. The lowest possible value for the total factor of productivity in the entrepreneurial $A_{e,1}$ is set to 0. The remaining two values for the total factor productivity of the entrepreneurial sector $A_{e,2}$ and $A_{e,3}$, the probability q of getting the typical draw $A_{e,2}$ as well as the fixed cost η of being an entrepreneur are calibrated in my model.

Labor income The labor income is given by the wage rate w and the effective units of labor y. The wage rate w is determined in equilibrium by the marginal product of labor in the corporate sector. I assume that the process for labor income is lognormal and AR(1), as is standard in the literature. Nevertheless, consistent with the idea that agents have an intrinsic ability, I model the labor income for high and low ability separately. I propose that the effective units of labor y follows this process:

$$\ln(y_t) = \rho \ln(y_{t-1}) + (1-\rho)\ln(y(\theta)) + \nu_t,$$

in which ρ is the serial correlation coefficient, $y(\theta)$, is the mean of effective units of labor, and ν_t is the labor shock which is assumed normally distributed with mean zero and standard deviation σ_v. The parameters ρ and σ_v are taken from Heaton and Lucas (1992) and are fixed at 0.53 and 0.25, respectively.

The above autoregression is common to both high and low types, the only difference is that the mean units of effective labor $y(\theta)$ is a function of ability θ. I fix $y(\theta_l)$ directly from the data. With complete information, one would expect those with low ability to become workers, hence I fix $y(\theta_l)$ to the mean labor income of workers in 1989 from the 1984-89 panel of the SCF ($26,956) divided by the equilibrium w found in my model. This is not a perfect measure for $y(\theta_l)$ because both in the real world and in my model there is imperfect information about one's type. However, considering that the vast majority of the population is of low type 93% , as explained above, and that only a fraction of the high types will be workers and a fraction of the low types will be entrepreneurs, the mean labor income of workers is a good proxy for the mean labor income of the low types.

The income process for low types described above is approximated using a five-state Markov chain as explained in Tauchen (1986) and Deaton (1991), resulting in a vector of discretized states for the effective labor units and a set of Markov transition probabilities between each of these states. The process for the high ability types has the same state space as that of the low types, but the transition probabilities are such that $y(\theta_h)$ is a multiple f of $y(\theta_l)$. The parameter f is calibrated in my model.

Parameters for calibration and moments of the data In total, there are eight parameters that I calibrate using moments of the data. Five of them refer to the entrepreneur's production function: the two highest values of the total factor productivity of the entrepreneurial sector $A_{e,2}$ and $A_{e,3}$; the probability q that an entrepreneur will draw $A_{e,2}$; the fixed cost of being an entrepreneur η; and the share of capital in the entrepreneurial sector α_e. The remaining three parameters determine the transition probabilities from low to high type $p1$ and from high to low type $p2$, and the ratio f of the mean of the labor income of the high type to that of the low type $y(\theta_h)/y(\theta_l)$.

Consequently, I use eight moments of the data to calibrate the parameters described above. Four of these moments relate to the wealth distribution: mean wealth of workers, mean wealth of entrepreneurs, 90th percentile of wealth for workers, and 90th percentile of wealth for entrepreneurs. The remaining four data moments are: the fraction of workers that become entrepreneurs, the fraction of entrepreneurs that exit, the ratio of the labor income for workers who enter entrepreneurship to the labor income of workers who stay as workers, and the mean active business assets of entrepreneurs. The resulting calibrated parameters are the following:

$A_{e,2} = 3$	$A_{e,3} = 11$	$\eta = 10$	$q = 0.8$
$f = 1.3$	$\alpha_e = 0.4$	$p_1 = 0.5$	$p_2 = 0.5$

where the model has been calibrated such that an η of 10 means that the fixed cost of being an entrepreneur is $10,000 dollars of 1989.

1.6 Numerical Algorithm and Results

1.6.1 Numerical Algorithm

The numerical algorithm used for the computation of the solution of the model can be summarized as follows:

1. Construct a grid for the state variables. The minimum asset level is given by the natural debt limit $a \geq -wy_{\min}/r$, which is \$310,150 dollars. As can be seen in figure 1 this asset level is never optimal in equilibrium. The maximum asset level is chosen so that it is not binding for the agents saving decisions.

2. Generate combinations of parameter values and for each of these combinations compute the model's general equilibrium solution as described in the following steps.

3. Fix a wage rate w and an interest rate r. Solve using value function iteration.

4. Compute the stationary distribution over the states.

5. Compute the implied w and r, and iterate steps 3-5 until convergence of the factor prices.

6. Pick set of parameter values that do the best job at matching moments of the data.

1.6.2 Results

In the stationary equilibrium of my model, agents who believe they are of high ability choose to become entrepreneurs whereas those who believe they are of low ability become workers, as can be seen in the first figure below. In addition, as high ability workers receive higher income realizations, they accumulate higher wealth and adjust their belief that they are of high type upward. This learning mechanism, coupled with risk aversion, will lead wealthier agents (who are likely to be the most able as well) to choose to become entrepreneurs, replicating the first stylized fact of a positive correlation between networth and entrepreneurial activity[3].

[3]The model has been calibrated to match the means of the distributions of wealth for entrepreneurs and workers separately. The mean net worth for workers in the model is about \$129,208 dollars, whereas in the data it is \$148,500. In turn, the mean net worth for entrepreneurs is \$320,690 dollars in the model and \$272,300

Figure 1: Belief distribution for entrepreneurs and workers

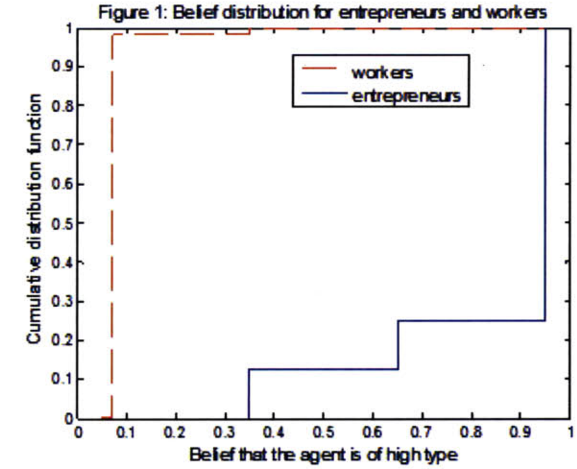
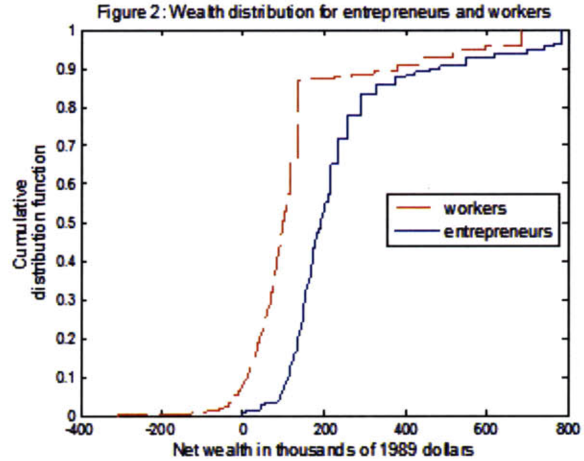


Figure 2: Wealth distribution for entrepreneurs and workers



The calibration of the parameters in the model is performed with the assumption of log utility, that is, imposing a relative risk aversion of 1. The model is also simulated for a Constant Relative Risk Aversion (CRRA) specification of utility, with a relative risk aversion coefficient of 2. The goal of this alternative simulation is to examine the effects of an increase in risk aversion in each of the implications of the model, disentangling the effect of learning from that of risk aversion in the results of the model.

dollars in the data. Nevertheless, the model does a poor job at generating as much dispersion in net wealth as in the data. More specifically, the interquartile range (difference between the 75% percentile and the 25% percentile) of net worth in the data is 1.6 times that of my model for workers and 4.3 times for entrepreneurs. As discussed in detail in the companion paper on calibration exercises and borrowing constrants, a way to allow for a more skewed wealth distribution is introducing slow decreasing returns to capital in the entrepreneurial production function; this however comes with important sacrifes of its own.

Table 1.4: **Results of the simulations and comparison with data**

	Data	Model	
		log	crra=2
Equilibrium			
Interest rate	NA	0.052	0.046
Fraction of entrepreneurs	0.068	0.079	0.075
Correlations[a]			
Wealth and entrepreneurship	0.175	0.177	0.190
Past wealth and entry	0.102	0.010	0.014
Wealth-to-income ratio and entrepreneurship	0.188	0.040	0.012
Cash flow and investment	0.216[b]	0.066	0.141

[a] The correlations in the data are computed taking into account that the data is weighted and using multiple imputation techniques. The p-values for all of the correlations when studying each implicate separately is 0.00, except for the correlation of cash flow and investment.

[b] The dispersion in the correlation coefficients for each of the implicates suggests that prepackaged multiple imputation techniques are not valid in this case. Nevertheless, in all of the implicates, the correlation is positive though not always significant.

The first two rows of Table 1.4 further describe the equilibrium of the model by listing the equilibrium interest rate and the fraction of entrepreneurs. In both specifications, the fraction of entrepreneurs is close to that of the data. A doubling of the risk aversion coefficient, leads to a drop in interest rate. The higher risk aversion, the more agents will save in the economy and the less they will invest in the riskier technology of becoming an entrepreneur, leading to a higher capital investment in the corporate sector. There are two competing effects on the marginal product of capital: On one hand the labor employed in the corporate sector increases, raising the marginal productivity of each unit of capital; and on the other hand, the capital employed in the corporate sector also increases, reducing the productivity of the marginal unit. In equilibrium, the effect on the level of capital more than offsets that on labor, generating a decrease in the marginal productivity of capital and a corresponding drop in the interest rate.

The remaining rows in the table display a list of correlations addressing the first set of stylized facts. To compute the data moments I use the panel 1984-89 of the Survey of Consumer Finances. Here is a description of the results:

1. Entrepreneurs are wealthier than workers.

The correlation between household net worth (total assets minus total debt) in 1989 and whether the household head reports being an entrepreneur is of 17%, which is very close to that found in both models. Whereas the literature on borrowing constraints would rationalize this correlation by arguing that only households with high wealth can surpass the capital market frictions by self-financing, the alternative theory proposed in this paper argues that the relationship is a consequence of ability and income being positively correlated. With imperfect risk-sharing, this translates into a positve correlation between income and wealth.

2. Wealth increases the propensity of becoming an entrepreneur.

In the data, the correlation is constructed by taking the set of households that are workers in 1983 and computing the correlation between household net worth in 1983 and a dummy for entry into entrepreneurship in between the two survey years, 1983 and 1989. When including the entire wealth distribution, a positive and economically significant correlation emerges. A large part of the borrowing constraint literature points to the positive linear relationship between wealth and entry as evidence of borrowing constraints. Nevertheless, when excluding the top 10% of the wealth distribution, the relationship is no longer significant in the data. This is reminiscent of Hurst and Lusardi's (2004) regression result that the role of past net worth on entry is only important at the top of the distribution[4]. Actually, the model in this paper is perfectly consistent with one of the three reasons proposed by Hurst and Lusardi (2004) for the positive relationship between wealth and entry at the top of the wealth distribution[5]. They note that households at the top of the distribution are much more likely to start a business in

[4] Hurst and Lusardi (2004) present regression results that include covariates, whereas I am just listing the simple correlation between the two variables.

[5] The remaining two reasons: higher wealth agents are less risk averse and business ownership as a luxury good are not studied in this paper.

the professional industry. In other words, outstanding lawyers, architects, or consultants, for example, are likely to earn high incomes, accumulate higher wealth and either be promoted to partner or start their own business practices.

In the model, there is a small but positive correlation between wealth and entry when including the entire wealth distribution as is noted in the table. In addition, the correlation stays small but becomes negative when exluding the top 10% of the wealth distribution. This exemplifies two competing effects of wealth on entry in my model. On one hand, high ability agents are likely to have higher wealth and enter entrepreneurship. On the other hand, agents that were of low type and (unknowingly) switch to high type (which occurs with a probability of p_1) will observe a larger than expected income realization, will update their belief about being high type upward, and will enter entrepreneurship if optimal. For the entire distribution, the first of these effects is larger, whereas if one excludes the top 10% of the distribution the second effect dominates.

3. Entrepreneurs have a higher wealth-to-income ratio than workers.

In the data, the wealth-to-income ratio is constructed as the reported household net worth in 1989 as a fraction of household income in 1988[6]. Both versions of the model produce entrepreneurs that are wealthier than workers, even when controlling for income. In both the data and the model, this means that the higher wealth of entrepreneurs is not due solely to higher income.

4. There is positive correlation between cash flow and investment.

In the data, the measure of cash flow is reported business income in 1982. Investment is taken as total holdings of business assets in 1989. Though this correlation is estimated with a lower precision in the data, as explained in more detail on the table, the correlation is positive in the data and in both of the specifications of the model.

[6] The SCF survey questions are such that in 1989 the respondent is asked to give an approximate value for his asset and debt holdings at the time of the survey and the total income received by the household in the previous period. Hence, there is data on wealth for 1989 and income in 1988.

Though the last three correlations are particularly smaller in the model than in the data, it is clear that the model can qualitatively generate the patterns in the data. In addition, the size of the correlations does not increase consistently for a higher risk aversion coefficient. Hence, the learning mechanism outlined in the model plays an important role in generating the set of positive correlations, and they are not entirely driven by risk aversion.

The remaining set of stylized facts address wealth class mobility in the panel, highlighting upward mobility for new entrepreneurs and downward mobility for exiting entrepreneurs. The transition matrices using the SCF 1983-89 panel are in Quadrini (2000) and are reproduced here for reference.

5. Transition matrices for family wealth show that entrepreneurs are more upwardly mobile.

Table 1.5: **Five-year transition matrices for net family wealth[a], 1984-89**

	Class 1	Class 2	Class 3	Class 1	Class 2	Class 3
	Staying workers			Switching workers		
Class 1	0.81	0.17	0.02	0.52	0.31	0.17
Class 2	0.22	0.65	0.13	0.12	0.51	0.37
Class 3	0.02	0.22	0.76	0	0.20	0.80
	Switching entrepreneurs			Staying entrepreneurs		
Class 1	0.81	0.14	0.05	0.25	0.49	0.26
Class 2	0.23	0.58	0.19	0.17	0.37	0.46
Class 3	0.01	0.21	0.78	0.02	0.09	0.89

[a] This table is taken directly from Quadrini (2000) who uses the SCF 1983-89 panel

Table 1.6: **One year transition matrices for family wealth in the baseline model**

	Class 1	Class 2	Class 3	Class 1	Class 2	Class 3
	Staying workers			Switching workers		
Class 1	0.96	0.04	0	0.45	0.45	0.09
Class 2	0.03	0.97	0	0	0	1
Class 3	0	0	1	0	0	1
	Switching entrepreneurs			Staying entrepreneurs		
Class 1	1	0	0	1	0	0
Class 2	1	0	0	0	0.73	0.27
Class 3	0.15	0.54	0.31	0	0.03	0.97

Tables 1.5 and 1.6 present the transition matrices for four subsets of households both in the model and in the data. The subsets of households are those who stay as workers, those who switch into entrepreneurship, those who remain entrepreneurs and those who exit entrepreneurship. Households have been divided into three groups according to their wealth. The rows correspond to the wealth class in the next-to-last period of the simulations; similarly, the columns stand for the wealth class in the last period of the simulations. As can be seen, the upward mobility for those entering and downward mobility for those exiting entrepreneurship occurs quickly in the model. For example, one hundred percent of new entrants of the second wealth class jump to the third wealth class in one period in table 6. This is certainly much faster than what the data reveals in table 5. Nevertheless, the general patterns of mobility present in the data are reproduced by the model. The alternative specification for risk aversion yields very similar results to the baseline model and is omitted.

6. Transition matrices for family wealth-to-income show that entrepreneurs are more upwardly mobile.

Hence, the upward mobility of entrepreneurs is not only a consequence of higher income, but is a deliberate decision of entrepreneurs to faster accumulate wealth.

Table 1.7: **Five-year transition matrices for family wealth to income[a], 1984-89**

	Class 1	Class 2	Class 3	Class 1	Class 2	Class 3
	Staying workers			Switching workers		
Class 1	0.79	0.19	0.02	0.54	0.30	0.16
Class 2	0.21	0.61	0.18	0.14	0.46	0.40
Class 3	0.05	0.23	0.72	0.07	0.17	0.76
	Switching entrepreneurs			Staying entrepreneurs		
Class 1	0.71	0.25	0.04	0.42	0.40	0.18
Class 2	0.23	0.55	0.24	0.12	0.46	0.42
Class 3	0.06	0.20	0.74	0.01	0.15	0.84

[a] This table is taken directly from Quadrini (2000) who uses the SCF 1983-89 panel

Table 1.8: **One year transition matrices for family wealth-to-income in the baseline model**

	Class 1	Class 2	Class 3	Class 1	Class 2	Class 3
	Staying workers			Switching workers		
Class 1	0.83	0.14	0.3	0.5	0.19	0.31
Class 2	0.14	0.65	0.20	0.33	0	0.67
Class 3	0.02	0.26	0.72	0	0	1
	Switching entrepreneurs			Staying entrepreneurs		
Class 1	1	0	0	0.14	0.36	0.50
Class 2	1	0	0	0.11	0.32	0.58
Class 3	0.44	0.13	0.44	0.07	0.14	0.78

7. New entrepreneurs have higher savings rates, followed by continuing entrepreneurs, non-

entrepreneurs and entrepreneurs that exit their businesses (which have a negative savings rate).

Table 1.9: **Median saving rate by occupation mobility**

	Staying workers	Switching workers	Switching entrepreneurs	Staying entrepreneurs
Data[a]	0.165	0.361	−0.483	0.042
Model	0	0.035	−0.199	0

[a] Taken from Gentry-Hubbard (2004).

The data on savings rate is computed by Gentry and Hubbard (2001) as the change in net worth divided by the average income in the two years divided by six (the number of years between the 1989 and 1984 surveys of the SCF). As can be seen in Table 1.9, the model is qualitatively consistent with the patterns in the data.

In summary, a model that combines occupational choice and agents that learn slowly about their type can qualitatively reproduce all of the stylized facts that have been repeatedly used in previous literature to argue in favor of borrowing constraints and that can be simulated within the context of this model.

1.7 Conclusions

The puzzling fact that entrepreneurs are not taking full advantage of the equity in their homes to finance their businesses and are, at the same time, making sizeable investments in financial assets unrelated to their entrepreneurial activity is the motivation for this paper. Nevertheless, if one thinks that the low mortgage rates and significant holdings of financial assets are a consequence of precautionary savings and a desire to diversify away from their businesses given that entrepreneurs suffer from large uninsured idiosyncratic shocks, this paper still provides an important contribution: it finds that replacing imperfect information for financial constraints can generate many of the patterns in the data that the standard literature holds as evidence of the effect of borrowing constraints on entrepreneurs.

In order to achieve this result, I have developed a model of occupational choice in which agents have imperfect information about their own ability. Ability is assumed positively correlated with income. Hence, in each period, agents observe their income realization and slowly update their beliefs about their type. Over time, more able agents will be accumulating higher wealth levels, while at the same time learning that they are of high type, and ultimately becoming entrepreneurs.

This paper does not argue that borrowing constraints play no role in the study of entrepreneurship in the United States, but rather that learning can generate similar implications proving it hard to identify how much of the observed empirical patterns are due to each of these possible explanations. This identification issue is crucial if one wishes to consider the macroeconomic effects of policies that redistribute wealth or indirectly subsidize entrepreneurial activity. This is an open area of research.

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Chapter 2

Portfolios of entrepreneurs: are borrowing constraints really binding?

Abstract

An implication of the vast literature on borrowing constraints for entrepreneurs is that business owners should be investing the marginal dollar of their wealth in their business. I use cross-sectional data from the Survey of Consumer Finances to compare portfolio allocations for workers and entrepreneurs; and panel data from the same sources to study portfolio changes for workers who stay as workers, workers who switch into entrepreneurship, continuing entrepreneurs, and entrepreneurs who exit entrepreneurship. First, I find that most entrepreneurs are far away from maxing out their mortgages and hold non-trivial positive positions in financial assets such as stocks and bonds. Second, I find that the entrepreneurs' mortgage rates, total debt, and holdings of stocks and bonds are similar to those of workers. Third, when comparing the portfolios separately by wealth class, I find that poorer entrepreneurs, who arguably could be more cash-strapped, actually use less available mortgage financing than their counterpart workers. Fourth, I find that those that have been entrepreneurs (either continuing entrepreneurs, exiting entrepreneurs or new entrepreneurs) are paying off their mortgages faster than non-entrepreneurs. Combined, these findings suggest that the portfolios of entrepreneurs are at odds with theories that propose borrowing constraints as the key ingredient in understanding occupational choice and entrepreneurial activity in the United States.

2.1 Introduction

Given the important role that entrepreneurship is believed to play in the process of economic growth and job creation, it is not surprising that the health of business enterprises is a matter of public policy. Financial assistance is common. In the United States, President Obama's new budget for 2010-2011 sets aside $30 billion to provide loans and tax-breaks for small businesses. Similarly, the Small Business Administration assists in the funding of hundreds of thousands of small business loans per year (about 100,000 loans totalling $19 billion in fiscal year 2006)[1]. Financial assistance for entrepreneurs is also high on the agenda in the European Union and many other countries around the globe.

The underlying premise behind these policies is that there are important frictions in the credit markets precluding individuals with positive net-present value business projects from implementing their ideas because they are unable to access the funds required to start a new business or grow an existing one. This paper uses evidence on the portfolios of entrepreneurs, most notably their mortgages and other types of debt secured by primary home, to argue that entrepreneurs in the US are not as borrowing constrained as the conventional literature suggests.

If entrepreneurs were severely borrowing constrained they may choose to pay the fixed cost to tap into their home equity to finance their business activities. In fact, comparing across occupation (workers and entrepreneurs), entrepreneurship seems to play no role in the amount of debt secured by primary residence. Moreover, using a two-period panel dataset to analyze the debt holdings across occupational transition categories I find that those who enter entrepreneurship do not incur in more mortgage debt. In fact, those who are entrepreneurs at any of the two time periods seem to pay off their mortgages at a more accelerated rate than those that stay as workers. Lastly, entrepreneurs and workers have similar holdings of total debt (not only debt secured by home) and financial assets like stocks and bonds.

This paper is related to Quadrini (2000), Caner (2003) and Gentry-Hubbard (2004), which study the wealth accumulation patterns of entrepreneurs in the US. These three papers, which

[1]Small Business Administration website: http://www.nationalbusiness.org/NBAWEB/Newsletter2006/2270.htm

also use data from the Survey of Consumer Finances, find that entrepreneurs accumulate wealth faster than workers. This result echoed conclusions of papers that found that wealthier households save at higher rates than the rest of the population (Carroll (2000) and Dynan, Skinner and Zeldes (1996)). Caner (2003) goes a step further to say that entrepreneurial households save more even when excluding business assets from the saving rate definition. Gentry-Hubbard (2004) present averages of portfolio allocation by occupation group. However, none of them focus on mortgage equity.

Another related paper is Hurst and Stafford (2004). They find that home owners that become unemployed with low levels of initial liquid assets are more likely to refinance their homes for consumption-smoothing purposes. This result serves as further motivation for this paper because if households use home equity for the financing of their non-durable consumption it is plausible that entrepreneurial households may use it as well to finance their business activities which could generate a positive stream of payoffs in the future.

The rest of the paper is organized as follows. Section 2 describes the dataset and the empirical definition of entrepreneurship. It also provides summary statistics on the businesses and the households that own and manage them. Section 3 presents the portfolio allocations of the different occupations, paying close attention to home equity, but also analyzing debt that is not secured by home and asset allocation. Section 4 concludes.

2.2 Data

The Survey of Consumer Finances (SCF) provides household-level occupation, background and detailed wealth information. It is the preferred database to study entrepreneurship because entrepreneurs are typically in the upper wealth classes and the SCF oversamples the wealthy. The data includes population weights which allow the calculation of population estimates from the sample data. I use these weights in all my calculations. The SCF deals with missing data by providing five replications for each household. Hence, multiple imputation techniques must be taken into account when analyzing the data.

Before analyzing the data, one must choose a definition of entrepreneurship. An entrepreneur could be defined as an agent who holds business assets. This, however, includes agents that do not have an active role in the management of the firm. Another way to distinguish between entrepreneurs and non-entrepreneurs using the SCF is by considering as entrepreneurs those that are self-employed in their main job, whereas workers are paid a wage. On the other hand, this method includes agents that can't find a job and must rely on some sort of self-employment for a living.

First, it is necessary to define an entrepreneur in terms of my data source. The SCF asks several questions that relate to whether a household is an entrepreneur or not. An entrepreneur in my model is not simply a manager of a firm, he effectively bears the uninsurable idiosyncratic risk of his firm. Nor is an entrepreneur somebody who is self-employed because he is in fact unemployable and can only manage to work in odd jobs. Hence, my definition of an entrepreneur is given by the intersection of those who are self-employed and those who hold an active management role in a business[2]. This is a standard definition; it was first used by Cagetti and Denardi (2006). With this empirical definition, entrepreneurs make up 6.8% of the U.S. population. Furthermore, as can be seen in Quadrini (2000) and Gentry and Hubbard (2004), no matter which definition of entrepreneurship is adopted the same pattern emerges: entrepreneurs are a small fraction of the US population, yet they hold a large fraction of the total net worth.

The following two tables further describe entrepreneurs and their firms. Table 2.1 provides summary statistics on the largest actively held business for each entrepreneur, including age of the firm as well as number of employees, sales, and profits. It also describes the entrepreneurs themselves by providing information on their age, the years of schooling and their gender. As noted on the table, most businesses have been operating for less than a decade. Both measures of the size of the business (number of employees and sales) have a skew to the right, with most businesses operating on a small scale though another fraction of businesses managing to grow

[2] I also computed the results below taking as entrepreneurs those that are self employed and hold assets of over $5,000 in value in a business in which they have an active management role. The results were not sensitive to this definition change.

further. The median number of employees is two (including the business owner), while those at the 95% percentile regarding this measure of size have 40 employees. The mean value of sales is at 50 times the median. Profits are also skewed to the right with a the mean being 30 times the median. Most entrepreneurs are middle-aged men. The mean level of educational attainment for the business owner is half-way through college. Table 2.2 portrays a break-down of the fraction of private-equity by industry. All major industries are represented in the sample.

Table 2.1: **Individual and firm characteristics**

Characteristic	Mean	Standard Deviation	Percentile				
			5th	25th	50th	75th	95th
Firm age	11.1	10.5	0	3	8	16	31
Employees [a]	25.2	226.0	1	1	2	6	40
Sales	4,333,469.3	70,064,648	0	20,400	88,200	370,400	3,414,000
Profits	749,318.9	17,513,816	−300	2,400	24,600	100,000	565,400
Entrepreneur age	49.3	11.9	29	40	49	56	67
Years of schooling [b]	14.2	2.35	10	12	14	16	17
Fraction male	78.9						

Source: Calculation uses 959 households of entrepreneurs, as defined in the main text of the paper, from the 2004 Survey of Consumer Finances. Some descriptive statistics are about the firm (i,e. firm age since founded/acquired, employees, etc). Other statistics are about the entrepreneur (i.e. age, years of schooling, fraction male). All firm statistics are for the firm in which the household has the largest actively managed position. All dollar values are in nominal 2004 dollars.

[a] Includes the entrepreneur.

[b] Schooling is measured by the highest level of education completed and not the time it took to complete it. 12 years means completed highschool; 16 years, college.

Table 2.2: **Percentage of private equity in each industry**

Industry	Percentage[a]
Agriculture, forestry, fishing, hunting, veterinary services, landscaping	6.32
Mining, construction	15.65
Manufacturing, printing, publishing	9.13
Wholesale and retail trade including restaurants and bars	14.89
Finance, insurance, real estate, rental and leasing, data processing; repair and maintenace	25.37
Utilities, transportation and warehousing, broadcasting and telecommunications, information services, professional, scientific, and technical services; personal and laundry services	24.90

Source: Calculation uses 959 households of entrepreneurs, as defined in the main text of the paper, from the 2004 Survey of Consumer Finances. Information is for the largest three actively held firms for each household.

[a] Businesses with a net worth greater than $ 100 million have not been categorized according to industry in the public version of the SCF 2004. These businesses make up 3.71 % of private equity

2.3 Portfolio allocations

It is interesting that papers that study entrepreneurship propose that borrowing constraints are the key mechanism in explaining the patterns of wealth accumulation of entrepreneurs vis-a-vis workers. I use the SCF to study the portfolios of both of these occupational groups as well as the transitions between groups, and argue that several aspects of the asset and debt holdings of entrepreneurs suggest that they are not as severely constrained as is widely assumed in the literature.

2.3.1 Home equity

I first focus on the holdings of home equity. According to the 2004 SCF, the vast majority of entrepreneurs (86.2%) live in a home owned at least in part by themselves or a member of their household, as opposed to renting their home (12% of entrepreneurs) or other more infrequent arrangements. I propose that business owners could access the equity in their homes as a source of finance for their entrepreneurial activity. Even for those entrepreneurs that do not own their homes, roughly half of them report to have positive equity in other types of real estate. Hence, they too could potentially finance their enterprises with mortgages. I focus on primary residences since this affects over six out of seven entrepreneurs.

If entrepreneurs were in fact severely borrowing constrained they may choose to pay the fixed cost to tap into their home equity to finance their business activities. The use of home equity as a source of funds for entrepreneurial activities has been overlooked in the literature. This is surprising partly because home equity is typically a large share of the portfolio and also because there are studies that have documented the use of home equity for consumption smoothing purposes. More specifically, Hurst and Stafford (2004) find that home owners that become unemployed with low levels of initial liquid assets are 25% more likely to refinance their homes than other households. In addition, a broad group of the population they describe as liquidity-constrained converted two-thirds of the equity they removed by refinancing into consumption between 1991 and 1994. Hence, if households use home equity for the financing of their non-durable consumption it is plausible that entrepreneurial households may use it as well to finance their ideas which could have a positive stream of payoffs in the future.

In principle, entrepreneurs can use the equity in their homes to finance their businesses by choosing to pay their primary mortgages more slowly, refinancing with cash-out, or opting for a second mortgage. A primary mortgage lender advances funds to a borrower, who uses them to finance the purchase of a home. In some instances, the borrower can slow down on the payment of principal by restructuring his mortgage to pay for interest only, for example, or arranging for negative amortization (Friedman and Harris (2001)). Another option is cash-out refinancing which occurs when a home owner refinances for an amount greater than what he owes on his home. In such a case, the home owner receives the difference in a cash payment that may be used for business financing for example. An alternative option is a second mortgage, which can take the form of a home equity loan (HEL) or a home equity line of credit (HELOC). Both types of second mortgage lenders have a subordinate claim on the underlying asset or house. The lenders typically set the credit limit to some percentage of the home's appraised value minus the amount owed on existing mortgages. The difference between these two credit resources is that a home equity loan (HEL) is like a traditional loan in the sense that it provides a lump-sum payment up front, repayable over a set period. Frequently, these loans carry payment schedules with equal payments throughout the loan period. On the other hand, a home equity line of credit (HELOC) is a form of revolving credit that evolved in the 1980s, in which the home-owner can borrow up to the preespecified credit limit whenever he wants. These plans set a fixed period during which funds can be drawn up to the credit limit and after which repayment must be made[3]. In any case, the funds proceeding from a second mortgage can equally be used to finance business expenditures much in the same way as those collected by refinancing. Hence, I will consider mortgages, home equity loans and home equity lines of credit as sources of business funding. I will use the terms debt secured by primary home and mortgages interchangeably

[3]This is a summary of consumer information documents provided by the Federal Reserve Board website.
http://www.federalreserve.gov/Pubs/equity/equity_english.htm
http://www.federalreserve.gov/pubs/arms/arms_english.htm
http://www.federalreserve.gov/pubs/riskyhomeloans/default.htm
http://www.federalreserve.gov/pubs/refinancings/default.htm

from now on and I will be in fact referring to the sum of all the aforementioned types of debt (mortgages, home equity loans and home equity lines of credit).

Developments in the Mortgage Market

Since the 1970s and until the housing and financial crisis that started in 2007, it became increasingly easier to contract mortgages and other loans guaranteed or collateralized by homes. Gerardi, Rosen, and Willen (2010) use an implication of the permanent income hypothesis to argue that credit market imperfections relating to the housing industry became less binding. According to the permanent income hypothesis, the higher the expected future income, the higher the desired consumption. The effect on actual consumption will rely on the efficacy of credit markets. In particular, imperfect credit markets will dampen the effect of higher future income on current house spending. Using household data from the Panel Study of Income Dynamics (PSID), Gerardi, Rosen, and Willen (2010) find that the estimated sensitivity of future income to present house expenditure increased by 80% from 1970 to 2005. They conclude that mortgage markets have become less imperfect over time.

Several developments in the housing market that have contributed to the increased supply of credit. Throughout the 1970s, regulations made bank deposits the principal source of funds for mortgages. Usury laws that established maximum loan rates, interstate banking prohibitions, and limits on branching were the norm. The drying up of funds for the mortgage industry revealed that this set-up was particularly ill-suited to deal with the high inflation and the accompanying high interest rates that arose in the mid 1960s (Morris (1975)). The collapse in housing finance triggered many regulatory changes including the preemption of state-imposed usury ceilings and the framework for a secondary market in which banks could sell the mortgages they originated to other investors. Gerardi, Rosen, and Willen (2010) credit the latter regulatory change as the most significant factor leading to mortgage markets becoming less imperfect over time, where "imperfectness" is improved upon by strengthening the correlation between current housing consumption and future income, by the argument exposed in the previous paragraph.

A few other important changes that contributed to the credit expansion include: 1) the adoption of the Equal Credit Opportunity Act that by 1976 outlawed gender, racial, religion, marital status, sex and national origin-based discrimination from the decision to grant credit (Elliehausen and Durkin (1989)); 2) the expansion of the menu of mortgage choices from exclusively fixed-rate mortgages to a wide array of adjustable rate mortgages catered to different risk appetites and expected flows of income, starting mid 1970s (Friedman and Harris (2001)); 3) the development of automated underwriting procedures reduced the cost of originating new mortgages (Straka (2000)); and 4) the creation of a subprime mortgage market in the 1990s allowed those with bad credit histories to get loans (Munnell et al. (1996)). In summary, the credit boom described above made it easier to use home equity as a source of finance for business activities, at least until the onset of the financial and housing crises of 2007.

Another reason entrepreneurs may profit from using home equity to finance their businesses is that interests paid on mortgage loans are tax deductible. Moreover, interests are deductible on second mortgages such as home equity loans and home equity lines of credit, if the additional loan on the home is $100,000 or less and the home is worth more than all loans on it (Friedman and Harris (2001)). This rule encourages homeowners to convert consumer loans such as credit cards, store debt, vehicle loans, and other installment loans, to mortgage debt.

Use of Home Equity as a Source of Borrowing

In spite of the abundance of credit resources for loans secured by property, only a small fraction of entrepreneurs say that they use personal assets to cosign or guarantee business loans. According to the 2004 SCF, 7.1% of entrepreneurs use personal assets as guarantee or collateral; 2.4 % report that they use mortgage debt or a home equity loan for this purpose. However, money is fungible so they could be using the funds freed up from choosing to repay their mortgages more slowly to finance investments in their businesses. The remainder of this section will analyze different measures of debt secured by primary homes by occupation (entrepreneur or worker) or occupational transition (new entrants to entrepreneurship, staying entrepreneurs, exiting entrepreneurs, staying workers).

The first two rows of the Table 2.3 present two alternative measures of debt secured by

Table 2.3: **Ratio of debt secured by primary residence to house value**

	Entrepreneurs	Nonentrepreneurs
Conditional median[a]	54.7	56.4
Ratio of debt to value of home[b]	32.9	35.2
Ratio of debt to value of home by wealth class[c]		
Class 1	65.0	82.0
Class 2	68.2	52.1
Class 3	31.0	26.3

Source: Calculation uses 4,519 households from the 2004 Survey of Consumer Finances.

[a] The conditional median is the median among households with debt secured by their home.

[b] Ratio of total debt secured by primary residence to total value of homes owned by occupation (entrepreneur or nonentrepreneur).

[c] Because entrepreneurs are typically wealthier than workers, the break-up by classes has very few entrepreneurs in the lower wealth classes. For example, when breaking-up the sample in three equal thirds, there are 7 entrepreneurs in class 1, 55 entrepreneurs in class 2, and 810 entrepreneurs in class 3.

primary residence as a fraction of house value for both entrepreneurs and workers. The first measure is the median ratio of debt to house value conditional on having debt secured by primary home, while the second measure is a ratio of the total debt secured by primary home to the total value of homes. As can be seen, entrepreneurs and nonentrepreneurs hold similar amounts of debt secured by primary home as a fraction of their home value, which is consistent with the regression results of Tables 2.4 and 2.5 analyzed later. Moreover, the median ratio of this debt is of 54.7% of the house value for entrepreneurs conditional on having a positive amount of debt secured by home. If we believe that borrowing constraints are important for US entrepreneurs, then this piece of evidence presents a puzzle. Why wouldn't cash-strapped business owners use the equity in their homes as a ready source of financing for their entrepreneurial activity by maxing out their mortgages? Moreover, separating entrepreneurs by wealth classes only compounds the puzzle. I group surveyed agents into three wealth classes, class I being the poorest. Poorer entrepreneurs, who might experience tighter constraints, actually have lower mortgage rates than workers within their class. Nevertheless, this finding should be taken with a grain of salt because there are very few entrepreneurs in the lower wealth classes as noted on the table.

Furthermore, both OLS and quantile regressions confirm that entrepreneurs and workers have similar levels of mortgage financing measured by the debt secured by primary home as previewed above. I regress the log of debt secured by primary home on a dummy that equals 1 when the household is made up of an entrepreneur. I control for the value of the home because higher levels of debt can be contracted on higher valued homes. I also include other demographic controls such as household income – which may proxy in part for financial sophistication of the household-, race, age, number of children, education, and marital status[4]. I also include, following the logic in Rajan and Zingales (1998), industry-dummies as classified in the SCF into six different industry categories (as in Table 2.2). Different industries may have different initial project size, as well as different requirements for continuing investments, and therefore command different levels of debt.

I also provide specifications that include a variable summarizing the intensity of the entrepreneur's investment into the business. It is plausible that the more invested the entrepreneur is in his business the higher the debt secured by home he would be willing to contract. I tried two alternative ways of measuring intensity of the business: level of assets in actively held businesses and number of household members that work or participate in the operation of the business.

Nevertheless, even if the mean level of debt secured by home is not affected by whether the household owns and manages a business, quantile regressions might still reveal that entrepreneurship is an important determinant of mortgage debt. This would be the case if for example most entrepreneurs were in the right tail of the distribution of mortgage debt. In other words, if entrepreneurs were strategically maxing out their mortgages to finance their businesses, entrepreneurship would have a positive and significant effect on mortgage debt in

[4]I also included dummies for the type of business (partnership, sole-proprietorship, subchapter S, limited parnership, limited liability company, and other types of corporations). The basic result that business owners do not use more of the equity in their homes to finance their businesses holds. Hence, the results of these regressions are not included in the paper.

quantile regressions. This is not the case as in the 45 quantile regressions tried (one for each decile of the distribution and for each of the four specifications), the coefficient on entrepreneurship was negative in 20 of the cases, positive but insignificant in 11 of the cases, positive and marginally significant with p-values in between 15 a 20% in 4 of the cases. The few cases in which entrepreneurship is close to being significant refer to the second and third decile in the distribution of mortgage debt. Therefore, it can be said with confidence that entrepreneurs and workers hold similar levels of mortgage debt. This holds true for those that have the most mortgage debt. Out of the quantile regressions, I am only presenting the median regression in Table 2.5.

Table 2.4: **Log of debt secured by primary home**

OLS regressions				
Entrepreneur	0.148	1.599	0.484	1.769
	(1.002)	(1.865)	(1.206)	(1.918)
log(Active business assets)		−0.119		−0.112
		(0.125)		(0.127)
Household members in firm			−0.241	−0.176
			(0.465)	(0.469)
log(House)	1.283^{***}	1.291^{***}	1.283^{***}	1.290^{***}
	(0.112)	(0.112)	(0.112)	(0.112)
log(Income)	0.101	0.105	0.100	0.104
	(0.110)	(0.111)	(0.110)	(0.112)
Industry dummies	yes	yes	yes	yes
Demographic controls	yes	yes	yes	yes
R-squared	0.671	0.671	0.654	0.671
Number of observations	3279	3279	3279	3279

Source: Survey of Consumer Finances 2004. Calculation uses 3279 households that own a home. Standard errors are in parenthesis. Coefficients that are significant at the 10% level have one star, those at the 5% level have two stars, and those at 1% level have three stars.

Table 2.5: **Log of debt secured by primary home**

Median Regressions				
Entrepreneur	−0.139	0.175	−0.105	0.152
	(0.237)	(0.393)	(0.358)	(0.423)
log(Active business assets)		−0.027		−0.028
		(0.027)		(0.028)
Household members in firm			−0.017	−0.014
			(0.159)	(0.151)
log(House)	1.113^{***}	1.113^{***}	1.112^{***}	1.113^{***}
	(0.031)	(0.031)	(0.031)	(0.032)
log(Income)	0.038	0.039	0.037	0.041
	(0.027)	(0.029)	(0.028)	(0.030)
Industry dummies	yes	yes	yes	yes
Demographic controls	yes	yes	yes	yes
R-squared	0.594	0.594	0.594	0.594
Number of observations	3279	3279	3279	3279

Source: Survey of Consumer Finances 2004. Calculation uses 3279 households that own a home. Standard errors are in parenthesis. Coefficients that are significant at the 10% level have one star, those at the 5% level have two stars, and those at 1% level have three stars.

The SCF panel dataset of 1983-1989 provides another way to assess whether US entrepreneurs use the equity in their homes to finance their business expenditures. The panel reports asset and debt holdings as well as occupation and many other characteristics for 1983 and 1989. Hence, comparing the changes in the mortgage rates by occupational transition between these two time periods allows for another test. I revisit the measures of mortgage debt presented in Table 2.3 and use the panel dataset to compute 1) the median change in the ratio of debt secured by primary home to house value and 2) the change in the total debt secured by primary home to house value by occupational transition group. I exclude from the database those households that did not own a home in either 1983 or 1989 in order to allow for an easier comparison.

Table 2.6: **Percentage change in total mortgages, house values, and ratios of mortgage to house value, 1983-89**

	Enter	Stay in	Stay out	Exit	All
Total mortgages	−0.078	0.240*	0.059	−0.250	0.043
House values	−0.065	1.139*	0.230	−0.130	0.218
Ratio of mortgage to house	−0.053	−0.175*	−0.033	−0.045	−0.034
Ratio of mortgage to house value by networth:					
Class 1	−0.230*	na	−0.124	na	−0.127
Class 2	na	na	−0.023	−0.317*	−0.026
Class 3	−0.050	−0.175*	−0.011	−0.020	−0.014
Ratio of mortgage to house value by income:					
Class 1	0.058*	na	−0.124	na	−0.127
Class 2	−0.134*	−0.442*	−0.023	−0.317*	−0.026
Class 3	−0.032	−0.066*	−0.011	−0.020	−0.014
Ratio of mortgage to house value by age:					
Young	−0.277*	−0.370*	−0.065	−0.095*	−0.073
Middle	0.020	0.115*	−0.024	0.091*	−0.020
Old	−0.040*	na	−0.025	−0.051	−0.025

Source: 1983-89 Survey of Consumer Finances. Calculation uses 1,116 households that owned a home both in 1983 and 1989. There are 30 households that were workers in 1983 and became entrepreneurs by 1989; 4 households that were entrepreneurs in both time periods; 1,062 households were workers in both periods; 20 households were entrepreneurs in 1983 and became workers by 1989. Calculations that are based on 10 households or less are starred.

Table 2.7: **Median percentage change in total mortgages, house values, and ratios of mortgage to house value, 1983-89**

	Enter	Stay in	Stay out	Exit	All
Total mortgages	−15,951	−25,547*	0	−9,606	0
House values	−4,255	89,493*	1,500	−37,787	1,500
Ratio of mortgage to house	−0.078	−0.308*	0	0	0
Ratio of mortgage to house value by networth:					
Class 1	0*	na	0	na	0
Class 2	na	na	0	−0.280*	0
Class 3	−0.096	−0.308*	0	0	0
Ratio of mortgage to house value by income:					
Class 1	0.267*	na	0	0*	0
Class 2	−0.114*	−0.308*	−0.005	−0.28*	−.005
Class 3	−0.096	−0.442*	−0.027	0	−0.027
Ratio of mortgage to house value by age:					
Young	−0.325*	−0.430*	−0.084	−0.175*	−0.092
Middle	−0.032	0.123*	−0.001	0.235*	−0.001
Old	0*	na	0	0	0

Source: 1983-89 Survey of Consumer Finances. Calculation uses 1,116 households that owned a home both in 1983 and 1989. There are 30 households that were workers in 1983 and became entrepreneurs by 1989; 4 households that were entrepreneurs in both time periods; 1,062 households were workers in both periods; 20 households were entrepreneurs in 1983 and became workers by 1989. Calculations that are based on 10 households or less are starred.

Since most mortgage payment schedules are set to pay-off the principal overtime, one could expect the level of debt secured by home to decrease for those households with homes in both 1983 and 1989. However, as noted earlier, the 1980s was a period of heavy deregulation in the mortgage markets. New mortgage products emerged and the use of securitization made lending to home owners less costly. As can be seen in the last column of the first row of Table 2.6, for those households that lived in their own homes in 1983 and 1989, the average debt secured by home increased over this time period. Nevertheless, there was a general increasing trend in house prices in most American cities during that period, as shown in the last column of the second row of Table 2.6. The latter of these occurrences dominate, and the ratio of debt secured by primary home to house value is decreasing over the period analyzed.

The SCF panel dataset provides information about the occupational transition between 1983 and 1989. As defined earlier an entrepreneurial household is one in which either the household head or spouse is self-employed and they have a positive level of active business assets. If a household was not an entrepreneur in 1983 but became one by 1989 the household is said to have entered entrepreneurship. Alternatively, a worker can stay out of entrepreneurship, while an entrepreneur may stay in entrepreneurship or exit. Tables 2.6 and 2.7 provide a break-down by occupational transition category, as well as networth, income and age in 1983.

If entrepreneurs took advantage of the equity in their homes to finance their businesses, one would expect those that enter entrepreneurship to incur in more mortgage debt to start their businesses. So the reduction in their mortgage to house value ratio should be smaller than for the rest of the transition groups.

The data limitations are such that if the household moved to a different house in between 1983 and 1989 the mortgage and house values will differ in the two periods probably because of the move. As long as the debt to house ratio doesn't change this does not present a problem when studying each household individually. However, an increase in the aforementioned ratio might be the consequence of an explicit decision by the household to incur in more debt or it could merely be due to the change of homes.

Changes in house prices could generate the same kind of ambiguity. Some of the changes in house prices are due to trends in the housing market which is exogenous to each individual household, but other changes to house prices might be the result of explicit decisions to enhance the residence such as repairs and renovations. However, as long as these changes do not affect one of the transitional occupation group more than the other the comparison remains valid. If the sample were such that most new businesses were concentrated in a given geographical area in which house prices might have had a different trend than the rest of the country, this would be a cause of concern. However, the sample is designed to be representative of US households; it does not concentrate on any particular geographic region.

As can be seen in tables 2.6 and 2.7, the decrease in the debt to house value is faster for new entrepreneurs than the sample average during that time period. In other words, instead of incurring in higher mortgage debt to help finance their businesses they are paying off their mortgages faster than average. In fact, the comparison with other occupational transition groups and in most of the ways to split the sample, households that had been entrepreneurs in 1983 or 1989 paid off their mortgages faster than those that were non-entrepreneurs in both of these periods. The few cases in which this does not hold are combinations of characteristics with very few observations.

In summary, compared to non-entrepreneurs the rest of the occupational transition groups are gaining ownership of the equity in their homes faster by paying off their mortgages at a more accelerated rate. This finding is in line with Quadrini (2000), Caner(2003), Gentry-Hubbard (2004) and other studies that document that entrepreneurs accumulate wealth faster than non-entrepreneurs.

2.3.2 Debt that's not linked to primary home

At first glance, it may seem relevant to look at total debt holdings, not only mortgage debt, to conclude that entrepreneurs are not obtaining as much external financing as they could. However, non-mortgage debt is harder to interpret given that total debt-to-asset ratio can be low due to demand or supply considerations. For instance, a low debt ratio may be the result of little need for outside debt or of a binding borrowing constraint that does not allow the business owner to incur in higher debt. Nevertheless, the ratio of total debt to assets is lower for entrepreneurs, even when excluding business assets. Because entrepreneurs are wealthier than workers, the conditional medians of debt for entrepreneurs are higher than that of workers.

Table 2.8: **Debt allocations of entrepreneurs and nonentrepreneurs**

	% with asset[a]	Conditional Median[b]	Portfolio Share[c]	
Entrepreneurs				
Debt secured by primary home	65.2	132,800	5.5	10.0
Other debt	71.5	16,458	2.2	4.0
All debt	85.1	130,666	7.7	14.0
Nonentrepreneurs				
Debt secured by primary home	46.6	91,400	13.5	
Other debt	66.4	10,966	4.3	
All debt	75.8	50,740	17.8	

Source: Calculation uses 4,519 households from the 2004 Survey of Consumer Finances.
[a] Weighted percentage of households with debt holdings of each type by group
[b] Shows the conditional median which is the median debt holding among households with that type of debt by group. Values are in 2004 dollars
[c] The portfolio share is the ratio of the total debt to total assets, by groups. For entrepreneurs there are two columns. The first column is the portfolio share as previously defined and the second column excludes business assets from total assets.

Regression analysis confirms that being an entrepreneur has no effect on the level of total debt, supporting the argument stated above. The regressions in Table 2.9, include a dummy that equals 1 if the agent is an entrepreneur, as well as the industry dummies and demographic controls that were included in the regressions for debt secured by primary home (Tables 2.4 and 2.5). Entrepreneurship has no significant effect on the level of household debt. In fact, the higher the investment in the business as measured by the level of business assets, the lower the debt of the household. The negative coefficient on the level of active business assets is significant and holds across OLS and median regressions. This is again in lines with the Quadrini (2000), Caner (2003) and Gentry-Hubbard (2004) observation that entrepreneurs accumulate wealth faster than workers.

Considering that it might be possible for entrepreneurship to positively impact the amount of debt incurred for those that owe the most debt, I ran quantile regressions. In fact, out of the

36 decile regressions that I ran (9 deciles for each of the four specifications), in 19 of the cases being an entrepreneur has a negative effect on the debt holdings, in 12 of the cases being an entrepreneur has a positive but very small effect on debt holdings, and in the remaining 5 cases being an entrepreneur has a positive and significant effect at the 10% level. These latter cases are not concentrated in any specific decile but rather scattered along the estimated deciles and specifications.

Table 2.9: **Log of debt holdings**

OLS regressions				
Entrepreneur	−0.678	1.663	−1.151	1.218
	(0.640)	(1.351)	(0.847)	(1.389)
log(Active business assets)		-0.194^{*}		-0.208^{**}
		(0.100)		(0.101)
Household members in firm			0.338	0.442
			(0.315)	(0.314)
log(Assets)	0.777^{***}	0.782^{***}	0.777^{***}	0.783^{***}
	(0.045)	(0.045)	(0.045)	(0.045)
log(Income)	0.161^{**}	0.168^{**}	0.163^{**}	0.170^{**}
	(0.082)	(0.082)	(0.082)	(0.082)
Industry dummies	yes	yes	yes	yes
Demographic controls	yes	yes	yes	yes
R-squared	0.633	0.633	0.633	0.633
Number of observations	4437	4437	4437	4437

Source: Survey of Consumer Finances 2004. Dependent variables are: (1) debt secured by primary home, (2) and (3) total debt. Standard errors are in parenthesis. Coefficients that are significant at the 10% level have one star, those at the 5% level have two stars, and those at 1% level have three stars.

Table 2.10: **Log of debt holdings**

Median regressions				
Entrepreneur	-1.240^{***}	0.426	-1.451^{***}	0.109
	(0.337)	(0.532)	(0.410)	(0.606)
log(Active business assets)		-0.147^{***}		-0.155^{***}
		(0.037)		(0.040)
Household members in firm			0.106	0.239
			(0.175)	(0.177)
log(Assets)	0.885^{***}	0.895^{***}	0.885^{***}	0.897^{***}
	(0.019)	(0.018)	(0.019)	(0.019)
log(Income)	0.046^{**}	0.049^{*}	0.051^{*}	0.051^{*}
	(0.029)	(0.028)	(0.028)	(0.030)
Industry dummies	yes	yes	yes	yes
Demographic controls	yes	yes	yes	yes
R-squared	0.567	0.567	0.567	0.567
Number of observations	4437	4437	4437	4437

Source: Survey of Consumer Finances 2004. Dependent variables are: (1) debt secured by primary home, (2) and (3) total debt. Standard errors are in parenthesis. Coefficients that are significant at the 10% level have one star, those at the 5% level have two stars, and those at 1% level have three stars. Standard packages for quantile regressions only allow analytic weights, whereas the SCF data is weighted by the inverse probability of sampling. These packages provide consistent estimates of the coefficient but inflated standard errors. Hence, the standard errors presented in the table are likely to be an overestimate of the true ones.

2.3.3 Allocation of assets

Next, I study the asset holdings of entrepreneurs versus workers. Gentry and Hubbard (2004) find that both types of agents hold, on average, very similar portfolios aside from the active business assets held by entrepreneurs. I focus on financial assets, because nonfinancial assets of these small entrepreneurs could be associated to the activity of their business (vehicles and real estate that are used for their everyday operations). In the strictest version of the borrowing constraint story, business owners facing binding liquidity would invest as much as possible in their businesses. I find that entrepreneurs are in fact investing as much as workers in financial assets such as stocks and bonds. An important clarification to make is that I am excluding holdings in retirement accounts which might prove difficult or costly to use as financing for investing in one's business. Nevertheless, the entrepreneurs' desire to diversify away from their sizeable investments in their businesses might be driving their holdings of financial assets, especially when considering that the portfolio share of business assets to total assets is on average 44.8%.

Table 2.11: **Financial Assets of entrepreneurs and nonentrepreneurs**

	% with asset[a]	Portfolio Share[b]	
Entrepreneurs			
Total financial	99.2	23.4	42.4
Financial minus retirement accounts	99.2	17.4	31.6
Pooled investment funds	25.2	4.0	7.2
Stocks	33.7	4.5	8.3
Bonds .	5.3	1.7	3.1
Nonentrepreneurs			
Total financial	93.4	40.5	
Financial minus retirement accounts	92.9	26.9	
Pooled investment funds	14.3	5.7	
Stocks	19.7	6.9	
Bonds	1.5	2.0	

Source: Survey of Consumer Finances 2004.
[a] Weighted percentage of households with asset holdings by occupation (entrepreneur or nonentrepreneur).
[b] Ratio of total debt/asset to total assets, by groups. For entrepreneurs, the second column excludes business assets from total assets.

2.4 Conclusions

This paper presents evidence that entrepreneurs are not taking advantage of available sources of financing to fund their business activities. Instead of maxing-out the debt secured by their homes, they have mortgage rates that are very similar to those of non-entrepreneurs. Furthermore, those entrepreneurs in the lower wealth classes have lower mortgage rates than workers, and households that recently became entrepreneurs are paying off their mortgages faster than those that stay as workers. Similarly, the holdings of total debt and financial assets such as stocks and bonds are similar across occupation groups.

Even if one thinks that the low debt rates and significant holdings of financial assets are a consequence of precautionary savings and a desire to diversify away from their businesses given that entrepreneurs suffer from large uninsured idiosyncratic shocks, my findings suggest that US entrepreneurs are not as severely constrained as the conventional literature on entrepreneurship assumes.

This conclusion leads to opportunities for further research. The two companion papers are in this vein. The first one proposes a model of occupational choice and learning, in which agents are not subject to borrowing constraints but have imperfect information about their ability instead. The stochastic general equilibrium of the model replicates many key facts that had been previously held as evidence of borrowing constraints without having the unfounded implications for the portfolios of entrepreneurs. The second paper takes Cagetti-De Nardi's standard model of occupational choice with financially constrained entrepreneurs and finds that this model results in strictly binding borrowing constraints even for the richest entrepreneurs. A recalibration of the model to match, among other things, measures of slackness in the financial constraints yields an economy that is far less responsive to redistributive policies.

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Chapter 3

What can calibration exercises say about the tightness of borrowing constraints on entrepreneurs?

Abstract

This paper finds that the standard general equilibrium model of occupational choice developed by Cagetti and De Nardi (2006) results in extremely binding borrowing constraints for entrepreneurs. Their desire to match the wealth distribution mandates very slow decreasing returns to scale on the entrepreneurial technology. An undesired consequence of the slow decreasing returns to scale is that borrowing constraints are considerably tighter in the model than in the data.

Next, I recalibrate the model to match measures of firm size and slack in the financial constraint given by the real estate equity available for borrowing on the entrepreneur's primary home. Finally, two policy experiments are analyzed. I show that the recalibration of the model, which yields faster decreasing returns to scale and a lower concentration of wealth, considerably dampens the effects of alternative redistributive policies aimed at favoring either high-ability would-be entrepreneurs or poor agents.

3.1 Introduction

It is widely accepted that credit constraints can have important implications for the economy. There is rich literature on the subject ranging from theoretical studies of the consequences of financial constraints on business-cycle fluctuations and long-term growth, as well as empirical papers that focus on highlighting evidence and costs of financial constraints.

Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) are examples of theories of how credit constraints affect business cycles. Other theoretical papers like Banerjee and Newman (1993) and Galor and Zeira (1993) study the effect of financial frictions on occupational choice, growth, and development. Empirical papers on the subject are equally as numerous. Some key examples are Fazzari, Hubbard and Petersen (1987) and Gilchrist and Himmelberg (1995) who discuss in detail the role of cash flow for investment. In turn, Petersen and Rajan (1994) study the benefits of lending relationships between small businesses and their creditors, associating close relationships to an increase in lending. Rajan and Zingales (1998) provide evidence that the development of sectors that are more dependent on external financing is slower in countries with less-developed capital markets.

There is, however, controversy on the tightness of the borrowing constraints affecting small firms in the United States. The issue of credit constraints for entrepreneurs is particularly important when considering that small firms are often the beneficiaries of redistributive policies (Li (1998)). In addition, recent literature on occupational choice identify borrowing constraints for entrepreneurs as the key mechanism in generating saving patterns and a wealth distribution similar to that of the US economy. If borrowing constraints do not play a crucial role for entrepreneurship in the US, then this literature is overstating the aggregative impact of financial frictions and missing the explanation for wealth disparity altogether.

The literature on borrowing constraints for entrepreneurs is mixed. On one hand, earlier papers like Holtz-Eakin, Joulfaian, and Rosen (1994), Evans and Leighton (1989), Blanchflower and Oswald (1998), and Evans and Jovanovic (1989) among others find that poorer agents are less likely to become entrepreneurs even after some attempts to control for the possible endogeneity between wealth and entry into entrepreneurship[1]. On the other hand, Hurst and Lusardi (2004) find that for the vast majority of the population of the US there is no relationship between net worth and entry into entrepreneurship. They argue the relationship is highly nonlinear: flat for most of the wealth distribution and only positive for the richest 5% of the population. Moreover, they conclude that using inheritances as an exogenous measure of wealth, as the aforementioned studies were doing, is not appropriate since both past and future inheritances predict entry into entrepreneurship. Hence, inheritances suffer from the same endogeneity concerns as wealth.

In addition, portfolios of entrepreneurs, particularly their holdings of mortgage debt and financial assets such as stocks and bonds, as analyzed in a companion paper, provide further evidence that entrepreneurs are not severely constrained. If they were, it would be puzzling that they did not incur in higher mortgage debt than workers, specially in light of the financial liberalization that the US mortgage market experienced since the 1970s and at least until the onset of the financial and housing crisis that started in 2007.

This paper uses a general equilibrium framework of occupational choice under credit frictions to evaluate the tightness of borrowing constraints for entrepreneurs both in the archetypal model and in the data. Specifically, I use Cagetti and De Nardi's (2006) standard model in which agents are free to enter and exit from entrepreneurship and choose the size of their investments subject to borrowing constraints[2].

I extend the original model to measure the slackness or the inverse of the tightness of the borrowing constraints as the difference between actual borrowing and maximum borrowing allowed for each agent. I then compare this to an estimate of the empirical measure of the slackness of the borrowing constraint: the fraction of home equity owned by the entrepreneur and available for borrowing. This and the companion papers in this package are the first to exploit the idea that financially constrained entrepreneurs may choose to tap into their home equity to finance their businesses. Home equity left for borrowing is, of course, an underestimate

[1] There may be a third variable such as ability, work ethic, preferences or entrepreneurial spirit that may be driving both net worth and entry into self-employed entrepreneurship.

[2] Other models in this vein are Quadrini (2000) and Li (2002), however, the Cagetti and De Nardi (2006) paper is more parsimonious and well-referenced.

of the slackness of the borrowing constraint since it is only one of many sources of financing available to entrepreneurs, such as other secured loans and unsecured loans including credit card debt, personal loans, lines of credit and business loans.

In this paper, I show that borrowing constraints are extremely binding in the model, though not in the data. This observation is important in light of the conventionally accepted explanation that tight borrowing constraints for entrepreneurs are the force behind understanding wealth dynamics and wealth distributions as skewed as that of the US. The tight constraints in the model are due to calibration exercises designed to match the wealth distribution therefore resulting in slow decreasing returns to scale in the entrepreneurial technology that lead to implausibly high first-best levels of capital for the entrepreneurial firms and binding constraints for all agents, including the wealthiest.

Next, I recalibrate the model by making some changes to the set of empirical moments that I am requiring the model to match. The purpose of this exercise is computing an economy that matches firm sizes and borrowing availability more closely, by allowing the generated wealth distribution to be less concentrated.

Finally, I use two policy experiments to further highlight the idea that the implications of redistributive policies will depend on the tightness of borrowing constraints. The nice fit of the Cagetti and De Nardi (2006) model with empirical observations, position it as a useful framework for the implications of policy experiments. Using their calibrated parameters, I study the effects of taxing wealth according to two different criteria. First, I tax the low-ability agents, while subsidizing the high-ability agents such that the net effect on the government balance is zero. Second, I tax high-wealth agents and offset the tax's effect with a subsidy on low-wealth agents. The positive effect that such redistributive policies have on the fraction of entrepreneurs, GDP, and capital in the entrepreneurship sector of the original calibration vanish almost completely in the recalibrated version of the model in which borrowing constraints are, realistically, less binding. The close-to-zero effect of the redistributive policies both on the extensive and intensive margins of entrepreneurship, is at a sharp contrast with President

Obama's array of tax-cuts targeted to entrepreneurs[3]. According to my results, such transfers do not affect the fraction of agents in entrepreneurship and do not increase the size of firms nor their production because entrepreneurs are typically wealthy enough that they are not severely financially constrained.

The rest of the paper is organized as follows. Section 2 describes the data and the model, including the details of the calibration. Section 3 presents the results of the original calibration highlighting the unrealistic tightness in the borrowing constraints even for very rich agents in subsection 3.1, as well as the results of the recalibration in 3.2. Section 4 studies the consequences of redistributive policies on both calibrations. Section 5 concludes.

3.2 Data and model

The general equilibrium framework used in this paper draws heavily on Cagetti and De Nardi (2006). As they do, I use the Survey of Consumer Finances (SCF) as my data source. The SCF is the preferred dataset for studying occupational choice in calibrated general equilibrium models for two reasons: first it oversamples the wealthy and hence gives a more accurate description of entrepreneurs (given that they are typically in the upper tail of the wealth distribution), and second, as Curtin, Juster, and Morgan (1989) point out, the aggregate wealth implied by the SCF is close to that resulting from the Federal Reserve's Flow of Funds Account, which makes it appropriate for the calibration of aggregates. As in the companion papers, I use the 1983-89 panel dataset of the SCF. Whenever cross-sectional one-year data is needed, as opposed to data on dynamics, the 1989 year is used. All dollar values are in dollars of 1989.

I use a standard definition of entrepreneur which is discussed in full extent in the companion papers. Further information on characteristics of the SCF and of both entrepreneurs and workers can be found there as well.

The rest of this section will briefly describe Cagetti and De Nardi's (2006) model for completeness. This study uses their model[4] and extends their paper in three ways: first, it compares

[3] Similar policies are popular in European and other OECD economics.

[4] I am very grateful for MariaCristina De Nardi for providing me with the FORTRAN code for their model.

the tightness of borrowing constraints generated in the model to those of the data and argues that they are unrealistically binding even for rich entrepreneurs; then, it recalibrates the model to match firm sizes and an empirical measure of borrowing constraints yielding faster decreasing returns to scale and a lower concentration of wealth; and finally, it studies the effects of two alternative redistributive policies both in the original model and in the recalibrated version of the model, highlighting how the results of the policies depend on the different degrees of tightness of the borrowing constraints.

The Cagetti and De Nardi framework uses a life-cycle model of intergenerational altruism where agents face two stages of life: young and old. The probability of aging and dying are parametrized such that the average duration of life and retirement are realistic. There is a continuum of infinitely lived households of measure one. Each household faces idiosyncratic risk but there is no aggregate uncertainty, as in Bewley (1977).

3.2.1 Preferences

The household's utility from consumption is given by a constant relative risk aversion utility function $c^{1-\sigma}/1-\sigma$. The household discounts the future at a rate of β, and discounts the utility of their offspring at a rate of η.

3.2.2 Technology

There are two sectors of production. The first one refers to entrepreneurs who use their labor in their own business, invest in capital, and don't hire outside workers. The production in the entrepreneurial technology is given by θk^{v}, where k is the entrepreneur's investment and $v \in [0, 1]$ is smaller for stronger decreasing returns in the entrepreneurial technology.

The second sector of production is the corporate sector, in which firms are not controlled by a single entrepreneur and are not subject to financial constraints. The corporate sector has a Cobb-Douglas production function

I recoded the model for MATLAB and extended it for the purpose of this paper.

$$Y_c = F(K_c, L_c) = AK_c^{\alpha} L_c^{1-\alpha},$$

where K_c and L_c are the total capital and labor inputs in the corporate sector. A is constant and capital depreciates in both sectors at a rate of δ. Capital's share of income in the corporate sector is given by α.

3.2.3 Financial Constraints

There is imperfect enforceability of contracts, meaning that debtors cannot be coerced into paying their obligations and that debtors can only obtain external financing for an amount that would be in their best interest to pay back. In particular, if an entrepreneur decided not to repay, he could run away with a fraction, f, of the firm's capital, k, and would become a worker next period.

3.2.4 Households

Each agent starts the period with assets a, an entrepreneurial ability θ, and a working ability y, which are his state variables. The ability is revealed at the beginning of each period, hence there is no within-period uncertainty about ability levels. However, next period's ability levels are unknown.

Young agent's problem At the beginning of each period, young agents decide whether to be workers or entrepreneurs

$$V(a, y, \theta) \equiv \max\{V_e(a, y, \theta), V_w(a, y, \theta)\}, \tag{3.1}$$

where $V_e(a, y, \theta)$ is the value function of the young entrepreneur and $V_w(a, y, \theta)$ is the value function of the worker.

The Entrepreneur Households that choose to be entrepreneurs invest k into their firms and borrow $k - a$ from a bank at an interest rate of r. The agent, who remains young with a probability π_y, will maximize

$$V_e(a, y, \theta) = \max_{(c,k,a')} \left\{ u(c) + \beta \pi_y EV(a', y', \theta' | y, \theta) + \beta(1 - \pi_y) EW(a', \theta' | \theta) \right\}, \tag{3.2}$$

where the labor and entrepreneurial ability follow first-order Markov processes. $W(a', \theta')$ is the value function of the old entrepreneur which will be defined later. The young entrepreneur maximizes (3.2) subject to the budget constraint (3.3); the incentive compatibility constraint (3.4), that restricts agents from borrowing more than what they would be willing to pay if defaulting means running away with a fraction f of the capital invested in the firm; and non-negativity constraints for assets and capital, (3.5) and (3.6), respectively.

$$a' = (1 - \delta)k + \theta k^v - (1 + r)(k - a) - c, \tag{3.3}$$

$$u(c) + \beta \pi_y EV(a', y', \theta' | y, \theta) + \beta(1 - \pi_y) EW(a', \theta' | \theta) \geq V_w(f \cdot k, y, \theta), \tag{3.4}$$

$$a \geq 0, \tag{3.5}$$

$$k \geq 0. \tag{3.6}$$

The Worker Similarly, the worker maximizes the value function V_w

$$V_w(a, y, \theta) = \max_{(c,a')} \left\{ u(c) + \beta \pi_y EV(a', y', \theta' | y, \theta) + \beta(1 - \pi_y) W_r(a') \right\}, \tag{3.7}$$

where W_r is the value function of the worker who becomes old and retires, as will be explained in the following subsection.

The worker's problem is subject to (3.5) and the budget constraint where τ is a tax on labor income wy that is used to finance social security

$$a' = (1 + r)a + (1 - \tau)wy - c. \tag{3.8}$$

3.2.5 Old agent's problem

Old entrepreneurs have two state variables, assets a and entrepreneurial ability θ. They choose to either remain entrepreneurs or retire:

$$W(a,\theta) \equiv \max\{W_e(a,\theta), W_r(a)\}. \tag{3.9}$$

The Entrepreneur If they remain entrepreneur's they may die with a probability $(1-\pi_o)$. They then bequest their firm to their offspring and discount their offspring's utility by η. They solve

$$W_e(a,\theta) = \max_{(c,k,a')} \left\{u(c) + \beta\pi_o EW(a',\theta'|\theta) + \eta\beta(1-\pi_o)EV(a',y',\theta'|\theta)\right\}, \tag{3.10}$$

subject to (3.5), (3.6), (3.3) and the incentive compatibility constraint that defines the borrowing constraint for the old entrepreneur

$$u(c) + \beta\pi_o EW(a',\theta'|\theta) + \eta\beta(1-\pi_o)EV(a',y',\theta'|\theta) \geq W_r(f \cdot k). \tag{3.11}$$

The Retired Retired agents can no longer join the workforce or become entrepreneurs They then solve

$$W_r(a) = \max_{(c,a')}\{u(c) + \beta\pi_o W_r(a') + \eta\beta(1-\pi_o)EV(a',y',\theta'), \tag{3.12}$$

subject to (3.5) and the budget constraint

$$a' = (1+r)a + p - c, \tag{3.13}$$

where p is a social security transfer.

3.2.6 Equilibrium

A steady state equilibrium in this economy is given by the risk-free interest rate r, the wage w, the proportional labor income tax τ, the allocations c, investments k, the occupational choices and a constant distribution of people over the state variables (a, θ, y), such that:

- The allocations c, a, k and occupational choices maximize the agent's problem as described above.
- Capital and labor markets clear. The total wealth in the economy equals the sum of the total capital employed in the entrepreneurial and corporate sectors. Entrepreneurs use their own labor, and the total labor employed by the corporate sector equals the number of workers in the economy.
- The factor prices w and r are given by the marginal products of each factor and the rate of return of investing in capital in the corporate sector equals the interest rate that clears savings and investment.
- The labor income tax τ funds the retired agents' pensions and is set such that the government's budget is balanced.
- The distribution of workers and entrepreneurs over the state variables (a, θ, y) is constant.

3.2.7 Calibration

Many parameters of the model can be estimated directly from the data without using the framework above or have been estimated time and time again by previous studies. These parameters are fixed in the model and not calibrated. A second set of parameters have unknown values and are calibrated to match moments of the data.

The original Cagetti and De Nardi (2006) estimation uses β, the high ability component of θ (since the low ability productivity is normalized to zero), v, f, and two elements of the $2x2$ Markov-transition matrix for entrepreneurial ability P_θ (since the sum of each column should be 1) to pin down six moments generated by the data. These moments are: the capital-output ratio, the fraction of entrepreneurs in the population, the fraction of entrepreneurs who exit, the fraction of workers who enter entrepreneurship, the ratio of the median net worth for entrepreneurs to that of workers, and the Gini coefficient for the wealth distribution. For a list of the calibrated and fixed parameters, please refer to the Appendix.

3.3 Results

3.3.1 From original calibration

General results and characteristics of the model are in the Cagetti and De Nardi (2006) paper. In this study I will include only results that pertain to the role of borrowing constraints in the model that are not in the original paper.

Occupational choice models that assume tight borrowing constraints for entrepreneurs are considered very successful in fitting many empirical observations, including the wealth distribution in the cross-section for entrepreneurs and workers, as well as patterns of wealth accumulation for the transitions to and from entrepreneurship that occur over time. These results rely crucially on the assumption of capital market imperfections that lead entrepreneurs to accumulate wealth to invest in their businesses. The purpose of this exercise is to compare the tightness of the borrowing constraints that entrepreneurs a la Cagetti and De Nardi (2006) face to the tightness of similar constraints in the data. If borrowing constraints in the model are significantly tighter than what the available home equity implies, then the aggregative impact of borrowing constraints, namely its effect on wealth accumulation and occupational choice, may be overstated.

In the absence of financial market imperfections, firm size would not depend on the wealth of entrepreneurs and would be a function of technological parameters. However, Cagetti and De Nardi introduce borrowing constraints in their model by assuming that there is imperfect enforceability of contracts, meaning that debtors cannot be coerced into paying their obligations and that debtors can only obtain external financing for an amount that would be in their best interest to pay back. In particular, if an entrepreneur decided not to repay, he could run away with a fraction, f, of the firm's capital, k, and would become a worker next period. Because the entrepreneur borrows $k - a$, the higher the agent's wealth invested in their own business the higher the loss if he defaults and hence the lower the incentive to default. Therefore, the wealthier the entrepreneur, the more he is able to borrow from his creditors. Within the context explained above, each agent chooses his optimal capital level given an upper bound or maximum capital level, $\bar{k}$, set by his borrowing constraint.

I have replicated Cagetti and De Nardi's (2006) life-cycle model of occupational choice. Using their baseline parameter values, I have computed several statistics referring to investment and borrowing by entrepreneurs. I study the distribution of actual borrowing and maximum possible borrowing in the model. I then compare the difference between the maximum and actual borrowing to an empirical measure of the slackness of borrowing constraints: a fraction of home equity. The implicit assumption here is that entrepreneurs who are borrowing constrained may choose to pay the fix cost to tap into their home equity to finance their businesses. Hence, entrepreneurs' holdings of home equity provide a measure of the inverse of the tightness of the borrowing constraint. Moreover, focusing on home equity is a clear understatement of the borrowing abilities of agents in the US given that there are many other avenues to obtain external financing. Nevertheless, available home equity provides a lower-bound for the difficult task of quantifying the slackness of the financial constraint.

As can be seen in Figure 3-1, actual firm size, k, follows the maximum firm size allowed by the borrowing constraint, $\bar{k}$, very closely in the Cagetti and De Nardi economy. This is because in their paper the optimal capital in the absence of financial frictions is extremely high. In the baseline specification, if an entrepreneur were rich enough not to face borrowing constraints he would invest \$2.32 billion dollars in his firm. Hence, there is an overwhelming incentive for entrepreneurs to invest as much capital as possible given that the optimal capital in the absence of credit frictions is orders of magnitude beyond the maximum firm size considered in the model which is \$75.8 million dollars[5].

It is not straightforward to find an empirical measure of the optimal capital level in the

[5] This is the maximum capital included in the gridspace for capital.

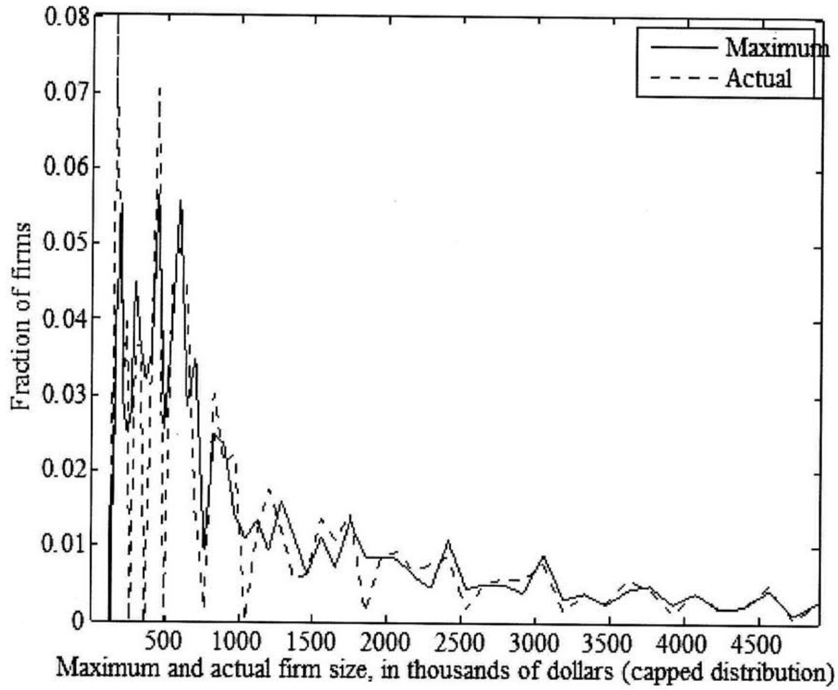

Figure 3-1: Distributions of maximum allowed and actual firm size in the model. Solid line: maximum allowed, dashed line: actual capital.

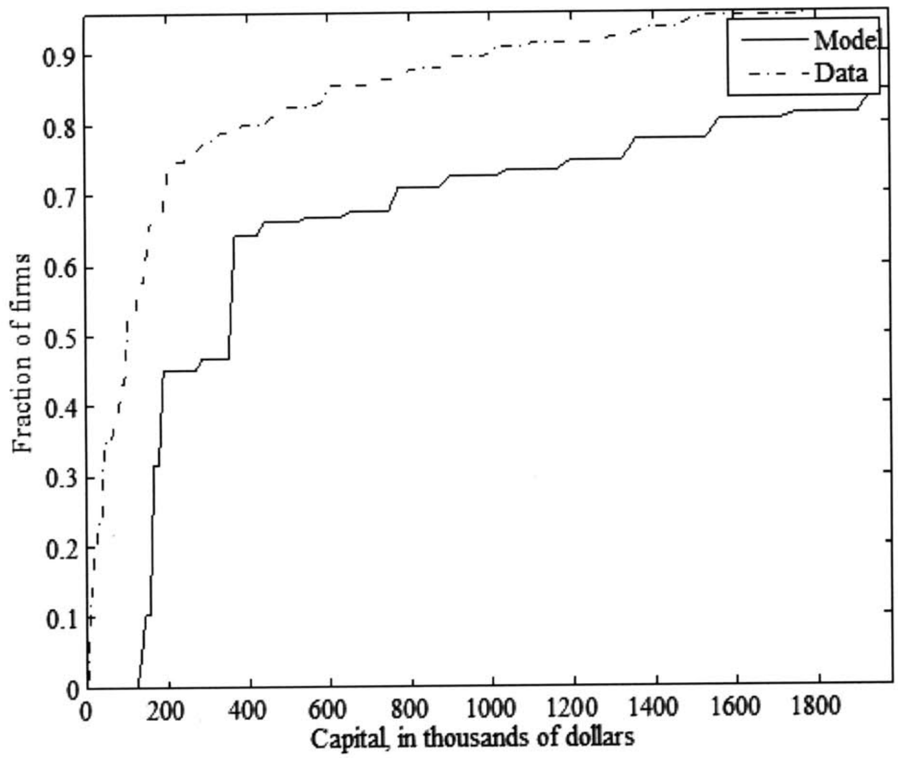

Figure 3-2: Cumulative distribution functions for the size of the firm. Solid line: model, dashed line: data.

absence of credit market frictions, however actual firm sizes may provide a clue, especially since most entrepreneurs are wealthy and it is plausible that some of them might not suffer from binding financial constraints. In the 1983-89 panel SCF, the median business assets of entrepreneurs in 1989 was \$100 thousand dollars of 1989; the 95% percentile of the distribution of business assets was \$1.5 million dollars, still considerably below the frictionless optimal in Cagetti and De Nardi's paper. Figure 3-2 compares the cumulative distribution function of capital both in the data and in the model. Following the argument stated above it is no surprise that firms are much larger in size in Cagetti and De Nardi's model than they are in the data. In fact the median firm in the model is four times as large as that in the data.

Another standard of comparison is the free-from-borrowing-constraints optimal firm size in similar papers. A companion paper provides a calibration of an occupational choice model that substitutes borrowing constraints for uncertainty about ability. That paper has the same technological specification as Cagetti and De Nardi but arrives at much smaller measures of optimal capital, ranging from \$39 thousand to \$103 thousand dollars depending on the agent's belief of his entrepreneurial ability[6].

The reason that the optimal capital levels differ in spite of the same technological specification is large differences in the calibration of the parameter referring to the curvature of the entrepreneurial technology. Specifically, the production technology in both papers is θk^v, where θ is a measure of ability and v is a measure of decreasing returns from investment. In Cagetti-De Nardi, the calibration result for v is 0.88 which is close to that of other calibration exercises presented in Quadrini (2000) and Li (2002), but is more than double that of the companion paper of 0.4 which is closer to the evidence from household-level estimations performed by Evans and Jovanovic (1989) and plant-level estimations by Cooper and Haltinwanger (2000) as well as the calibration results presented by Buera (2008).

The key difference between these two strands of literature is that the first set of papers above, Cagetti and De Nardi (2006), Quadrini (2000) and Li (2002), rely on borrowing constraints for calibration exercises that try to match the wealth distribution of the US. It is therefore not surprising that they need low decreasing returns to capital -equivalently, high v- to have large optimal firm sizes triggering binding borrowing constraints that drive entrepreneurial households to accumulate high wealth. On the other hand, in the second set of papers a smaller v implies strong decreasing returns for the firm and allows optimal capital to be smaller, diminishing the bite of borrowing constraints.

Maximum borrowing and actual borrowing for entrepreneurs are also very similar. This is a direct implication of maximum and actual firm size being closely linked, given that in the model entrepreneurs borrow $k - a$ and their maximum borrowing is given by $\bar{k} - a$. Hence, the only difference between figures 3-1 and 3-3 is that the later one subtracts financial wealth from firm size.

Figure 3-4 presents the distribution of the difference between the maximum and actual

[6]In Cagetti and De Nardi (2006) there is effectively only one level of optimal capital. They consider two different ability levels but normalize one of them to zero so that low ability agents always choose to be workers.

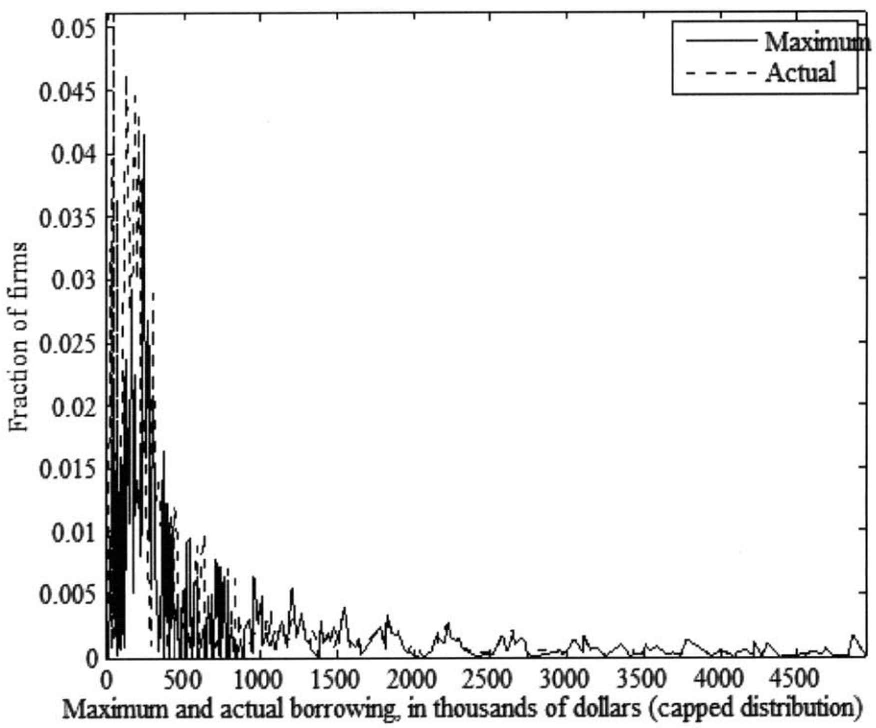

Figure 3-3: Distributions of maximum allowed and actual borrowing in the model. Solid line: maximum allowed, dashed line: actual borrowing.

borrowing. Even though maximum and actual borrowing are very closely linked, 52% of entrepreneurs are borrowing below the maximum they could get from their creditors. There are of course no closed-form solutions for such an exercise but analyzing the policy functions and the functions that provide the maximum level of capital, two distinctive patterns emerge.

The first one is unsurprising: for a given level of entrepreneurial and labor ability, there is a cut-off level of wealth, a_1, below which everybody is a worker and above which everybody is an entrepreneur. This is a direct implication of the borrowing constraint mechanism explained above in which the wealthier the entrepreneur, the more he is able to borrow. Consequently, if the agent is poor enough it would not be optimal for him to enter entrepreneurship even if he is of high entrepreneurial ability.

The second pattern is less straightforward and may even seem counterintuitive at first. There is another cut-off level of wealth , $a_2(> a_1)$. Up to numerical error, all agents with wealth in between ($a_1 < a < a_2$) are not borrowing as much as their creditors will allow, whereas those with $a > a_2$ are borrowing as much as they are able to. It may seem counterintuitive that the wealthier have binding borrowing constraints but not the agents below the treshold of a_2. The reason for this is that the first best capital level is much higher than the highest capital level allowed in Cagetti-De Nardi's computation of the model, as was explained in detail earlier. Hence, even the richest entrepreneurs have an incentive to invest as much as their borrowing constraint allows. Actually, the second pattern provides a clue for why maximum and actual borrowing differ in 52% of the firms in spite of low decreasing returns to scale. Entrepreneurs decide each period whether to allocate their available funds to their business, accumulate financial wealth, or consume today. There is a strong incentive provided by the low decreasing returns to scale to allocate as much as possible to the firm. This incentive is countered, especially for the relatively poor entrepreneurs, by the desire for consumption-smoothing. The persistence in the entrepreneurial ability implies that Cagetti-De Nardi's entrepreneurs are likely to be of high ability in the future periods so they will probably remain entrepreneurs and transition to higher wealth classes overtime[7]. Consequently, poorer entrepreneurs would like to smooth their

[7] The cross-occupation and wealth groups transition matrices is exhibited in Cagetti and Denardi (2009) for the model augmented by the main elements of the US tax structure. Similar cross-occupation and wealth groups

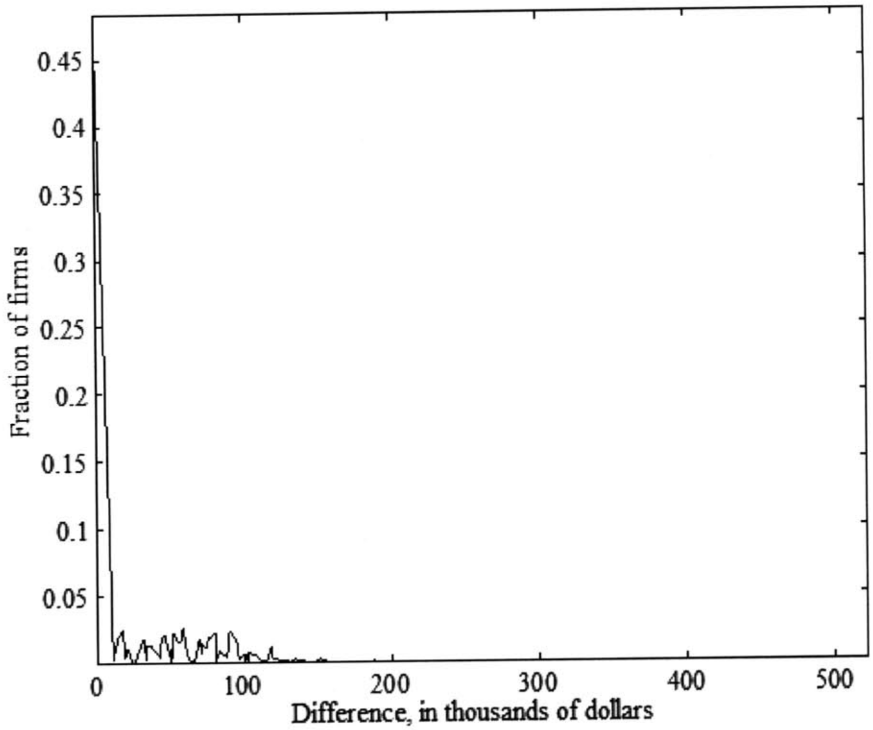

Figure 3-4: Distribution of the gap between maximum and actual borrowing in the model

consumption and have higher consumption today at the cost of investing below the maximum allowed by their creditors.

Next, with data from the SCF, I compute the home equity that can be used for borrowing, which I am taking as a measure for the slackness or inverse of the tightness of borrowing constraints. The data for 1989 in the 1983-89 panel SCF includes a question on the value of the home and another one on the home equity owned by the agent. I can use these two variables to measure how much is currently owed on the home. I then assume that agents must own at least 10% of their home so the maximum that can be borrowed is 90% of the house value, to accommodate for down payments[8]. Finally, an empirical measure of how much more entrepreneurs can borrow using their home equity as collateral, can be obtained by subtracting

matrices can be found in the companion paper "Entrepreneurship, Learning, and Wealth", Taveras (2009).

[8]The assumption of a minimum down payment of 10% comes from Haurin, Hendershott, and Wachter (1996) who use the National Longitudinal Survey of Youth to study the relationship between wealth accumulation and home ownership during 1985-89. They mention 10% as the minimum down payment at that time.

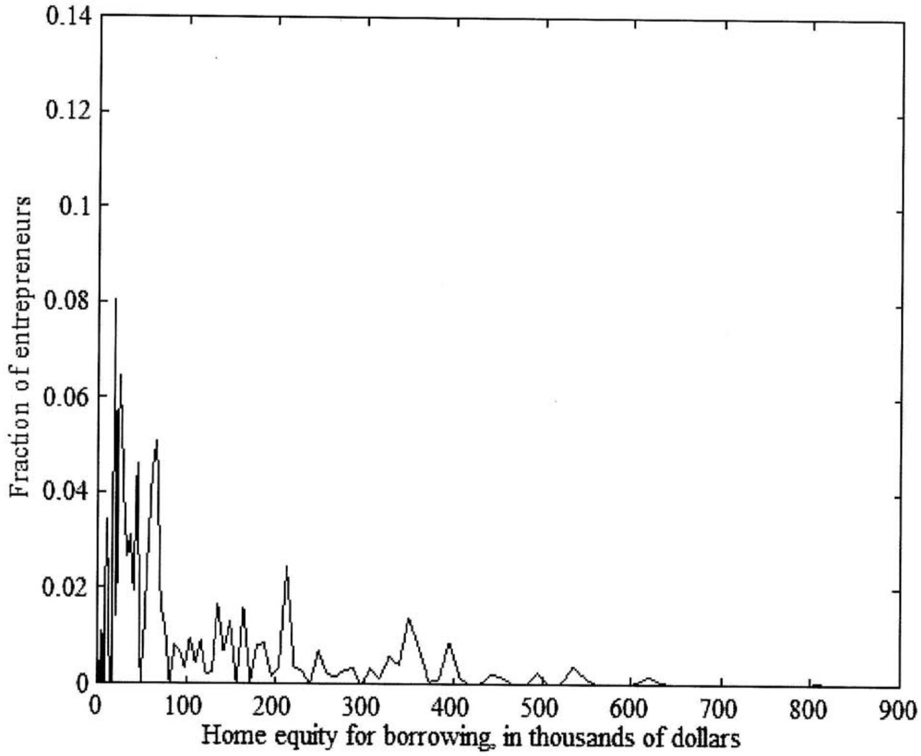

Figure 3-5: Distribution of home equity available for borrowing in 1989 for the SCF 1983-89 panel dataset.

what the agent has already borrowed from his home from the maximum that he can borrow. Figure 3-5 summarizes the fraction of entrepreneurs for each level of home equity available for borrowing.

Next, I compare the measure of slackness of financial constraints both in the model and in the data. Recalling the argument above, a summary measure of the slackness of the financial constraint in the model is the difference between maximum capital and optimal capital. The larger the difference the less binding the constraint. In the data, the level of home equity available for financing provides a measure of the slackness of the financial constraint. The comparison is provided in Figure 3-6, which provides three cumulative distribution function: the solid line is produced by the model, and the dashed and dotted line are generated from the data assuming that agents can borrow a maximum of 75% and 90% of their home equity,

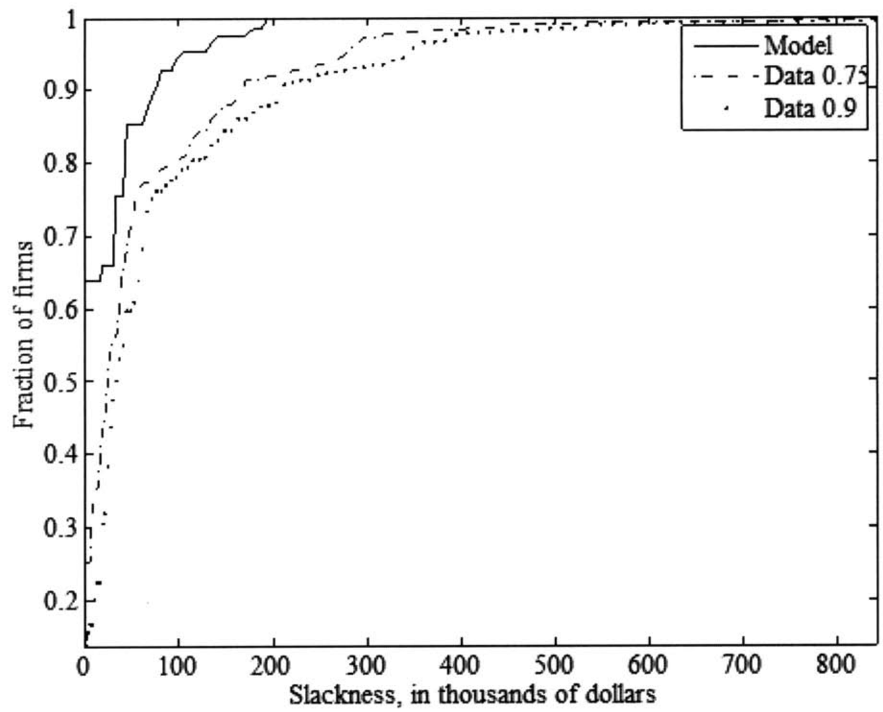

Figure 3-6: Cumulative distribution function for the slackness in the borrowing constraint. Solid line: model (obtained from the gap between maximum and actual borrowing), dashed line: data (agents can borrow up to 90% of the house value), dotted line: data (agents can borrow up to 75% of house value).

respectively. According to Figure 3-6, the financial constraints are tighter in the model than they are in the data, for both down payment assumptions.

Table 3.1 presents a summary of the distribution of several variables relating to the slackness of borrowing constraints in the data. First it exhibits the size of firms measured by the level of active business assets, as well as the home equity owned by entrepreneurs, and the home equity left for borrowing as defined earlier. The last row of the table shows the ratio of home equity left for borrowing to active business assets, which is a measure of the slackness in the financial constraint. A ratio of 0, for example, means that the entrepreneur cannot borrow any amount using his home as collateral; whereas a fraction of 1 means that if the entrepreneur took full advantage of his home equity to finance his business he would double his business assets. As Table 3.1 summarizes, the median entrepreneur can use his home equity to increase his firm size to almost one-third of the original; entrepreneurs in the 95th percentile have enough home equity that they can multiply their business assets by a factor of eight if they wanted to. The data reveals that a large fraction of entrepreneurs do not suffer from binding constraints if one considers that they can make use of their home equity to finance their business activities.

Table 3.1: **Firm size, home equity, and slackness of the borrowing constraint in the data**

Percentile	5th	25th	50th	75th	95th
(1) Active business assets	5,019	36,667	100,000	216,333	1,472,485
(2) Home equity	0	18,083	44,333	84,000	381,733
(3) Home equity left for borrowing [a]	0	10,999	33,287	69,499	340,667
(4) Ratio of (3)-to-(1)	0	0.042	0.281	0.827	8.338

Source: Data for 1989 retrieved from the1983-1989 panel dataset of the Survey of Consumer Finances.
[a] Assumes entrepreneurs can borrow up to 90% of their house value.

3.3.2 Recalibration

This paper's recalibration of the model sets out to match firm sizes and borrowing availability more closely, as opposed to wealth disparity and inter-occupational moments of the wealth distribution, as in the original calibration. I preserve the same set of fixed and calibrated parameters to keep things as comparable as possible. Hence there are again six parameters β, θ, v, f, and two elements of the Markov-transition matrix for entrepreneurial ability P_θ, to match six moments of the data. Four of these moments are the same as in the original paper: the capital-output ratio, the fraction of entrepreneurs in the population, the fraction of entrepreneurs who exit, and the fraction of workers who enter entrepreneurship. The remaining two are the ratio of the median firm size-to-networth for entrepreneurs and the median funds available for borrowing as a fraction of firm size.

Given the features that the model sets out to match, I present how well the model matches other moments such as the distribution of firm size, the slackness in the borrowing constraints and the wealth distribution. Matching the ratio of median firm size-to-networth, has conse-

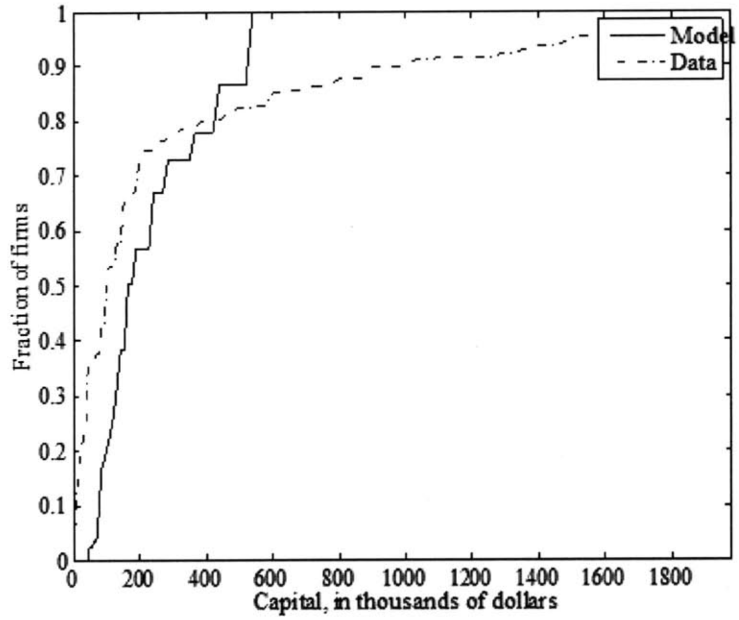

Figure 3-7: Cumulative distribution functions for the size of the firm. Solid line: model, dashed line: data.

quences on the resulting distribution of firm sizes but a model may match the ratio and miss the distribution of firm sizes altogether. The same can be said about the ratio of the median funds available for borrowing-to-firm size and the distribution of the slackness of the borrowing constraint.

As could be anticipated from the previous section, the recalibration results in firms that are smaller and, for most of the distribution, closer to the size of firms in the data by yielding faster decreasing returns to scale, that is a lower v, which goes from 0.88 in the original model to 0.4 in the recalibration (for the full set of calibrated parameters, please refer to the Appendix).

Figure 3-7 presents the cumulative distribution function for the size of firms in the data and in the model. The distribution functions follow each other closely for the lower 90% of the distribution, and are in fact considerably closer than the analogous curves resulting from the Cagetti-De Nardi's (2006) calibration and presented in Figure 3-2. The largest 10% of firms in the model are smaller than the largest 10% of firms in the data, as can be seen in Figure 3-7.

Next, the recalibration very closely matches the availability of borrowing constraints for

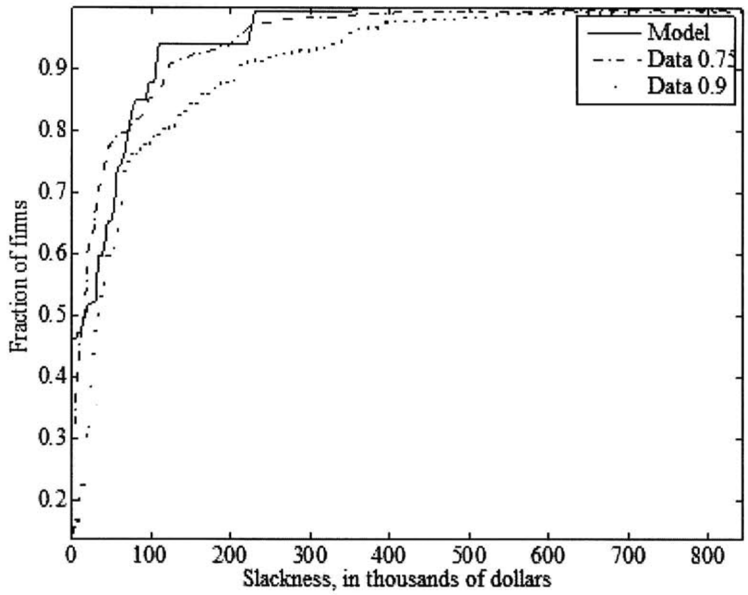

Figure 3-8: Cumulative distribution function for the slackness in the borrowing constraint. Solid line: model (obtained from the gap between maximum and actual borrowing), dashed line: data (agents can borrow up to 90% of the house value), dotted line: data (agents can borrow up to 75% of house value).

entrepreneurs. The original calibration in Cagetti-De Nardi's (2006) paper resulted in very binding constraints for entrepreneurs. This paper argues that home equity can be a source of financing for entrepreneurs. More specifically, when analyzing the portfolios of entrepreneurs in the data, entrepreneurs have considerable holdings of home equity from which they could borrow. Figure 3-8 displays the distribution of the difference between the maximum that an entrepreneur can borrow and his actual debt in the recalibrated model (the solid line) against two measures the home equity left for borrowing, that is the home equity available after taking into account that agents can borrow up to a "down payment" of 10% (dotted line) and 25% (dashed line). The recalibration of the model succeeds in producing a similar degree of tightness in the borrowing constraints as in the data, as shown in Figure 3-8 (the results of the original calibration are in 3-6).

As anticipated, calibrating the model to match the desired moments listed above comes with an important drawback, which is that the fast decreasing returns to scale in the entrepreneurial production function generates a distribution of wealth that is far less skewed than in the data. Table 3.2 exhibits several statistics referring to the distribution of wealth as well as other characteristics of both calibrations and the data. As can be seen, all of the measures of wealth inequality reveal that wealth is more equally distributed in the new calibration. It would be interesting to see whether a model that includes borrowing constraints for entrepreneurs and a richer entrepreneurial ability structure[9] could match firms sizes, slackness in the borrowing constraints, and wealth inequality.

Table 3.2: **Comparing data and models**

	K/Y	i	% Entrepreneur	Wealth gini	% Wealth on top		
					5%	20%	40%
Data	3		6.8%	0.8	54	81	94
Original calibration [a]	3	6.5%	7.5%	0.8	60	83	94
Recalibration [b]	2.8	10%	7.8%	0.6	12	41	56

[a] Reproduced by the author but also available in Cagett-DeNardi (2006).
[b] Recalibration with a different set of moments to match as explained in this section

Comparing the original calibration of Cagetti and De Nardi (2006) to this calibration, the risk free interest rate i is 3.5 basis points higher in the recalibration. The faster decreasing returns to scale in the entrepreneurial technology allows borrowing constraints to be less binding which results in would-be-entrepreneurs having lower savings rates in the recalibration because they no longer need to accumulate financial wealth to escape binding borrowing constraints when investing in their business activities. As a result, the supply of savings in the economy is lower, and the risk-free interest rate is higher. Table 3.3 in the next subsection, exhibits how the recalibration affects key aspects of the model. The smaller firms in the recalibrated version of the model provide lower gross entrepreneurial product. Equally, the capital in the corporate sector is also lower in the recalibration because the higher interest rates translate into higher

[9] While there are two levels of entrepreneurial ability in this model, the low ability is normalized such that it is not profitable for low ability agents to become entrepreneurs. Hence, in this model all entrepreneurs posess the same level of high ability.

costs of capital. Hence, gross domestic product in the recalibrated economy is below that of the original calibration.

3.4 Policy experiments

The original model includes one proportional payroll tax that is levied on young workers and pays for the social security pensions that retired agents receive. In this section, I build on this set-up and add two alternative redistributive policies to the tax structure, highlighting how the consequences of these policies depend on the tightness of the borrowing constraints. In summary, the faster decreasing returns to scale in the recalibration dampens the effect of the redistributive policies in the economy. On the second column, Table 3.3 shows the no-policy benchmark for both the original and my calibration. This column presents key aspects of the economy such as the dollar level of GDP, total savings, and capital in the entrepreneurial sector, as well as the interest rate and the fraction of entrepreneurs. The columns to the right exhibit the effect of the different redistributive policies.

First, I consider a policy that takes wealth from the low-ability agent and transfers it to the high-ability one. Specifically, I model a 1% proportional tax on wealth of the low-ability households accompanied by a lump-sum subsidy to high-ability households. The lump-sump subsidy, shown as the last element in each column, is such that the budget remains balanced, keeping other aspects of fiscal policy as in the original model. This exercise relaxes the borrowing constraint for the high-ability agent, while tightening it for the low-ability one. In effect, this policy transfers a positive lump-sum to all entrepreneurs, given that entrepreneurs all have high ability in equilibrium in this model (low-ability agents are better off as workers).

Such a policy has more impact on GDP, total savings, fraction of entrepreneurs, and capital in the entrepreneurial sector in the original calibration than with the faster decreasing returns to scale present in the recalibration of the model. Whereas GDP increases by almost 12% in the original calibration and the fraction of entrepreneurs in the economy goes from 7.5 to 10.4%, in the recalibration of the model GDP increases by 2.8% and the fraction of entrepreneurs goes from 7.8 to 8.1%. The intuition here is that a wealth transfer from low-ability to high-ability is a direct transfer to would-be entrepreneurs. Hence it facilitates entry into entrepreneurship and relaxes borrowing constraints for those that are already entrepreneurs. Since borrowing constraints are less binding in the recalibration of the model, a redistributive policy like this one would have a dampened effect on the economy.

Next, I model a policy that taxes wealthy agents and subsidizes poor agents. I consider a proportional tax of 1% of wealth to agents that have a net worth of $500,000 and assign a lump-sum subsidy to households with a net worth below the same treshold, such that the subsidy balances the government budget. The selection of the $500,000 carefully considers that the recalibration yields a more equitable distribution of wealth. For example, if the treshold is set at one million dollars, less than a ten thousandth of the population has wealth above $500,000 and would be affected by the tax in the recalibrated version of the model (5% in the original Cagetti-De Nardi's calibration). The redistributive policy would then have close to no effect on the recalibrated model. In turn, with the $500,000 treshold, about 9.5% of the population has wealth beyond the treshold and would pay the tax on wealth in the recalibrated model, while 8% of the population would do so in the original version (as can be seen the fraction of the population above the $500,000 treshold is very similar in both calibrations, even though the wealth distribution in the original version of the model has a thicker right tail).

Four versions of this policy that taxes the wealthy and subsidizes the poor are considered, each with a different target group. The first version limits its taxes and subsidies to young entrepreneurs. The second one, broadens the target population to both young and old entrepreneurs. Next, I broaden the target population even further to include everybody except the retired agents. Finally, all agents even those who have retired are affected by either taxes or subsidies, depending on their wealth level.

In the original calibration, in which borrowing constraints are severely binding, policies (I) and (II), which target the transfers to the population of entrepreneurs only, result in a larger fraction of the population becoming entrepreneurs. As shown in the first panel of Table 3.3, transferring wealth from rich to poor in the original calibration of the model allows poor high-ability agents to amass enough wealth, escape borrowing constraints, and enter entrepreneurship. This leads to higher capital in entrepreneurial firms and higher GDP. These results are in part muted when the transfer from rich to poor is not targeted to entrepreneurs. In policies (III) and (IV) young workers and old retired agents respectively are affected by the policy. In these two types of interventions, wealth from some of the rich entrepreneurs ends up in the hands of poor workers, resulting in lower increases in GDP, capital in entrepreneurial firms, and fraction of the population in entrepreneurship. Furthermore, since rich agents save a higher fraction of their wealth than poor agents do, a transfer from rich to poor lowers aggregate savings. Consequently, the drop in the supply of savings increases equilibrium interest rate. With regards to the lump-sum subsidy that poor agents receive, the inclusion of workers and retired agents in the policy's target group triggers sharp decreases in the level of the subsidy. The lower subsidies are due to the inclusion of more poor agents as a fraction of the target group since most rich agents are entrepreneurs. Hence, the revenues of the taxes on the rich are being divided among a higher number of agents with the broadening of the target group.

In turn, in the recalibration of the model, borrowing constraints are not as binding as in the original version. Hence, the effects of transferring wealth from rich to poor agents are severely dampened, as can be seen in the second panel of Table 3.3. The fraction of entrepreneurs in the population is not affected regardless of the target population of the policy. The GDP and total capital in the entrepreneurial sector increase at a much lower rate than in the original calibration, meaning that the size of firms does slightly increase with the transfer. The level of the subsidy required to balance the budget is much lower in the recalibrated version of the model than in the original, because taxing rich agents in the recalibrated version of the model translates into lower revenues for the government than in the original version of the model. The lower revenues are a direct consequence of the recalibration resulting in a more equitable wealth distribution.

In summary, the general result is that redistributive policies in the recalibrated model are less effective in terms of changes to the fraction of the population in entrepreneurship, capital in the entrepreneurial sector, and GDP.

Table 3.3: **Redistributive policies in both calibrations**

	No-policy	Change from no-policy to taxing [a]				
		Low-ability	Rich [b]			
			I	II	III	IV
Original Calibration						
GDP	68,000	11.9%	7.2%	8.6%	3.8%	0.6%
Total savings	188,631	18.9%	10.4%	13.1%	6.1%	-1.8%
Interest rate	6.5%	0%	0%	0%	0.8%	1.0%
% entrepreneurs	7.5%	2.9%	2.7%	2.7%	1.2%	1.3%
Capital in entrepreneurial sector	55,643	49.7%	31.8%	35.8%	13.7%	11.8%
Subsidy	NA	11,712	9,639	8,456	1,041	675
Recalibration						
GDP	55,638	2.8%	0.8%	0.6%	1.8%	1.4%
Total savings	105,750	8.8%	2.8%	2.3%	6.4%	5.3%
Interest rate	10.0%	0.3%	0.2%	0.2%	0.6%	0.6%
% entrepreneurs	7.8%	0.3%	0%	0%	0%	0%
Capital in entrepreneurial sector	17,154	3.5%	4.5%	3.4%	5.2%	4.0%
Subsidy	NA	11,709	450	450	225	225

[a] % Change from no-policy for all variables except for the subsidy which is in dollars. For GDP, total savings, and capital in entrepreneurial sector the % change is the variable with the policy divided by the no-policy minus 1, whereas the change in interest rate and the fraction of entrepreneurs is the rate with the policy minus the rate without the policy.

[b] There are several specifications all with the same treshold of $500,000: I. Taxes rich young entrepreneurs, subsidizes poor young entrepreneurs; II. Taxes rich young and old entrepreneurs, subsidizes poor young and old entrepreneurs; III. Taxes rich, subsidizes poor (both entrepreneurs and workers, excluding retired agents); IV. Taxes rich, subsidizes poor (entrepreneurs and workers, including retired agents).

3.5 Conclusions

While the archetypal model of occupational choice is able to match the skewness of the wealth distribution, this achievement comes with important drawbacks. Slow decreasing returns to scale in the entrepreneurial technology are needed to match the highly unequal distribution of wealth in the US. The slow decreasing returns to scale translate into firms that are much larger than in the data and borrowing constraints that are strictly binding, even for extremely rich entrepreneurs. Firms in the model are several times greater than those in the data. In turn, a comparison of borrowing constraints in the model and the data reveals that borrowing constraints are tighter in the model even when limiting financing to what, according to the data, could be derived from home equity taking into account down payments and outstanding loans on the home. Hence, matching the wealth distribution mandates important sacrifices in the characteristics of small firms and entrepreneurs, which is precisely the topic that the occupational choice models set out to study.

The disadvantages of modeling entrepreneurs that are far more financially constrained than in the data becomes even more evident when studying the effects of redistributive policies that set out to aid high-ability would-be entrepreneurs or poor agents. These policies alleviate some of the financing constraints that entrepreneurs face, resulting in a higher fraction of population in entrepreneurship, higher capital used in entrepreneurship, and higher GDP for the original calibration. Recalibrating the model to match firm sizes and a degree of slackness in the borrowing constraints comparable to the data, yields very different results for the same redistributive policies. The policies have a much dampened effect in the fraction of entrepreneurs (in fact a zero change in all the cases involving transfers from the rich to the poor), GDP, and capital used in entrepreneurship.

Perhaps a more satisfactory way to reconcile the characteristics of firms and entrepreneurs as well as the unequal distribution of wealth in the US is by augmenting the model to include a richer ability structure. In a companion paper, it is shown how, in the absence of borrowing constraints, a richer ability structure can produce wealth accumulation and occupational transition patterns that match many stylized facts in the data. An even richer model that encompasses borrowing constraints and several ability levels for entrepreneurs may reproduce firms that are small in size and thick tails in the wealth distribution. Nevertheless, the computational needs of such a model must not be underestimated, though without doubt this will be less time-consuming in the future as computing capabilities progress further.

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3.6 Appendix

3.6.1 Description of calibration

A. Fixed parameters (taken directly from Cagetti-De Nardi (2006)		
	Value	Source
σ	1.5	Attanasio et al (1999)
δ	0.06	Stokey and Rebelo (1995)
α	0.33	Gollin (2002)
A	1	Normalization
π_y	0.978	Average length of working life: 45 years
π_o	0.911	Average length of retirement: 11 years
P_y	5-state discretized labor income	Storesletten et al. (1999)
p	40% of yearly income	Kotlikoff et al (1999)
η	1	Perfect altruism

B. Calibrated parameters.		
	Cagetti-De Nardi (2006)	Recalibration done in this paper
β	.865	.867
θ	$[0, .51]$	$[0, 1.84]$
P_θ	$\begin{matrix} 0.964 & 0.036 \\ 0.206 & 0.794 \end{matrix}$	$\begin{matrix} 0.964 & 0.036 \\ 0.33 & 0.67 \end{matrix}$
v	.88	.40
f	75%	90%