Personal Bankruptcy Law and Entrepreneurship A Quantitative Assessment *

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Abstract

Every year 400,000 entrepreneurs fail and 20% of them file for bankruptcy. Thus the personal bankruptcy law has important implications for entrepreneurship. The option to declare bankruptcy encourages entrepreneurship through providing insurance since entrepreneurs may default in bad times. However, perfectly competitive financial intermediaries take the possibility of default into account and they charge higher interest rates which reflect these default probabilities. Thus personal bankruptcy provides insurance at the cost of worsening credit conditions. We develop a quantitative general equilibrium model of occupational choice that examines the effects of the US personal bankruptcy law on entrepreneurship. The model explicitly incorporates the US legislative framework and replicates empirical features of the US economy regarding entrepreneurship, wealth distribution and bankruptcy filings by entrepreneurs. Our quantitative evaluation shows that the current US bankruptcy law is too lenient. It provides too much insurance at the expense of worsened credit conditions. According to our simulations, halving the wealth exemption level from the current one would increase entrepreneurship, the median firm size, welfare and social mobility without increasing inequality. However, eliminating the possibility of bankruptcy completely would reduce welfare and entrepreneurship.

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1 Introduction

Entrepreneurs employ half of all workers in the US and they create three quarters of all new jobs. Over time, successful entrepreneurs, for example Bill Gates in 1978 or Larry Page and Sergey Brin in 1997, grow their small firms into big enterprises, for example Microsoft and Google today. Personal bankruptcy law is important for entrepreneurs because if an entrepreneur's firm is not incorporated he or she is personally liable for all the debts of this firm. And even if the firm is incorporated, the entrepreneur very often has to provide personal guarantees to secure a loan (Berkowitz and White, 2004). Ten percent of entrepreneurs fail each year, and out of these around 20 percent file for bankruptcy.

This paper investigates quantitatively the effects of personal bankruptcy law on entrepreneurship. The main effect of personal bankruptcy on entrepreneurship is to provide insurance. However, this comes at the cost of worse credit conditions. Bankruptcy introduces some contingency in a world of incomplete credit markets where only simple debt contracts are available. However it provides only partial contingency and does not complete markets fully. This contingency provides insurance against entrepreneurial failure at the cost of worsening credit conditions. If the bankruptcy law does not allow default under any circumstances, i.e. if there is full commitment, credit will be available at lower interest rates because borrowers will not default. This comes at the expense of borrowers having no insurance against business failure. If, however, the bankruptcy law makes default very easy, borrowers might be insured against bad outcomes. But in order to compensate for the default risk, banks have to charge higher interest rates or ration credit all together. In both extreme cases, the equilibrium outcome would be one of almost no credit. In the former case, there is no demand for credit, whereas in the latter there is no supply of credit. In such a world, many firms are inefficiently small, especially those owned by poorer entrepreneurs.

This trade-off is at the center of recent public discussions and policy changes in Europe and the US. In Europe, the bankruptcy law is much harsher than in the US. Many countries, for example Germany, the Netherlands and the UK, have made legislation more lenient with the explicit aim of fostering entrepreneurship.[1] The policy changes in the US went in the opposite direction. Following the huge increase in personal bankruptcy filings, US Congress passed a law in 2005 making personal bankruptcy less beneficial for filers. Even though the focus of this discussion has been on consumer bankruptcy, the effects on entrepreneurship are important because around 80,000 failed entrepreneurs file for bankruptcy each year. Our paper quantitatively assesses the relative strength of these two opposing forces, insurance versus credit conditions, on the number of entrepreneurs, on the access of poor agents to entrepreneurship, on firm size, and on welfare, inequality and social mobility.

We build an infinite horizon heterogeneous agent model, which has an occupational choice problem at its core. Agents differ with respect to their entrepreneurial and working productivity. During each period, they decide whether to become an entrepreneur or a worker, based on a noisy signal of their productivities. Cagetti and De Nardi (2006) also have this occupational choice at the center of their model, which is able to explain US wealth distribution, in particular its extremely skewed nature at the top.

[1] In a companion paper, we are currently investigating the effects of introducing a US type of law in Europe.

However, in their model, entrepreneurship is a risk-free activity because there is no uncertainty about current productivities. Thus there is no default in equilibrium and there is no insurance role for bankruptcy. We have default in our model because in the US 20% of failing entrepreneurs file for bankruptcy.

Despite the importance of personal bankruptcy law for entrepreneurship, there is no quantitative literature on this topic. Starting with Athreya (2002), the literature so far has focused exclusively on consumer bankruptcy. For example, Livshits, Macgee, and Tertilt (2007) compare the US system under which future earnings are exempt after having declared bankruptcy with a European type of system under which future earnings are garnished to repay creditors. They find that the welfare differences between the systems depends on the persistence and variance of the shocks. Chatterjee, Corbae, Nakajima, and Rios-Rull (2007) show that the recent tightening of the law in the US implies large welfare gains.[2] We complement this literature by examining the effects of bankruptcy on entrepreneurship.[3]

Our model is able to replicate key macroeconomic variables of the US economy: the capital output ratio, the fraction of entrepreneurs in the population, the exit rate, the bankruptcy filings of entrepreneurs, the wealth of entrepreneurs compared to workers. Based on this model, we conduct two experiments to assess whether the current exemption level and the current exclusion period are optimal. The wealth exemption level determines how much wealth a person can keep in case of a default. The length of the credit market exclusion period determines when someone who has defaulted in the past regains access to credit.

Our main result is that the current system is too lenient with respect to the exemption level. There are significant welfare gains from halving the current exemption level. These are in the order of 1.4% of annual consumption per household, which corresponds to $700 in 2007. The welfare gains from lowering the exemption level not only occur from an ex ante, expected utility perspective, but also across the entire wealth distribution. Both the rich and the poor would gain. The reason for this result is that the current system provides too much insurance. This worsens credit conditions for entrepreneurs to such an extent that there are simply fewer of them. Entrepreneurship would increase from 7.6% of the population to 8.6% if the exemption level were halved because credit would become cheaper. However, completely abolishing bankruptcy would lead to a welfare loss in the order of $60 per household since some insurance is valuable.

The effects of changing the exclusion period are small. Reducing the exclusion period from five to two years would yield a welfare gain in the order of $90 annually per household. It would allow the talented entrepreneurs who had defaulted in the past to regain access to credit sooner and therefore they could operate bigger firms. In contrast to increasing the exemption level, this form of insurance is less harmful for credit conditions since it does not reduce the amount the banks recover in the event of default. However, since the number of talented defaulters is small compared to all defaulters, these effects are quantitatively small.

[2]Other papers in this growing literature are Athreya (2006), Athreya and Simpson (2006), Li and Sarte (2006), Mateos-Planas and Seccia (2006).

[3]Zha (2001) is a theoretical investigation of similar issues. However his model abstracts from occupational choice, that we show to be the crucial channel through which bankruptcy law affects entrepreneurship. Moreover he does not calibrate his model to the US economy. Therefore his simulations give only qualitative suggestions.

Our results are consistent with the empirical finding of Berkowitz and White (2004) who show that in states with higher exemption levels, credit conditions are worse. Further our results are partially consistent with the findings of Fan and White (2003). They show that entrepreneurship increases when the exemption level is increased from a very low level. However, we differ for high exemption levels: we find that high exemption levels lead to a decline in entrepreneurship, while they find the opposite.

The paper is organized as follows, Section 2 provides an overview of US bankruptcy law and presents data on entrepreneurial failure. In Section 3 we present our model and discuss the equilibrium condition. In Section 4 we discuss our calibration strategy and present the baseline results. Section 5 explains the main mechanism of the model. In Section 6, we conduct the policy experiments and Section 7 concludes.

2 Entrepreneurial failure and personal bankruptcy in the US

Personal bankruptcy procedures in the US consist of two different procedures: Chapter 7 and Chapter 13. Under Chapter 7, all unsecured debt is discharged immediately. Future earnings cannot be garnished. This is why Chapter 7 is known as providing a "fresh start". At the same time, a person filing for bankruptcy has to surrender all wealth in excess of an exemption level. The exemption level varies across US states, ranging from $11,000 in Maryland to unlimited for housing wealth in some states, for example Florida. Therefore, we calculate the population-weighted average across states. The resulting average exemption level is $77,591 in 1993.[4]

Under Chapter 13 agents can keep their wealth, debt is not discharged immediately and future earnings are garnished. Entrepreneurs are better off under Chapter 7 for three reasons: they have no non-exempt wealth, their debt is discharged immediately and they can start a new business straight away, since their income will not be subject to garnishment (see White, 2007). 70% of total bankruptcy cases involving entrepreneurs are under Chapter 7. Therefore we will focus on Chapter 7 only.

Persons can file for bankruptcy only once every 6 years. The bankruptcy filing remains public information for ten years. But there is no formal rule about bankruptcy filers being excluded from credit. However, US Congress could pass a law regulating the duration of the exclusion period. Moreover, in practice, we observe that bankruptcy filers do not get credit for a periods ranging from 3 to 8 years (Athreya, 2002) after the filing.

The US. Small Business Administration reports an exit rate of on average 9.7% per annum for small firms in the period from 1990-2005.[5] Out of these failing firms 9.3% file for bankruptcy, according to the official data from the Administrative Office

[4]The wealth exemption level does not change much over time. We choose 1993 because it is in the middle of the sample years for our data on entrepreneurship wealth distribution and bankruptcies.

[5]The U.S. Small Business Adminstration splits small firms into employer and non-employer firms. Employer firms have at least one employee working in the firm. There are roughly five million employer and 15 million non-employer firms in the U.S. Since the focus of our paper is on entrepreneurs who own and manage the firm we use only the data for employer firms since non-employer firms have in many cases the owner not working in the firm. To ensure consistency across our three databases, when we use data from the Survey of Consumer Finance (SCF) and the Panel Study of Income Dynamics (PSID) we define entrepreneurs as business owners who manage a firm with at least one employee.

of the Courts.[6] Unfortunately, the official data on personal bankruptcy caused by a business failure seem to be severely downward biased. Lawless and Warren (2005) estimate that the true number could be three to four times as big. Their own study is based on an in-depth analysis of bankruptcy filers in five different judicial districts. Their explanation of this discrepancy is the emergence of automated classification of personal bankruptcy cases. Almost all software used in this area has "consumer case" as the default option. Thus reporting a personal bankruptcy case as a "business related" case requires some - even though small - effort while being completely inconsequential for the court proceedings. In addition to their own study they report data from Dun & Bradstreet according to which business bankruptcies are at least twice the official number.[7]

In the calibration of our model we set the baseline exemption level equal to $77,591. The baseline exclusion period is set to six years. We calibrate the model such that the ratio of bankruptcies over exits is equal to 20%.

3 The model

Our economy is populated by a unit mass of infinitely lived heterogeneous agents. Agents face idiosyncratic uncertainty, but there is no aggregate uncertainty. At the beginning of every period, agents decide whether to become workers or entrepreneurs. An entrepreneur must decide how much to invest and, if he is allowed to, how much to borrow. An entrepreneur who has defaulted in the past five years is not allowed to borrow. Since we focus on the implications of personal bankruptcy for entrepreneurs, workers are not allowed to borrow. Agents have only a noisy signal of their productivities and are subject to uninsurable risk. After the shocks are realized, production takes place. At the end of the period borrowers decide whether to repay or whether to default and how much to consume and how much to save. If they default, they will be borrowing constrained in the next period. They cannot borrow but they can save. Anticipating this behavior banks vary the interest rate charged for each loan taking into account the individual borrower's default probability. The remainder of this section presents the details of the model.

3.1 Bankruptcy law and credit status

Agents who have borrowed can declare bankruptcy. In the event of a default the agent's debt is discharged, and at the same time any assets in excess of an exemption level X are liquidated. There are transaction costs in the liquidation process so that banks can only obtain a fraction f of each unit of capital they liquidate.

[6] While one can obtain exit rates from the PSID data (Quadrini, 2000), it is impossible to obtain reliable bankruptcy data from the PSID. There is only one wave in which respondents were asked about past bankruptcies.

[7] Dun & Bradstreet (D&B) is a credit-reporting and business information firm. D&B compiles its own independent business failure database. Until the emergence of automated software for law firms and courts in the mid 1980s, the official business bankruptcy data and the index compiled by D&B have a positive and significant correlation of 0.73. From 1986-1998 this correlation coefficient becomes negative and insignificant. Extrapolating from the historic relationship between the D&B index and personal bankruptcy cases caused by business failures leads to the conclusion that the official data underreport business bankruptcy cases at least by a factor of two.

An agent who has declared bankruptcy in the past can save but he cannot borrow for a certain period of time. We call this agent *borrowing constrained* and we denote his credit status as BC. We assume that every *borrowing constrained* agent, whether worker or entrepreneur, faces a credit status shock at the end of the period. With probability $(1-\varrho)$ the agent remains *borrowing constrained.* With probability ϱ the agent can borrow again. He becomes an *unconstrained* agent with credit status UN.[8] This probability ϱ captures the duration of the credit market exclusion period and is calibrated such that the average exclusion period is six years, the value observed in the data.

3.2 Households

Our economy is populated by a unit mass of infinitely lived heterogeneous agents. Each agent differs according to the level of assets a, the entrepreneurial productivity θ, the working productivity φ, and the credit status $S \in \{UN, BC\}$.

3.2.1 Preferences

For simplicity we abstract from labor-leisure choice. All agents supply their unit of labor inelastically either as workers or as entrepreneurs. There is no disutility of labor. Agents discount the future at the rate β. Therefore they maximize the following utility function

$$U = \mathbb{E}\left\{\sum_{t=0}^{\infty} \beta^t u(c_t)\right\}$$

3.2.2 Productivities

Each agent is endowed with a couple of stochastic productivity levels: one as an entrepreneur θ, and one as a worker φ. We make the simplifying assumption that working and entrepreneurial ability processes are uncorrelated. At the beginning of each period the agent knows only his past productivities φ_{-1} and θ_{-1}, but his productivity as a worker and as entrepreneur during the current period, denoted by φ and θ, are revealed only after he has taken the occupational choice and investment decisions.

The workers' ability process Following the literature[9] we assume that labor productivity follows the following AR(1) process[10]

$$\log \varphi_t = (1-\rho)\,\mu + \rho \log \varphi_{t-1} + \varepsilon_t$$

where ε_t is *iid* and $\varepsilon \sim N(0, \sigma_\varepsilon)$. If the agent becomes a worker his labor income during current period is given by $w\varphi$.

[8] The length of the exclusion period is transformed into a probability in order to avoid an additional state variable that keeps track of the numbers of years left before the solvency status is returned to UN. This procedure is standard in the literature, see Athreya (2002) and Chatterjee et al. (2007).

[9] See for example Storesletten, Telmer, and Yaron (2004).

[10] In the simulation we discretize this process by methods based on Tauchen (1986).

The entrepreneurs' ability process In contrast to the case of working ability, there are no reliable estimates of the functional form for the case of entrepreneurial ability. Therefore, following Cagetti and De Nardi (2006), we will assume a parsimonious specification where entrepreneurial productivity follows a 2-state Markov process with $\theta^L = 0$ and $\theta^H > 0$ and transition matrix

$$P_\theta = \begin{bmatrix} p^{LL} & 1 - p^{LL} \\ 1 - p^{HH} & p^{HH} \end{bmatrix}$$

We calibrate the 3 parameters (θ^H, p^{HH} and p^{LL}) to match some observed features of entrepreneurial activity in the US economy.

3.3 Technology

Entrepreneurial sector Every agent in the economy has access to a productive technology that, depending on her entrepreneurial productivity θ, produces output according to the production function

$$Y_i = \theta_i \chi_i k_i^\nu$$

where θ_i is agent $i's$ persistent entrepreneurial productivity described above. We assume that production is subject to an *iid* idiosyncratic shock with $\chi_i \in \{0, 1\}$, where $\chi_i = 0$ happens with probability p^χ. This *iid* shock represents the possibility that an inherently talented entrepreneur (i.e. an agent with high and persistent θ_i) might choose the wrong project or could be hit by an adverse demand shock. Quadrini (2000) shows that the entry rate of workers with some entrepreneurial experience in the past, is much higher than the entry rate of those workers without any experience. Therefore it seems that entrepreneurs come mostly from a small subset of total population. If their firms fail, they are very likely to start a new firm within a few years. The *iid* shock χ_i helps us to capture this difference in the entry rates.

Corporate sector Many firms are both incorporated and big enough not to be subject to personal bankruptcy law. Therefore we follow Quadrini (2000) and Cagetti and De Nardi (2006) and assume a perfectly competitive corporate sector which is modeled as a Cobb-Douglas production function

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

where K_c and L_c are capital and labor employed in this sector. Given perfect competition and constant returns to scale the corporate sector does not distribute any dividend. Capital depreciates at rate δ in both sectors.

3.4 Credit market

We assume that there is perfect competition (free entry) in the credit market. Therefore banks must make zero profit on any contract.[11] The opportunity cost of the lending

[11] In many papers on consumer bankruptcy banks cross-subsidize loans. This implies however that a bank could make positive profits by denying credit to the most risky borrowers, as in Athreya (2002) and Li and Sarte (2006). For an approach similar to ours, see Chatterjee et al. (2007) By the law of large numbers average ex post profits will be zero too.

to entrepreneurs is the rate of return on capital in the corporate sector. This is also equal to the deposit rate.[12] Banks offer one period non-contingent debt contracts. The only agent who interacts with the banks is the *unconstrained* entrepreneur. The banks know everything about the agent: his assets and his productivities. For any given value of $(a, \theta_{-1}, \varphi_{-1})$ and for any amount lent b, by anticipating the behavior of the entrepreneur, the banks are able to calculate the probability of default and how much they will get in the case of default. Perfect competition implies that they set the interest rate, $r(a, \theta_{-1}, \varphi_{-1}, b, X)$, such that they break even. This interest rate depends on the exemption level X because it affects the incentives to default and the amount the bank recovers in this event. Therefore the banks offer a menu of one period debt contracts which consists of an amount lent b and a corresponding interest rate $r(a, \theta_{-1}, \varphi_{-1}, b, X)$ to each agent $(a, \theta_{-1}, \varphi_{-1})$.

3.5 Timing

At the beginning of the period, agents who have defaulted in the past and who have not received the positive credit status shock are *borrowing constrained*. The other agents are *unconstrained*. All agents face an occupational choice: they choose whether they become entrepreneurs or workers. However they make this decision without knowing their productivities (θ, φ). Since these productivities follow a Markov process they use past productivities $(\theta_{-1}, \varphi_{-1})$ to forecast their current productivities (φ, θ).

Workers deposit all their wealth at the banks, receiving a rate of return r^d. After productivities are realized and production has taken place, they choose consumption and savings. At the end of the period the *borrowing constrained* worker receives the credit status shock. With probability ϱ he remains *borrowing constrained* next period (i.e. $S' = BC$). With probability $(1 - \varrho)$ he becomes *unconstrained* next period (i.e. $S' = UN$).

The *borrowing constrained* entrepreneur can choose how much to invest in his firm before the current θ is realized. He deposits the remaining wealth at the bank. Thus the entrepreneur faces a portfolio choice between investing in his own firm (risky asset) or in a safe bank deposit. But he can not borrow. After (θ, φ) and χ are realized and production has taken place, he chooses consumption and savings. At the end of the period he receives the credit status shock.

The *unconstrained entrepreneur* can borrow from perfectly competitive banks. Before knowing (θ, φ) and χ, he chooses his capital stock by deciding how much to borrow (or invest at rate r^d). If the entrepreneur borrows, by picking from the menu $\{b, r(a, \theta_{-1}, \varphi_{-1}.b)\}$ offered by the the banks, he invests everything in his own firm. After (θ, φ) and χ are realized and production has taken place, the entrepreneur can decide whether to repay his debt and be *unconstrained* next period (i.e. $S' = UN$) or whether to declare bankruptcy and be *borrowing constrained* next period(i.e. $S' = BC$). After that he chooses consumption and savings.

Summarizing, the timing is as follows:

1. The agent enters the period with a state $(a, \theta_{-1}, \varphi_{-1}, S)$;
2. The agent chooses whether to become a worker or an entrepreneur;

[12] In our model the banks are isomorphic to a bond market in which each agent has the possibility to issue debt.

3. *Unconstrained* entrepreneurs choose from the menu $\{b, r(a, \theta_{-1}, \varphi_{-1}, b, X)\}$ offered by perfectly competitive banks;

4. Real and financial investment decisions are taken;

5. Productivities (θ, φ) and the *iid* shock $\chi \in \{0, 1\}$ are realized and production takes place;

6. Bankruptcy decisions are taken by the *unconstrained* entrepreneurs;

7. Consumption and saving decisions are taken;

8. The credit status shocks for all *borrowing constrained* agents are realized;

9. End of period: the new state is $(a', \theta, \varphi, S')$.

Since the credit state S consists only of the two states BC and UN, we define the individual state variable as $(a, \theta_{-1}, \varphi_{-1})$, and we solve for two value functions $V^{UN}(a, \theta_{-1}, \varphi_{-1})$ and $V^{BC}(a, \theta_{-1}, \varphi_{-1})$ one for each credit status.

3.6 The problem of the *borrowing constrained* agent

The *borrowing constrained* agent cannot borrow, but he can save at an interest rate r^d. At the beginning of the period he can choose whether to become an entrepreneur, which gives utility $N^{BC}(a, \theta_{-1}, \varphi_{-1})$ or a worker which yields utility $W^{BC}(a, \theta_{-1}, \varphi_{-1})$. Therefore the value of being a *borrowing constrained* agent with state $(a, \theta_{-1}, \varphi_{-1})$ is

$$V^{BC}(a, \theta_{-1}, \varphi_{-1}) = \max\left\{N^{BC}(a, \theta_{-1}, \varphi_{-1}), W^{BC}(a, \theta_{-1}, \varphi_{-1})\right\}$$

where the "max" operator reflects the occupational choice.

Worker At the beginning of the period the *borrowing constrained* worker deposits all his wealth at the bank. Then (θ, φ) are realized, production takes place and he receives labor income $w\varphi$. At the end of the period, he chooses consumption and saving, taking into account that he will receive a credit status shock. With probability ϱ he will be still *borrowing constrained* next period with an utility $V^{BC}(a', \theta, \varphi)$, while with a probability $(1-\varrho)$ he will become *unconstrained* with an utility $V^{UN}(a', \theta, \varphi)$. His saving problem, after uncertainty is resolved,[13] is the following

$$\tilde{W}^{BC}(a, \theta, \varphi) = \max_{c, a'}\left\{u(c) + \beta\left[\varrho V^{BC}\left(a', \theta, \varphi\right) + (1-\varrho) V^{UN}\left(a', \theta, \varphi\right)\right]\right\}$$
$$s.t.\ c + a' = w\varphi + \left(1 + r^d\right) a$$

Therefore, before uncertainty is resolved, the expected utility of a *borrowing constrained* worker with wealth a and productivities $(\theta_{-1}, \varphi_{-1})$ is

$$W^{BC}(a, \theta_{-1}, \varphi_{-1}) = \mathbb{E}\left\{\tilde{W}^{BC}(a, \theta, \varphi)\right\}$$

[13] We denote with a "˜" all the value functions, *after* uncertainty (about θ, φ and χ) is resolved. The value functions without "˜" are *before* uncertainty is resolved.

Entrepreneur At the beginning of the period the *borrowing constrained* entrepreneur chooses the amount of capital, $k \in [0, a]$, to invest in his firm and the amount $a - k$ to deposit at the bank. After (θ, φ) and the shock χ are realized he will decide how to allocate the resources $\chi\theta k^\nu + (1 - \delta) k + \left(1 + r^d\right)(a - k)$ among consumption and savings. His saving problem is

$$\tilde{N}^{BC}(a, \theta, \varphi, \chi, k) = \max_{a', c} \left\{ u(c) + \beta \left[\varrho V^{BC}\left(a', \theta, \varphi\right) + (1 - \varrho) V^{UN}\left(a', \theta, \varphi\right) \right] \right\}$$
$$s.t.\ c + a' = \chi\theta k^\nu + (1 - \delta) k + \left(1 + r^d\right)(a - k)$$

Therefore the optimal value of the *borrowing constrained* entrepreneur is

$$N^{BC}(a, \theta_{-1}, \varphi_{-1}) = \max_{0 \leq k \leq a} \mathbb{E}\left\{ \tilde{N}^{BC}(a, \theta, \varphi, \chi, k) \right\}$$

where the expectation operator $\mathbb{E}\{\cdot\}$ now considers also the temporary shock χ.

3.7 The problem of the *unconstrained* agent

At the beginning of the period the *unconstrained* agent faces the following occupational choice

$$V^{UN}(a, \theta_{-1}, \varphi_{-1}) = \max \left\{ W^{UN}(a, \theta_{-1}, \varphi_{-1}), N^{UN}(a, \theta_{-1}, \varphi_{-1}) \right\}$$

where $W^{UN}(a, \theta_{-1}, \varphi_{-1})$ is the utility of becoming a worker and $N^{UN}(a, \theta_{-1}, \varphi_{-1})$ of becoming an entrepreneur.

Worker The problem of the *unconstrained* worker is identical to the *borrowing constrained* one except that the agent will be *unconstrained* in the future for sure. His saving problem, after uncertainty is resolved, is the following

$$\tilde{W}^{UN}(a, \theta, \varphi) = \max_{c, a'} \left\{ u(c) + \beta V^{UN}\left(a', \theta, \varphi\right) \right\}$$
$$s.t.\ c + a' = w\varphi + \left(1 + r^d\right) a$$

Therefore his expected utility is

$$W^{UN}(a, \theta_{-1}, \varphi_{-1}) = \mathbb{E}\left\{ \tilde{W}^{UN}(a, \theta, \varphi) \right\}$$

Entrepreneur The *unconstrained entrepreneur* decides how much to invest in his firm $k = a + b$ by choosing how much to borrow $(b > 0)$ or save at rate r^d $(b < 0)$. If he borrows he can choose from the menu $\{b, r(a, \theta_{-1}, \varphi_{-1}, b, X)\}$ offered by the banks. After (θ, φ) and the shock χ are realized he can choose whether to declare bankruptcy (default) or whether to repay and how much to consume and save. He solves the problem backwards.

If he repays his debt, he has to choose how to allocate his resources, $\chi\theta k^\nu + (1 - \delta) k - b[1 + r(a, \theta_{-1}, \varphi_{-1}, b, X)]$, between consumption and savings. Given that the decision of repaying is done when current productivities (θ, φ) and the shock χ are known, his utility from repaying is given by

$$\begin{aligned} \tilde{N}^{pay}(a, b, \theta, \varphi, \chi) &= \max_{c,a'} \left\{ u(c) + \beta V^{UN}(a', \theta, \varphi) \right\} \\ s.t.\ a' + c &= \chi \theta k^{\nu} + (1 - \delta) k - b \left[1 + r(a, \theta_{-1}, \varphi_{-1}, b, X) \right] \\ k &= a + b \end{aligned}$$

If he defaults, his debt is discharged. But he loses all his assets in excess of the exemption level X. Thus, the resources to allocate between consumption and savings are $\min \{\chi \theta k^{\nu} + (1 - \delta) k, X\}$. Moreover if he defaults he will be *borrowing constrained* next period. Therefore by declaring bankruptcy he gets

$$\begin{aligned} \tilde{N}^{bankr}(a, b, \theta, \varphi, \chi) &= \max_{c,a'} \left\{ u(c) + \beta V^{BC}(a', \theta, \varphi) \right\} \\ s.t.\ a' + c &= \min \{\chi \theta k^{\nu} + (1 - \delta) k, X\} \\ k &= a + b \end{aligned}$$

He will declare bankruptcy if $N^{bankr}(a, b, \theta, \varphi\, \chi) > N^{pay}(a, b, \theta, \varphi, \chi)$ and vice versa. Thus, at the beginning of the period the agent choose the optimal amount of b from the menu $\{b, r(a, \theta_{-1}, \varphi_{-1}, b, X)\}$ anticipating his future behavior. Therefore his utility is given by

$$N^{UN}(a, \theta_{-1}, \varphi_{-1}) = \max_{\{b, r(a, \theta_{-1}, \varphi_{-1}, b, X)\}} \mathbb{E} \left[\max \left\{ \tilde{N}^{pay}(a, b, \theta, \varphi, \chi), \tilde{N}^{bankr}(a, b, \theta, \varphi, \chi) \right\} \right]$$

where the "max" operator inside the square brackets reflects the bankruptcy decision, and the "max" operator outside the square brackets reflects the borrowing decision.

3.8 The zero profit condition of the banks

We assume that the banks observe the state variables $(a, \theta_{-1}, \varphi_{-1})$ at the moment of offering the contract. For any given state $(a, \theta_{-1}, \varphi_{-1})$ and for any given loan b, the bank knows in which states of the world the agent will declare bankruptcy, by solving the problem of the agent. Therefore it is able to calculate exactly the probability that a certain agent with characteristics $(a, \theta_{-1}, \varphi_{-1})$ will default for any given loan b. Denote this probability $\pi^{bankr}(a, \theta_{-1}, \varphi_{-1}, b, X)$. The default probability depends on the exemption level X because it affects the incentive to default directly.

If the agent repays the bank receives $[1 + r(a, \theta_{-1}, \varphi_{-1}, b, X)]\, b$. If the agent defaults the bank sells the firm's un-depreciated capital and it does not obtain the full value, but only a fraction f. This captures two features. First, since business wealth is not exempt under Chapter 7, the agent will try to move as much wealth as possible out of his firm into exempt wealth, e.g. housing. Second, as for example Ramey and Shapiro (2001), the sales value of business assets is below their value with the firm. Therefore the bank receives: nothing if $\chi \theta k^{\nu} + f(1 - \delta)(a - b) < X$ while it receives $\chi \theta k^{\nu} + f(1 - \delta)(a + b) - X$ otherwise.

The zero profit condition of the bank is given by

$$\begin{pmatrix} \left[1 - \pi^{bankr}(a, \theta_{-1}, \varphi_{-1}, b, X)\right] \left[1 + r(a, \theta_{-1}, \varphi_{-1}, b, X)\right] b + \\ + \pi^{bankr}(a, \theta_{-1}, \varphi_{-1}, b, X) \max \{\chi \theta k^{\nu} + f(1 - \delta)(a + b) - X, 0\} \end{pmatrix} = (1 + r^d) b$$

3.9 Equilibrium

Let $\eta = (a, \theta_{-1}, \varphi_{-1}, S)$ be a state vector for an individual, where a denotes assets, θ_{-1} entrepreneurial productivity, φ_{-1} working productivity and S the credit status. From the optimal policy functions (savings, capital demand, default decisions), from the exogenous Markov process for productivity and from the credit status shocks, we can derive a transition function, that, for any distribution $\mu(\eta)$ over the state provides the next period distribution $\mu'(\eta)$. A stationary equilibrium is given by

- a deposit rate of return r^d and a wage rate w
- an interest rate function $r(\eta)$
- a set of policy functions $g(\eta)$ (consumption and saving, capital demand, bankruptcy decisions and the occupational choice)
- a constant distribution over the state η, $\mu^*(\eta)$

such as, given r^d and w and a bankruptcy regime X and ϱ:

- $g(\eta)$ solves the maximization problem of the agents;
- the corporate sector representative firm is optimizing;
- capital, labor and goods market clear:
  - capital demands come both from entrepreneurs and from the corporate sector, while supply comes from saving decisions of the agents;
  - labor demand comes from corporate sector, while labor supply come from the occupational choice of the agents;
- the function $r(\eta)$ reflects the zero profit condition of the banks
- The distribution $\mu^*(\eta)$ is the invariant distribution associated with the transition function generated by the optimal policy function $g(\eta)$ and the exogenous shocks.

The model has no analytical solution and must be solved numerically. The algorithm used to solve the model and other details are presented in the appendix.

4 Calibration and baseline results

4.1 Parametrization

4.1.1 Fixed parameters

Following standard practice in the literature we try to minimize the number of parameters of the model used to match the data. We therefore select some parameters which have already been estimated in the literature. We choose $\rho = 0.95$ for the auto-regressive coefficient of the earnings process.[14] The variance of the earnings process is chosen to match the Gini index of labor income as in PSID data which is 0.38.[15] The process is approximated using a 4-states Markov chain, using the Tauchen (1986) method as suggested by Adda and Cooper (2003).[16] Total factor productivity is normalized to 1, while the share of capital in the Cobb-Douglas technology for the corporate sector is set to $\xi = 0.36$. Depreciation rate is set $\delta = 0.08$. Felicity is assumed to be CRRA with coefficient of relative risk aversion $\sigma = 2$. These parameters are summarized in table 1.

Table 1: The fixed parameters

Parameter	**Symbol**	**Baseline**
TFP	A	1 (normalization)
Share of capital	ξ	0.36
Depreciation rate	δ	0.08
CRRA	σ	2
Working productivities	$\varphi_1 < \varphi_2 < \varphi_3 < \varphi_4$	$\begin{bmatrix} \varphi_1 = 0.316, \varphi_2 = 0.745 \\ \varphi_3 = 1.342, \varphi_4 = 3.163 \end{bmatrix}$
Transition matrix	P_φ	$\begin{bmatrix} 0.8393 & 0.1579 & 0.0028 & 0.0000 \\ 0.1579 & 0.6428 & 0.1965 & 0.0028 \\ 0.0028 & 0.1965 & 0.6428 & 0.1579 \\ 0.0000 & 0.0028 & 0.1579 & 0.8393 \end{bmatrix}$

4.1.2 Bankruptcy policy parameters

The two policy parameters are the exemption level X and the probability ϱ of remaining borrowing constrained. The law does not state any formal period of exclusion from credit after bankruptcy filing. For our baseline specification, we set $\varrho = 0.2$ which corresponds to an average exclusion period from credit of 5 years.[17] The exemption level differs according to the different states. Using US state data for 1993 we calculate population-weighted average across states of the total exemption[18] ("homestead" plus "personal property" exemption). The resulting average exemption level is \$77,591, taking an average household labor income of \$45,000 corresponds to a value of **1.72** for the exemption/wage ratio. Table 2 summarizes the bankruptcy parameters.

[14] In a life cycle setting, Storesletten et al. (2004) and Storesletten, Telmer, and Yaron (2001) find ρ in the range between 0.95 and 0.98. We choose $\rho = 0.95$ to take into account that the agents in our model are infinitely lived. Since the intergenerational auto-regressive coefficient is lower. Solon (1992) estimates it around 0.4.

[15] The exact value of the variance is $\sigma_\varepsilon^2 = .08125$. This is higher than the estimate of Storesletten et al. (2004) of about 0.02. We abstract from many important factors that are empirically relevant for the earnings distribution, e.g. human capital, life-cycle savings. Therefore, in order to generate the observed inequality, we need a higher variance of the earnings process.

[16] Floden (2007) shows that for highly correlated processes the method of Adda and Cooper (2003) achieves a higher accuracy than the original methods of Tauchen (1986) and Tauchen and Hussey (1991).

[17] This choice is in line with the consumer bankruptcy literature which sets the average length of exclusion in this range. Athreya (2002) sets this at 4 years, Li and Sarte (2006) to 5 years, Chatterjee

Table 2: the bankruptcy parameters

Parameter	Symbol	Value
Exemption/wage	X/w	1.72
Exclusion period (expressed as probability)	ϱ	0.2

4.1.3 Calibrated parameters

We are left with the following 7 parameters to be calibrated: high entrepreneurial productivity (θ^H), entrepreneurial productivity transition matrix (p^{HH}, p^{LL}), concavity of entrepreneurial production function (ν), capital specificity (f), discount factor (β) and the probability of the transitory shock (p^χ).

We choose these 7 parameters such that the model matches the following 7 moments of the US economy. First we want the model to match the *capital-output ratio* (K/Y) in US economy. In the literature we find values ranging from 2.5 to 3. We target it to be 2.8. We target the *fraction of exits through bankruptcy* (bankruptcy/exit). Given the discussion in Section 2 we set this equal to 20%. The *fraction of entrepreneurs in the total population* is 7.6% in the Survey of Consumers Finances.[19] Based on data from the US Small Business Administration *exit rate* for entrepreneurs is equal to 9.3%. Therefore we set the baseline target at 9.3%. However the exit rate based on the PSID is higher (around 13.6%).[20]

Quadrini (2000) points out that the entry rate for workers who had some entrepreneurial experience in the past is much higher than the entry rate for those without any experience. It seems that entrepreneurs come mostly from a small subset of total population. If their firms fail, they are very likely to start a new firm within a few years. In the PSID the ratio of *entry rate of experienced entrepreneurs over the average entry rate* is 13. This is an important target because the bankruptcy law affects the possibility and the speed of re-entry for failed entrepreneurs.

Since the benefits of bankruptcy depend crucially on the wealth of an agent we match some features of the wealth distribution. The US wealth distribution is extremely skewed with the top 40% of richest households holding around 93% of total assets.[21] The Gini coefficient is very high, at around 0.8. There is a large literature that tries to match the wealth distribution in the US. The most difficult part is to match the extremely rich agents at the top end of the distribution. But, as we show below, for our model it is particularly important to match the lower end of the distribution. Therefore we target the *share of wealth held by the richest 40%*. As a last target we choose to match the *ratio of the median wealth of entrepreneurs to the median wealth in the whole population*. This target captures features of both the wealth distribution and entrepreneurial productivity and technology. We set the target to 5.6 as found in the

et al. (2007) to 10 years.

[18] We took the data from Berkowitz and White (2004) and top-coded the unlimited homestead exemption to the maximum state exemption.

[19] See Appendix B for data sources, definitions and further details.

[20] One possible explanation for this difference could be that the PSID undersamples wealthy households. Therefore successful entrepreneurs are likely to be undersampled.

[21] See Appendix B for details.

SCF.[22] The targets are summarized in the second column of table 4.

4.2 The baseline calibration

We first present the baseline version of the model. Table 3 reports the value of the calibrated parameters in the baseline specification.

TABLE 3: THE CALIBRATED PARAMETERS

Parameter	**Symbol**	**Benchmark Value**
High entrepreneurial productivity	θ^H	0.52
Entrepreneurial productivity transition	p^{HH}, p^{LL}	0.95 , 0.9937
Concavity of entrepreneurial technology	ν	0.875
Capital specificity	f	0.4
Discount factor	β	0.865
Probability of transitory shock	p^χ	0.185

Table 4 reports the value of the targets and the actual results achieved in the baseline specification.

TABLE 4: THE BASELINE CALIBRATION TARGETS

Moment	**Target**	**Model**
Fraction of Entrepreneurs (in %)	7.6	7.6
Ratio of medians (in %)	5.6	4.34
Share of net-worth of top 40%	93.0	89.4
K/Y	2.8	2.687
Exit Rate (in %)	9.3	9.4
Bankruptcy/Exit (in %)	20.0	22.0
Entry rate of experienced/Average entry rate	13.0	8.3

The equilibrium rate of return on capital in the corporate sector (r^d) is 7.81%. Since the equilibrium wage is 1.0207, each unit in our model correspond approximately to $44,000 in 1993. Less than one percent (0.79%) of the total population is borrowing constrained. Even though our model does not replicate exactly the ratio of medians and the share of the wealth held by the richest 40%, it captures the main features that entrepreneurs are several times richer than workers and that most of the wealth is held by the richest. Table 5 shows that our model does not replicate the wealth concentration at the top end of the wealth distribution. In particular the richest one percent hold 16% of total wealth in our model while they hold 35% in the data.[23] However for the purpose of our policy experiments it is important that the model

[22] This ratio ranges from 4.8 to 5.6 in the SCF according to definitions of entrepreneurs and samples adopted.

[23] This is the reason that the Gini coefficient of wealth is 0.64 in the model, while it is 0.8 in the data. Cagetti and De Nardi (2006) and Castaneda, Diaz-Gimenez, and Rios-Rull (2003) show that life-cycle savings and the bequest motive are essential to match the wealth distribution. Introducing these features in the model would be computationally too costly.

replicates the middle and lower part of the wealth distribution since bankruptcy law affects almost exclusively these agents.

Table 5: wealth distribution: data and model

	percentage wealth in top				
	1%	5%	20%	40%	60%
US data (SCF 1995)	35	56	81	93	99
Benchmark model	16	38	65	84	95

Even though our model does not replicate the difference in the entry rate between experienced and inexperienced workers exactly it captures the fact that the former are many times more likely to enter entrepreneurship than the latter.

Quadrini (2000) reports that around 40% of total capital is invested in the entrepreneurial sector. In our baseline specification this fraction is slightly higher, around 45%. However the US. Small Business Administration estimates that the share of the entrepreneurial sector in terms of employment is 50%.

5 Investigating the model's mechanisms

5.1 Occupational choice

The key ingredient of the model is occupational choice. Figure 1 represents the occupational choice of an *unconstrained* agent with high entrepreneurial productivity and low working productivity.

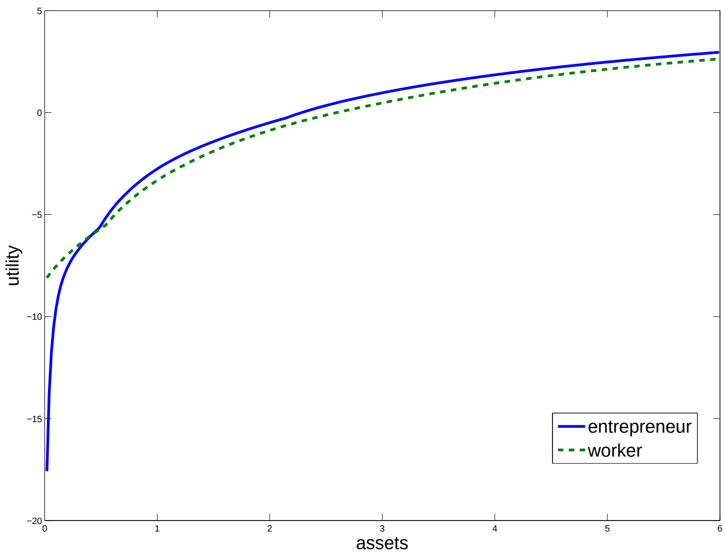

Figure 1: Occupational choice ($S = UN, \theta_{-1} = \theta^H, \varphi_{-1} = 0.316$)

The dotted line shows the value function of becoming a worker, whereas the solid line shows the value function of becoming an entrepreneur.[24]

The first result is that, otherwise identical agents choose differently according to their wealth: poor agents become workers while rich agents become entrepreneurs. This result is standard in the occupational choice under credit market imperfections literature (see e.g. Banerjee and Newman, 1993). The main reasons are that poor agents have smaller firms and face higher interest rates. They have smaller firms because, being poor, they need to borrow more but they face higher rates on the loans. The cost of financing is higher for the poor for two reasons. First, they have a higher incentive to default. Defaulting rich agents have to give up all their wealth above the exemption level. Second, in the event of default the bank gets less when the agent is poor. Thus, to break even, the bank has to charge a higher interest rate. That is, in this model, wealth acts as collateral.

5.2 The behavior of the unconstrained agents

The second important ingredient is the decision of the *unconstrained* entrepreneurs. The solution of the entrepreneurs' problem is represented in Figure 2.

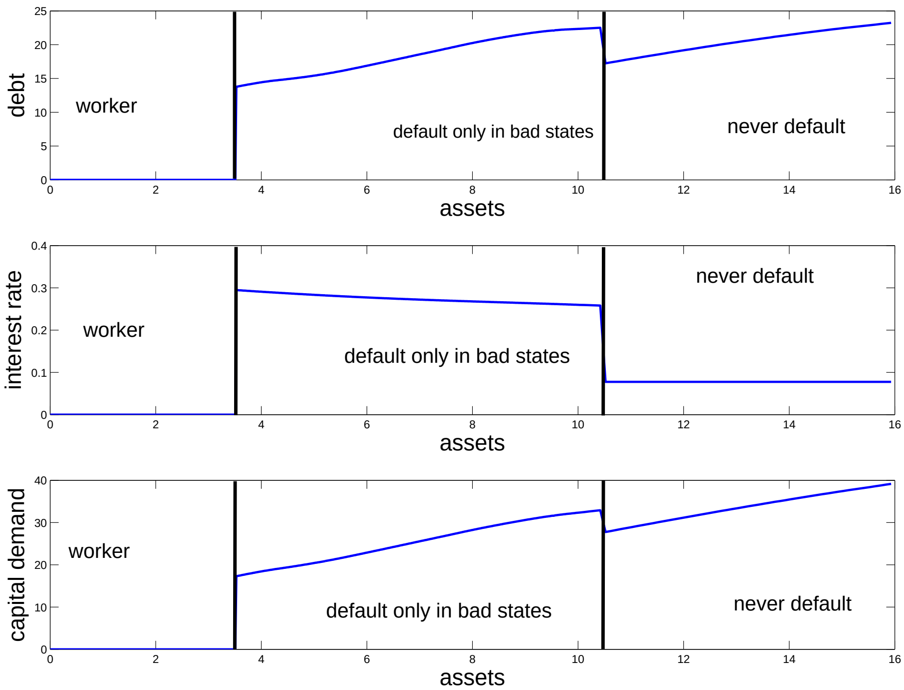

FIGURE 2: INTEREST RATE AND FIRM SIZE ($\theta_{-1} = \theta^H$, $\varphi_{-1} = 1.341$)

[24]The value functions have kinks since the actual value function for an unconstrained agent is given by the upper envelop of the two functions in Figure 1. Therefore discounted utility tomorrow is kinked as well. The kinks do no coincide exactly with the intersection of the two functions. However the kinks must be close to the intersection of the two curves exactly because the value function tomorrow, $V^{UN}(a, \theta_{-1}, \varphi_{-1})$ is identical for the entrepreneur and the worker.

The upper panel shows credit demand (debt) of the entrepreneur, the middle panel represents the corresponding interest rate charged and the lower panel capital demand (firm size). As shown above the poorer agents (e.g. agents with assets $a = 2$) become workers while all the others become entrepreneurs ($a > 3.5$). The very rich entrepreneurs (e.g. $a = 14$) will never find it profitable to default. Their wealth is so high that defaulting is too costly for them. Therefore they can borrow at rate r^d. The "middle class" entrepreneurs (e.g. $a = 6$) will instead default if their productivity θ drops to θ^L or a bad shock ($\chi = 0$) happens, since the cost of bankruptcy is lower for them. Then the bank, in order to break even, must charge a higher interest rate. The interest rate depends (negatively) on the assets of the entrepreneur, because in the event of default the bank will be able to seize the difference between the assets of the entrepreneur and the exemption level. Capital demand for the "middle-class" entrepreneurs is increasing because of the cost of borrowing is declining. The discontinuity in all three functions between "middle-class" and rich entrepreneurs (around $a = 10.5$) is due to the change in the default decision. Those who default are insured against the bad outcome whereas those who do not default are not. This explains why relatively poorer agents (e.g. $a = 10$) have slightly bigger firms than relatively richer agents (e.g. $a = 11$).

5.3 A first look at the effects of bankruptcy

Bankruptcy affects the problem of the unconstrained agents, because it changes credit conditions and the extent of insurance available. We examine these effects with the following experiment. We compare the behavior of the unconstrained agents and the banks in two different situations: one in which bankruptcy is allowed and one in which bankruptcy is absent. Figure 3 shows the capital demand function and the interest rate function in these situations.

The effects of allowing bankruptcy depend on the wealth of the agent. First, the behavior of the very rich (e.g. $a = 12$) is not affected. They are entrepreneurs and they repay their debt even in the bad states. As explained above, even if bankruptcy is available, it is too costly for them. Second, allowing bankruptcy affects the behavior of the less rich agents (e.g. $a = 8$). They are entrepreneurs in both situations. But when bankruptcy is allowed they borrow more because they can and will default in the bad states. Therefore their firms are bigger (upper panel). This insurance comes at expense of higher interest rates (lower panel). Anticipating default in the bad states the banks have to charge higher interest rates in order to break even. We call this increase in the firm size the *intensive margin.* Third, the occupational choice of even less rich agents (e.g. $a = 4$) is affected. When bankruptcy is not allowed they are not insured against bad outcomes. Therefore they do not want to borrow, even though they could borrow at rate r^d. They become workers. When bankruptcy is allowed they are insured against bad outcomes. Therefore they borrow, even though they have to pay a high interest rate. This increases the rewards of entrepreneurship enough to change their occupational choice. We call this increase of the number of entrepreneurs the *extensive margin.* Fourth, the occupational choice of the very poor agents (e.g. $a = 2$) is not affected, they are workers in both situations.

In this particular experiment abolishing bankruptcy reduces entrepreneurship and firm size, the intensive and the extensive margins are negative. The negative effect of lowering the amount of insurance available dominates the positive effect of better credit conditions.

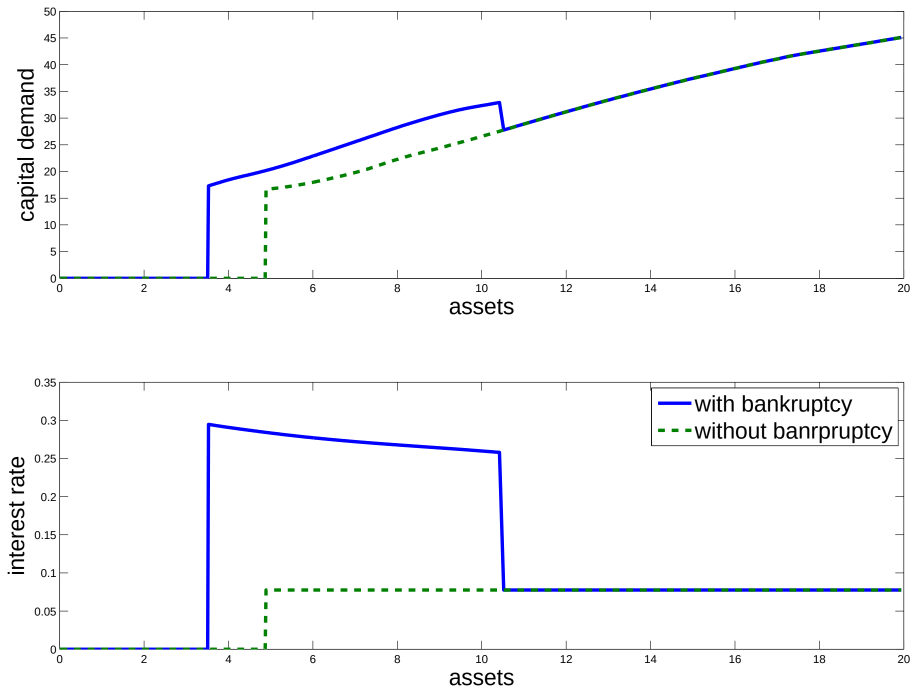

FIGURE 3: FIRM SIZE AND INTEREST RATE ($S = UN, \theta_{-1} = \theta^H, \varphi_{-1} = 1.314$)

6 The effects of bankruptcy reforms

We now turn to analyze the effects of changes in the bankruptcy law. We conduct two different experiments:

1. we change the exemption level from zero, which corresponds to eliminating bankruptcy completely, to a very high level, twice the current level;
2. we change the length of the credit market exclusion period from three to 20 years.[25]

We will focus our attention mainly on changes in the following variables: entrepreneurship, the poors' access to entrepreneurship, welfare, distributional issues and social mobility.

6.1 Changing the exemption level

Our first policy experiment is to analyze the effects of changing the exemption level. First we inspect the changes in the policy functions and later we analyze the quantitative results. Figure 4 reports capital demand (upper panel) and the interest rate (lower panel) for 3 different values of X/w. It shows the effects of increasing the exemption

[25] In the model this corresponds to changing the probability of receiving a positive solvency shock ϱ from 0.5 to 0.05.

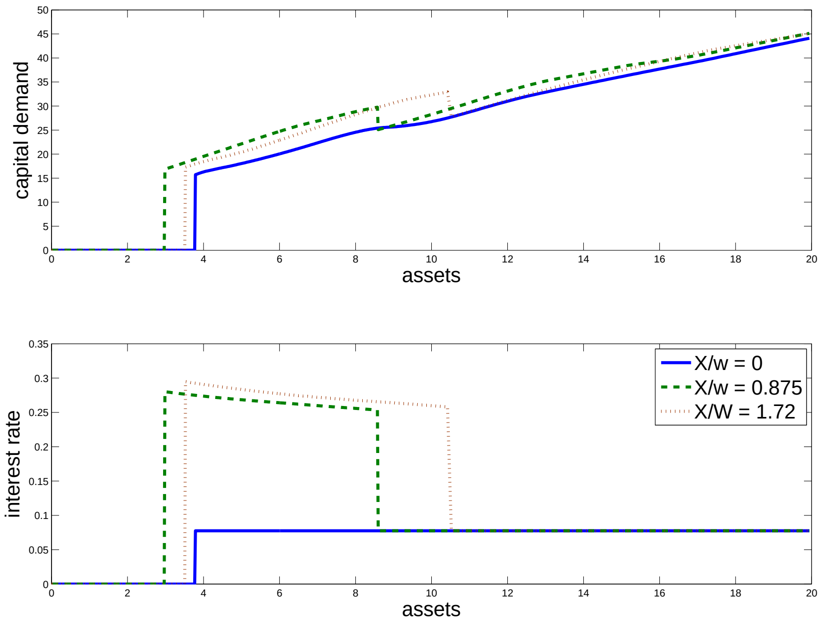

Figure 4: Firm size and interest rates, different exemption levels ($\theta_{-1} = \theta^H, \varphi_{-1} = 1.342$)

level from $X/w = 0$, which corresponds to completely eliminating bankruptcy to an intermediate one ($X/w = 0.875$) and to the actual one ($X/w = 1.72$). Increasing the exemption level, from zero to 0.875 has two effects. Both, the firms get bigger (intensive margin) and more agents enter entrepreneurship (extensive margin). The insurance effect is dominating. Further increasing the exemption level, to the current level of 1.72, has three effects. First, agents with assets around 3, who were entrepreneurs before, become workers because credit conditions worsen so much that they outweigh the increase in insurance. The extensive margin is negative. Second, agents with assets around 6 are charged higher interest rates for the same reasons. Thus they run smaller firms. For these agents the intensive margin is negative. Third, agents with assets around 10 switch from never defaulting to defaulting in the bad states. Now they runs bigger firms, even if credit conditions are worse, because of the insurance effect. For these agents the intensive margin is positive.

The magnitude of these effects depends on the number of agents affected. The extensive margin is unambiguously positive. The sign of intensive margin, however, is ambiguous. It depends on the wealth distribution. The increase in capital demand of agents with asset around 10 is bigger than the decrease in capital demand of agents with asset around 6. But the overall effects depends on the number of agents in these areas of the wealth distribution.

Figure 5 shows the effects on welfare of changing the exemption level. Increasing the exemption level from zero, we have an increase in welfare. The insurance effect is dominating the worsening credit market effect. More agents become entrepreneurs (see also Table 6) and welfare increases. However, increasing the exemption level even further worsens credit market conditions. Agents borrow less, and therefore fewer

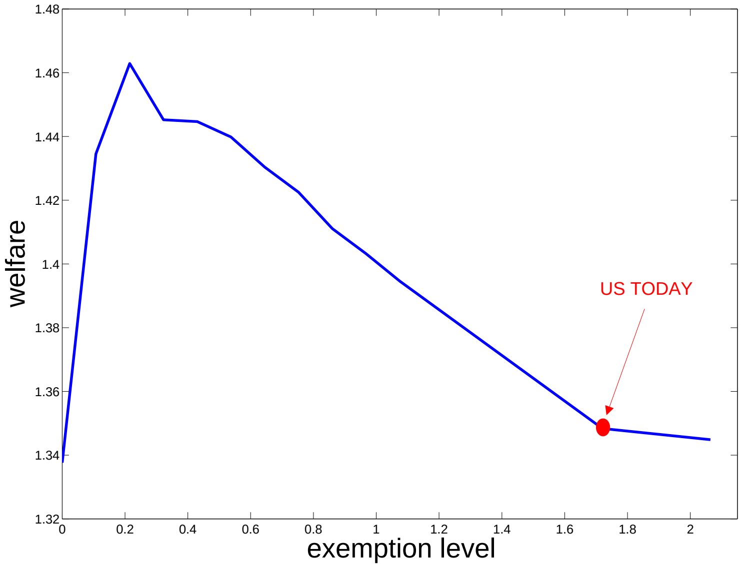

FIGURE 5: THE WELFARE EFFECTS OF CHANGES IN THE EXEMPTION LEVELS

agents find it profitable to become entrepreneurs. The current exemption level in the US, $X/w = 1.72$, is too high. Bankruptcy law is too lenient. There are sizeable welfare gains in reducing the exemption level.

Table 6 reports the variables of interest for 5 values of X/w. Column 2 reports results when bankruptcy is very harsh ($X/w = 0$). Column 4 reports results for the baseline calibration ($X/w = 1.72$) and column 6 for doubling the current exemption level ($X/w = 3.5$).

TABLE 6: THE EFFECTS OF CHANGES IN THE EXEMPTION LEVEL

X/w	**0**	**0.875**	**1.72**	**2.625**	**3.5**
Exit rate (in %)	9.5	9.9	**9.4**	9.6	9.6
Fraction of Entrepreneurs (in %)	7.4	8.1	**7.6**	7.4	7.4
Bankruptcy/Exit (in %)	0	45.9	**22.2**	0.2	0.3
Capital/Output	2.677	2.693	**2.677**	2.677	2.677
Median assets of Entr/ Median assets	4.467	4.157	**4.347**	4.429	4.429
Share of Capital in entr. sector (in %)	47.8	49.4	**47.9**	47.8	47.8
Gini of Assets	0.635	0.636	**0.635**	0.635	0.635
Share of assets in top 40% of pop (in %)	89.0	89.3	**89.0**	89.0	89.0
Median output in entrepreneurial sector	15.05	14.55	**14.58**	15.05	15.05
Welfare (%-change in cons.-equivalent)	-0.07	1.26	**0**	-0.05	-0.05
Welfare of the POOR	-0.09	1.27	**0**	-0.07	-0.06
Welfare of the RICH	-0.02	1.23	**0**	0.03	0

The first pattern to notice is that very harsh and very generous bankruptcy laws produce very similar results (see column 2 and column 6). When bankruptcy is harsh the demand for risky loans (loans with high interest rate due to high positive default probability) is zero. Entrepreneurial activity is so risky that only relatively rich agents, who always repay and get credit at rate r^d, become entrepreneurs. When bankruptcy law is very generous, the banks have to charge such high interest rates on risky loans that nobody demands them. Again, only rich agents become entrepreneurs. This also explains that the ratio of medians is highest in the case of no bankruptcy and very generous bankruptcy law. Even though for each level of assets entrepreneurs borrow less and therefore have smaller firms, the median firm size is bigger under extreme bankruptcy laws, see Figure 6[26]. The reason for this result is again that only rich agents, who have bigger firms, become entrepreneurs.

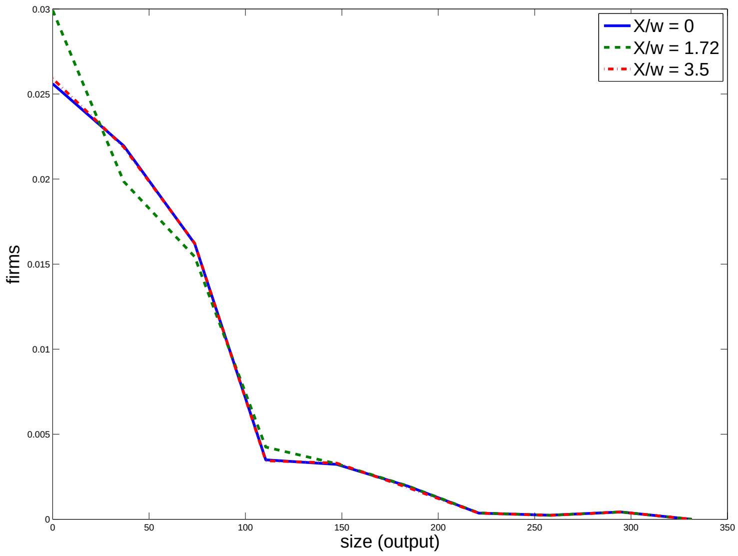

FIGURE 6: FIRM SIZE DISTRIBUTION FOR DIFFERENT EXEMPTION LEVELS

Next we investigate the effects of increasing the exemption level gradually from $X/w = 0$ to $X/w = 3.5$ on entrepreneurship, the poors' access to entrepreneurship, welfare, wealth distribution and social mobility. As can be seen in table 6 almost all variables follow a hump-shaped pattern.

Entrepreneurship Increasing the exemption level first increases and then decreases the fraction of entrepreneurs. The insurance effect dominates the credit market conditions effect for low exemption levels. The opposite is true for high exemption levels. Exit rate and the fraction of exits through bankruptcy follow the behavior of the fraction of entrepreneurs. The fraction of exits through bankruptcy first increases from zero percent to 46% when the exemption level increases from $X/w = 0$ to $X/w = 0.875$. As insurance is higher, a bigger fraction of exits happens through bankruptcy. When the exemption level increases further, from $X/w = 0.875$ to $X/w = 3.5$ the fraction falls gradually back to zero percent because only the rich, who never default, become entrepreneurs.

[26]We smoothed the firm size distribution by creating ten equally sized bins to make the figure easier to read.

The impact of different exemption levels on the investment behavior of entrepreneurs can be understood from the firm size distribution, see Figure 7.[27]

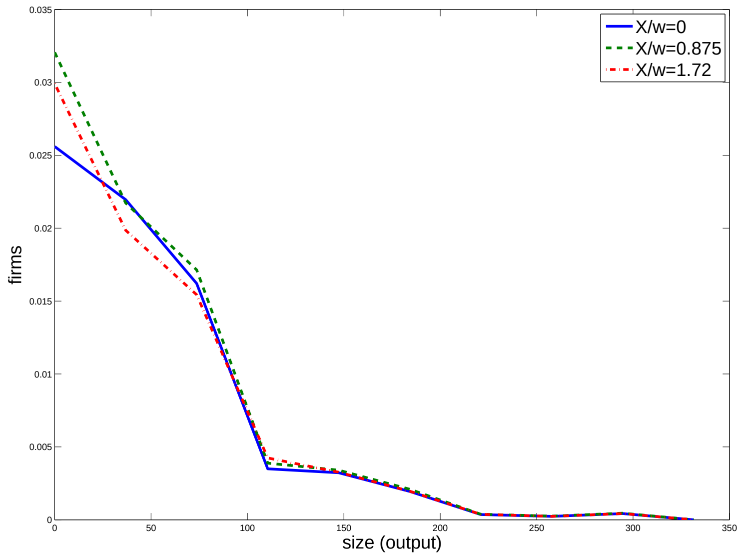

FIGURE 7: FIRM SIZE DISTRIBUTION DIFFERENT EXEMPTION LEVELS - DETAILED

Increasing the exemption level from $X/w = 0$ to $X/w = 0.875$ leads to the creation of more small firms due to positive extensive and intensive margins (see also Figure 4). When we further increase the exemption level to $X/w = 1.72$ some of these new small firms disappear because the negative effects worse credit market conditions dominate.

Access to entrepreneurship of the poor Next we turn to how bankruptcy law affects the determinants of entry into entrepreneurship. There is allocative inefficiency in our model because insurance markets are missing. Part of this inefficiency is reflected in some poor highly productive agents not becoming entrepreneurs, either because they receive too little insurance or because the conditions at which credit is available are too bad. Table 7 reports the effects of different exemption levels on the minimum assets needed for the highly productive ($\theta_{-1} = \theta^H$) agent to become an entrepreneur.

TABLE 7: MINIMUM WEALTH FOR ENTREPRENEURSHIP

X/w	**0**	**0.875**	**1.72**	**2.625**	**3.5**
φ_{-1}= 0.316	0.481	0.160	0.421	0.381	0.361
φ_{-1}= 0.745	1.323	0.842	1.263	1.323	1.323
φ_{-1}= 1.342	3.768	2.946	3.507	3.768	3.768
φ_{-1}= 3.163	16.032	15.030	15.230	16.032	16.032

The rows show these values for the levels of working productivity (φ_{-1}). The

[27]As shown in Figure 6, the firm size distribution for higher exemption levels is identical to the case $X/w = 0$. Therefore in Figure 7 we report only the cases: $X/w = 0$, $X/w = 0.875$, and $X/w = 1.72$.

attractiveness of becoming a worker is increasing in working productivity, i.e. the outside option to entrepreneurship is increasing in working productivity. Thus in order to enter entrepreneurship, the expected profits must be higher for an agent with high working productivity. Since richer agents need to borrow relatively less and since they receive better credit conditions, their expected profits are higher. This implies that, to become an entrepreneur, an agent with high working productivity must be richer than an agent with low working productivity.

At each level of working productivity the wealth level at which an agent enters entrepreneurship is lowest when $X/w = 0.875$. Thus, even from an efficiency point of view a less generous bankruptcy law would improve upon the status quo. However, abolishing bankruptcy completely would make it more difficult for the poor to become entrepreneurs, thereby worsening allocative efficiency.

Welfare Following Aiyagari and Mcgrattan (1998), to assess welfare we first calculate expected utility in each bankruptcy policy regime separately

$$V = \int_{\eta} V(\eta) d\mu^{*}(\eta)$$

where $\eta = (a, \theta_{-1}, \varphi_{-1}, S)$ and $\mu^{*}(\eta)$ is the equilibrium steady state distribution. Thus, expected utility is measured over all asset levels, productivities and the credit status. This utilitarian social welfare function weights all households equally. Then we calculate the constant, at all states and dates, amount of consumption, *consumption equivalent*, that yields expected utility V.[28] We compare two bankruptcy policy regimes by calculating the percentage change in consumption equivalent that makes agents indifferent between the two regimes. For example, for a given regime Q, that yields utility V^{Q}, this percentage change in consumption equivalent is given by

$$\lambda^{Q} = \left(\frac{V^{Q} + 1/\left[(1-\sigma)(1-\beta)\right]}{V^{bench} + 1/\left[(1-\sigma)(1-\beta)\right]} \right)^{1/(1-\sigma)} - 1$$

where a positive λ^{Q} implies that regime Q increases welfare with respect to the baseline regime.

Table 6 shows that welfare follows the same hump-shaped pattern as the other variables. In particular welfare is highest for exemption level $X/w = 0.875$. Thus, halving the current exemption level would increase welfare by 1.26%, which corresponds to an increase in annual consumption of approximately \$700 for the average household.

Table 6 also shows that there no adverse distributional effects. Both, rich and poor agents[29] gain from reducing the exemption level from the current one.

Wealth distribution and social mobility Entrepreneurs are relatively less rich compared to the entire population when $X/w = 0.875$. This is shown by the

[28] Thus, we first calculate a constant $\bar{c}$ that yields that same utility as V. Given CRRA preferences this is the solution to:

$$\left(\frac{\bar{c}^{(1-\sigma)} - 1}{1-\sigma} \right) \frac{1}{1-\beta} = V \quad .$$

[29] We define a poor agent as one with assets less than the median. Comparing the top and bottom quintiles yields similar results.

ratio of median assets in table 6. This is again due to the fact that there are more poor entrepreneurs when $X/w = 0.875$ than for any other exemption level. However changing the exemption level has little effects on the wealth distribution: it does not change significantly the Gini coefficient and the share of wealth held by the richest agents. The changes in entrepreneurship and firm sizes are too small to significantly affect the wealth distribution.

We investigate the effects on social mobility by dividing all agents in 3 wealth classes: poor, middle-class and rich, where each class accounts for 1/3 of total population. Then we compute the transition between these classes over a 10 year horizon for the different values of the exemption level. The results are reported in tables 8 to 10.[30]

TABLE 8: 10-YEARS TRANSITION MATRIX: $X/w = 0$

	poor	middle-class	rich
poor	0.721	0.246	0.033
middle-class	0.277	0.482	0.241
rich	0.004	0.270	0.726

TABLE 9: 10-YEARS TRANSITION MATRIX: $X/w = 0.875$

	poor	middle-class	rich
poor	0.717	0.249	0.034
middle-class	0.279	0.478	0.243
rich	0.004	0.274	0.722

TABLE 10: 10-YEARS TRANSITION MATRIX: $X/w = 1.72$

	poor	middle-class	rich
poor	0.720	0.248	0.032
middle-class	0.276	0.480	0.244
rich	0.005	0.271	0.724

These tables show that there is slightly more mobility in the intermediate case ($X/w = 0.875$) since the probabilities along the main diagonal are smaller. As shown in table 7, for intermediate exemption levels poorer agents have more insurance and therefore enter entrepreneurship. Thus, in our model, entrepreneurship is a vehicle of social mobility. This is consistent with the findings of Quadrini (2000).

6.2 Changing the exclusion period

The second policy experiment we conduct is to change the length of time an agent who has defaulted is excluded from borrowing.[31] As discussed above we model this

[30] Again, results for $X/w = 2.625$ and $X/w = 3.5$ are not reported. They are very similar to the case with $X/w = 0$.

[31] The length of the exclusion period is determined mainly by banks in the US, but in principle this could be regulated by a law.

as changes in the probability of a favorable credit status shock: ϱ. Therefore a low ϱ represents a long exclusion period while a high ϱ represents a short exclusion period.

Table 11 reports the effects of gradually increasing the exclusion period from three years ($\varrho = 0.5$) to 20 years ($\varrho = 0.05$) on the main variables. The baseline value of five years ($\varrho = 0.2$) is reported in column four.

TABLE 11: THE EFFECTS OF CHANGES IN THE EXCLUSION PERIOD

X/w	**0.5**	**0.25**	**0.2**	**0.1**	**0.05**
Exit rate (in %)	9.3	9.4	**9.4**	9.6	9.8
Fraction of Entrepreneurs (in %)	7.7	7.6	**7.6**	7.5	7.4
Bankruptcy/Exit (in %)	23.6	22.7	**22.2**	22.1	20.1
Capital/Output	2.686	2.680	**2.677**	2.668	2.654
Median assets of Entr/ Median assets	4.43	4.39	**4.34**	4.23	4.16
Share of Capital in entr. sector (in %)	48.8	48.0	**47.9**	46.7	45.4
Gini of Assets	0.65	0.65	**0.63**	0.64	0.63
Share of assets in top 40% of pop (in %)	89.2	89.1	**89.0**	88.8	88.6
Median output in entrepreneurial sector	14.99	14.54	**14.58**	13.70	12.29
Welfare (%-change in cons.-equivalent)	0.12	0.02	**0**	-0.18	--0.43
Welfare of the POOR	0.05	-0.04	**0**	-0.09	-0.28
Welfare of the RICH	0.34	0.21	**0**	-0.46	-0.84

Table 11 shows first that reducing the length of the exclusion period increases welfare, and the fraction of entrepreneurs monotonically. However these changes are quantitatively much smaller than in the case of changing the exemption level. The main implication of increasing ϱ is to allow highly productive, failed agents to regain access to credit earlier.

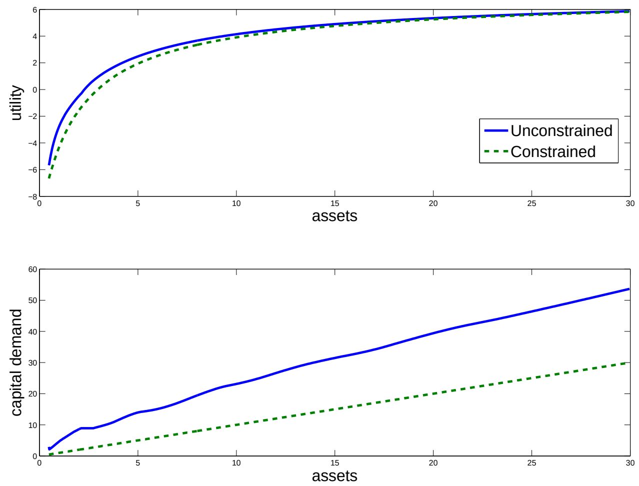

FIGURE 8: UTILITY AND CAPITAL DEMAND OF BORROWING CONSTRAINED AND UNCONSTRAINED ENTREPRENEUR

Figure 8 shows the difference in utility and the difference in firm size for a highly productive agent between being borrowing constrained and being unconstrained. One important difference between changing the exemption level and changing the exclusion period is that the credit market conditions effects are smaller. Both, increasing the exemption level and lowering the exclusion period, increase the attractiveness of defaulting. However, the latter does not affect the amount recovered by banks in the event of a default. Therefore the interest rates charged by banks do not change for most agents, see for example the agents with assets between four and ten in Figure 9. These agents default in the bad states for all values of ϱ. However agents with assets around 10.5 change their behavior. Instead of repaying their debt in all states, as they do when $\varrho = 0.05$, they default in the bad states when $\varrho = 0.5$ because defaulting is more attractive. Therefore they borrow more and have bigger firms. For similar reasons, agents with assets around 3.5 enter entrepreneurship only when ϱ increases.

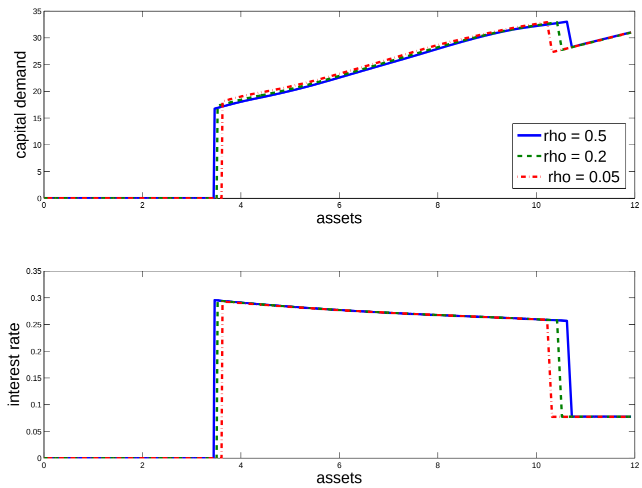

FIGURE 9: CAPITAL DEMAND AND INTEREST RATE, DIFFERENT ϱ ($\theta_{-1} = \theta^H$,$\varphi_{-1} = 1.341$)

Some of the defaulters are hit by the very persistent change in entrepreneurial productivity. Therefore only a fraction of defaulters are still highly productive as entrepreneurs. This implies that the overall effects are small.

Next we investigate the effects of increasing the exclusion period from three years ($\varrho = 0.5$) to 20 years ($\varrho = 0.05$) on entrepreneurship, the poors' access to entrepreneurship, welfare, wealth distribution and social mobility in detail.

Increasing the exclusion period from three years ($\varrho = 0.5$) to 20 years ($\varrho = 0.05$) lowers the fraction of entrepreneurs. As shown in Figure 9, poorer agents do not enter entrepreneurship as often as before because the cost of defaulting is higher. The median firm size decreases because relatively rich entrepreneurs change their behavior. When they are hit by a bad shock they do not default anymore. This implies that they are fully exposed to the production risk. Therefore they operate smaller firms.

The wealth levels needed to become an entrepreneur, one for each level of working productivity, are reported in table 12.

Increasing the exclusion period implies that more wealth is needed to enter entrepreneurship. Therefore it makes access to entrepreneurship more difficult for poor

Table 12: minimum wealth for entrepreneurship

ϱ	0.5	0.25	0.2	0.1	0.05
φ_{-1}= 0.316	0.38	0.42	0.42	0.46	0.48
φ_{-1}= 0.745	1.26	1.28	1.28	1.28	1.28
φ_{-1}= 1.342	3.47	3.53	3.53	3.59	3.63
φ_{-1}= 3.163	15.63	15.73	15.73	15.73	15.63

but highly productive agents. But these changes are small, in particular when compared to the changes when the exemption level is lowered.

Increasing the exclusion period also reduces welfare. Note that even though the Gini coefficient is highest for the shortest exclusion period ($\varrho = \mathbf{0.5}$), welfare for both, rich and poor, is highest in this case as well. Lowering the exclusion period from the current five years to three years would increase welfare by 0.12%, which corresponds to an increase in annual consumption of approximately \$70 for the average household. Increasing the exclusion period to 20 years would yield a welfare loss of approximately 0.43%, which corresponds to a decrease in annual consumption of approximately \$230 for the average household. As tables 13 to 15 show there are hardly any changes in social mobility.

Table 13: 10-years transition matrix: $\varrho = 0.5$

	poor	middle-class	rich
poor	0.721	0.248	0.032
middle-class	0.276	0.480	0.244
rich	0.005	0.270	0.725

Table 14: 10-years transition matrix: $\varrho = 0.2$

	poor	middle-class	rich
poor	0.721	0.247	0.032
middle-class	0.276	0.479	0.244
rich	0.005	0.271	0.724

TABLE 15: 10-YEARS TRANSITION MATRIX: $\varrho = 0.05$

	poor	middle-class	rich
poor	0.720	0.248	0.032
middle-class	0.276	0.480	0.244
rich	0.005	0.271	0.724

7 Conclusion

This is the first paper to explore quantitatively the effects of personal bankruptcy law on entrepreneurship in a general equilibrium setting with heterogeneous agents. First, we developed a dynamic general equilibrium model with occupational choice which explicitly incorporates the US bankruptcy law. Our model endogenously generates interest rates that reflect the different default probabilities of the agents. Our model accounts for the main facts on entrepreneurial bankruptcy, entrepreneurship, wealth distribution and macroeconomic aggregates in the US.

Then, we used the model to quantitatively evaluate the effects of changing the US bankruptcy law. The simulation results show that reducing the exemption level would increase the fraction of entrepreneurs and welfare. These effects are significant: halving the exemption level would have positive welfare effects in the order of 1.4% of average consumption. All households, rich and poor, would be better off. However eliminating bankruptcy completely would reduce the number of entrepreneurs and welfare. The key mechanism driving most of our results is the occupational choice of agents. The fraction of entrepreneurs would increase by one percentage point if the exemption level were reduced by 50%.

We are currently extending our research program along two dimensions. First, we are incorporating the transition to the new steady state. So far, our results are based on a comparison of steady-states. Transitional effects might be important to evaluate welfare. In addition it might explain why the current law is too lenient. It could be that some groups lose during the transition and therefore oppose changes.

Second, we are expanding our model to incorporate explicitly a European type of bankruptcy law. The laws in European countries are much harsher than the law in the US. For example in Italy, debt is never discharged. A defaulter is liable forever. We are analyzing the effects of introducing a US type of law on the Italian economy.

Appendices

A Computational strategy

The state vector for an individual is given by $\eta = (a, \theta_{-1}, \varphi_{-1}, S)$. The aggregate state variable is a density $\mu_t (a, \theta_{-1}, \varphi_{-1}, S)$ over the state variable. We assume that a take value on a grid G_a of dimension n_a. Therefore the dimension of the individual state space is $n = n_a \times n_\theta \times n_\varphi \times 2$ where $n_\theta = 2$ is the number of states for the entrepreneurial productivity and $n_\varphi = 4$ is the number of states for the working productivity.

In order to solve the model we use the following:

Algorithm 1 *Our solution algorithm is:*

1. *Assign all parameters values*
2. *Guess a value for the endogenous variable r.*
3. *Given r the FOC of the corporate sector uniquely pin down the wage rate w. The representative competitive firm in the corporate sector will choose K_c and L_c such as*

$$r^d = \xi A K_c^{\xi-1} L_c^{1-\xi} = \xi A \left(\frac{K_c^d}{L_c^d}\right)^{\xi-1} \tag{A-1}$$

$$w = (1-\xi) A K_c^{\xi} L_c^{-\xi} = (1-\xi) A \left(\frac{K_c^d}{L_c^d}\right)^{\xi} \tag{A-2}$$

   Therefore r uniquely pins down $\left(\frac{K_c}{L_c}\right)$ and in turn uniquely pins down w.

4. *Given (r, w) we solve for the optimal value functions and corresponding policy functions by value function iteration. The details of the zero profit conditions for the banks are presented in the next subsection.*
   (a) *First we solve for the following policy functions*[32]*:*
      - *Saving policy function:* $\mathsf{a}' (a, \theta_{-1}, \varphi_{-1}, \theta, \varphi, S, OCC)$ *which for any state today $(\theta_{-1}, \varphi_{-1})$ and for any state tomorrow (θ, φ), for any given level of assets a, for any given credit status $S \in \{UN, BC\}$ and for any occupational choice $OC \in \{W = 0, E = 1\}$ gives us the optimal saving decision of the agent;*
      - *Capital demand function* $\mathsf{k} (a, \theta_{-1}, \varphi_{-1}, S, OCC)$ *for entrepreneurs;*
      - *default decision* $\mathsf{d} (a, \theta_{-1}, \varphi_{-1}, \theta, \varphi, S, OCC)$ *for unconstrained entrepreneur;*

   (b) *The above policy function allow us to calculate the implied value functions $V (a, \theta_{-1}, \varphi_{-1}, S, OCC)$*

[32] Note that given our timing the saving and bankruptcy decisions are taken when the uncertainty about $\theta'$and φ' has been resolved, therefore they appear as argument of the policy function.

(c) *This in turn allows us to solve for the occupational choice function*

$$\mathsf{OC}^*(a,\theta_{-1},\varphi_{-1},S)=\begin{cases}=1 & V(a,\theta_{-1},\varphi_{-1},S,E)\geq V(a,\theta_{-1},\varphi_{-1},S,W)\\ =0 & \text{otherwise}\end{cases}$$

5. *The policy functions, the exogenous transition matrix for the shocks (both for θ_{-1} and for φ_{-1}) and the credit status shock ϱ allow us to derive the probability that an agent in a certain state η will be in the state η' next period, for any give state η. Given the dimension of the state, all these probability form a transition matrix P_η of dimension $n\times n$.*

6. *The transition matrix P_η maps the any current distribution*[33] *μ_η into a next period distribution μ'_η by simply*

$$\mu_{\eta,t+1}=P'_\eta\times\mu_{\eta,t}$$

We calculate the steady state distribution over the state μ^*_η by solving for a

$$\mu^*_\eta=P'_\eta\times\mu^*_\eta$$

7. *From this we can derive all we need for market clearing conditions*

   - *the saving for the whole economy*

$$SA(r)=\sum_{i=1}^{na}\sum_{j=1}^{n_\theta}\sum_{v=1}^{n_\varphi}\sum_{u=1}^{2}a_i\times\mu^*(a_i,\theta_{-1j},\varphi_{-1v},S_u)$$

   - *the supply of labor*

$$L^s(r)=\sum_{i,j,v,u}\mu^*(a_i,\theta_{-1j},\varphi_{-1v},S_u)\times\left[1-\mathsf{OC}^*(a_i,\theta_{-1j},\varphi_{-1v},S_u)\right]\varphi_{-1v}$$

   - *the demand of capital from entrepreneurial sector*

$$K^d_{ENTR}(r)=\sum_{i,j,v,u}\mathsf{p}^*(a_i,\theta_{-1j},\varphi_{-1v},S_u)\times\mathsf{OC}^*(a_i,\theta_{-1j},\varphi_{-1v},S_u)\times\mathsf{k}^*(a_i,\theta_{-1j},\varphi_{-1v},S_u)$$

   where $\mathsf{k}^*(a_i,\theta_{-1j},\varphi_{-1v},S_u)=\mathsf{k}\left[a_i,\theta_{-1j},\varphi_{-1v},S_u,OC^*(a_i,\theta_{-1j},\varphi_{-1v},S_u)\right]$

8. *Labor market clearing implies that labor supply $L^s(r)$ is equal to labor demand (that comes from corporateL^d_c). Plugging this into the FOC (A-1) of the corporate sector we get capital demand from corporate sector:*

$$K^d_c(r)=\left(\frac{r}{\xi A}\right)^{\frac{1}{\xi-1}}L^S(r)$$

9. *Now we look at capital market clearing:*

$$K^d_{ENTR}(r)+K^d_c(r)=SA(r)$$

10. *If there is not equilibrium at point 9 we adjust interest rate, we go back to point 3 and we iterate until market clears*[34]*.*

[33] Note that in our framework the distribution of household over the state μ_η, is vector of dimension n whose elements sum up to 1.

[34] In practice we first run a grid search over different values for r and then bisect until we get market clearing.

A.1 Value function iteration

Given the presence of kinks in the problem we use value function iteration algorithm to solve for the value functions. We approximate the value functions using cubic splines.

The iteration goes as follows.

1. We guess a value function both for the UN and the BC agent: $V^{BC0}(a, \theta_{-1}, \varphi_{-1})$ and $V^{UN0}(a, \theta_{-1}, \varphi_{-1})$

2. Given the guesses, we solve for 4 value functions, two for the workers $(W^{BC}(a, \theta_{-1}, \varphi_{-1})$ and $W^{UN}(a, \theta_{-1}, \varphi_{-1}))$ and two for the entrepreneurs $(N^{BC}(a, \theta_{-1}, \varphi_{-1})$ and $N^{UN}(a, \theta_{-1}, \varphi_{-1}))$. The only non standard problem is to find $N^{UN}(a, \theta_{-1}, \varphi_{-1})$ where we must take the zero profit condition of the bank into account. The solution is described in the next subsection.

3. Form the function we can derive a new guess for the value function

$$V^{BC1}(a, \theta_{-1}, \varphi_{-1}) = \max\left\{N^{BC}(a, \theta_{-1}, \varphi_{-1}), W^{BC}(a, \theta_{-1}, \varphi_{-1})\right\} \tag{A-3}$$

$$V^{UN1}(a, \theta_{-1}, \varphi_{-1}) = \max\left\{N^{UN}(a, \theta_{-1}, \varphi_{-1}), W^{UN}(a, \theta_{-1}, \varphi_{-1})\right\} \tag{A-4}$$

4. Therefore we have can construct an iteration of the form

$$\begin{bmatrix} V^{BCj}(a, \eta) \\ V^{UNj}(a, \eta) \end{bmatrix} \to \begin{bmatrix} V^{BCj+1}(a, \eta) \\ V^{UNj+1}(a, \eta) \end{bmatrix}$$

A.2 The zero profit condition

In the derivation of the optimal choice of the unconstrained entrepreneur we assume that he can borrow from a perfectly competitive banking sector: that is there is free entry in the sector. This implies that the bank makes zero profit on each contract. What we need is a menu of contracts that the bank offers, where each contract is an amount lent $b(a, \theta_{-1}, \varphi_{-1}, X)$ and an interest rate $r(a, \theta_{-1}, \varphi_{-1}, b, X)$ that, give the assumption of perfect symmetric information, can depend on the individual state of the agent

Banks will get repaid if the type-$(a, \theta_{-1}, \varphi_{-1})$ agent finds it optimal not to declare bankruptcy at the end of the period, given the amount lent. We denote the probability of bankruptcy as $\pi^{bankr}(a, \theta_{-1}, \varphi_{-1}, b, X)$. Therefore the zero profit condition is given by

$$\left(\begin{array}{c} \left[1 - \pi^{bankr}(a, \theta_{-1}, \varphi_{-1}, b, X)\right]\left[1 + r(a, \theta_{-1}, \varphi_{-1}, b, X)\right] b + \\ + \pi^{bankr}(a, \theta_{-1}, \varphi_{-1}, b, X) \max\left\{\chi\theta k^{\nu} + f(1-\delta)(a-b) - X, 0\right\} \end{array}\right) = (1+r)b$$

So in order to find the equilibrium interest rate $r(a, \theta_{-1}, \varphi_{-1}, b, X)$ charged to each type of agent we must find the probability that the agent defaults. However it is important to note that the contracts the bank offers must all make zero profits in expectations, also the out-of-equilibrium contracts (i.e. those the agent does not choose).

We solve the problem of unconstrained entrepreneurs over a grid. For any given type $(a, \theta_{-1}, \varphi_{-1})$ we find the optimal choice given a grid of possible levels of loans:

$b_i \in [b_{\min}, b_{\max}]$. Given each value of $b_i > 0$ (if $b_i < 0$ the agent saves so he does not need the bank and gets an interest rate r) there are only three possibilities[35]:

- The agent always repays, both in event of bad and of a good shock to entrepreneurial productivity. In this case $\pi^{bankr}(a, \theta_{-1}, \varphi_{-1}, b, X) = 1$, an therefore the only interest rate compatible with zero profits is r.
- The agent repays only in the case of a bad shock. In this case we know that $\pi^{bankr}\left(a, \theta^H, \varphi_{-1}, b, X\right) = 1 - p^{HH}$ and $\pi^{bankr}\left(a, \theta^L, \varphi_{-1}, b, X\right) = 1 - p^{LL}$ and we can calculate, for any b, the unique interest rate $r(a, \theta_{-1}, \varphi_{-1}, b, X)$ such as the bank breaks even.
- The agent never repays so he never get credit.

Therefore our strategy is, for any $b_i \in [b_{\min}, b_{\max}]$

1. First we check what happens if the agent is offered the rate r^d.
2. If the agent always repays we are done.
3. If the agent does not repay we check what would he do if he was offered the unique interest compatible with his defaulting only in the bad state. If he actually defaults only in the bad state, we are done.
4. If at point 3 we find out that given that interest rate the agent will always default (in the good and in the bad state) we know that the agent will never get credit so we set his utility to $-\infty$.
5. We do this for all the $b_i \in [b_{\min}, b_{\max}]$ and then the agent picks the b_i that maximizes his utility.

B Data on Entrepreneurship

To calibrate the model and to select a value for the targets we need a the definition of entrepreneur. Given the need to target bankruptcy, we are bounded in the choice by the availability of data on business bankruptcy filings. The main source for data on business bankruptcy is *The Small Business Economy* (2006) by the US Small Business Administration, Office of Advocacy[36]. Their definition of entrepreneurs (see Table B-1) is a business owner who actually runs his business and has at least one employee. Given this definition the main data on entrepreneurs, entrepreneurs' termination and bankruptcy are reported in table B-1.

[35]This is under the assumption of only two state for entrepreneurial talent and that this is the only case that matters.

[36]The original sources of data are:

- for the employers, from the Bureau of Census and U.S. Department of Commerce
- for employer' births and terminations, from the Census Bureau
- for bankruptcies. from the Administrative Office of the U.S. Courts (business bankruptcy filings).

Table B-1: entrepreneurship exit and bankruptcy

Year	Entrepreneurs	Exit	Exit Rate	Bankruptcy	Bankruptcy/Exit
1990	5073795	531400	0.105	64853	0.122
1991	5051025	546518	0.108	71549	0.131
1992	5095356	521606	0.102	70643	0.135
1993	5193642	492651	0.095	62304	0.126
1994	5276964	503563	0.095	52374	0.104
1995	5369068	497246	0.093	51959	0.104
1996	5478047	512402	0.094	53549	0.105
1997	5541918	530003	0.096	54027	0.102
1998	5579177	540601	0.097	44367	0.082
1999	5607743	544487	0.097	37884	0.070
2000	5652544	542831	0.096	35472	0.065
2001	5657774	553291	0.098	40099	0.072
2002	5697759	586890	0.103	38540	0.066
2003	5767127	540658	0.094	35037	0.065
2004	5865400	544300	0.093	34317	0.063
2005	5992400	544800	0.091	39201	0.072
Average	**5493734**	**533328**	**0.097**	**49136**	**0.093**

SOURCE: US Small Business Administration, Office of Advocacy (2006)

To get the fraction of entrepreneurs in the population we apply the same definition of entrepreneurs to several waves of the Survey of Consumer Finances (1989-2004). We define an household as entrepreneurial if the head owns and runs a business with at least one employee. The fraction of the population engaged in entrepreneurial activity, for several waves of the SCF is reported in the last column of table B-2. According to our definition we get that the fraction of entrepreneurial household in total population is given by **7.62%**. This number does not differ from the number obtained using other definitions of entrepreneurship used in the literature[37]

Using the same definition we calculate again using data from the Survey of Consumer Finances, the median net worth for entrepreneurial household and for the total population. The results are reported in the table B-3 which reports the median wealth for other definition of entrepreneurship as well.

The corresponding ratio of the median entrepreneurial wealth to the median wealth in total population is therefore **5.66**[38].

In the literature another source of data on entrepreneurship is the Panel Study on Income Dynamics (Quadrini, 2000). Given the panel structure it is particularly useful to calculate exit and entry rates. However one major drawback is that it undersamples rich household, and therefore entrepreneurs. Unfortunately PSID does not report

[37] Cagetti and De Nardi (2006) define as entrepreneurial an household whose head owns and runs a business and declares herself as self employed. Gentry and Hubbard (2004) define as entrepreneurial an household who owns and runs a business with a total market value of at least 5000$.

[38] Using other definitions of entrepreneur the ratio of median wealth of entrepreneurs is lower: 4.8 and 5.3 when using Cagetti and De Nardi (2006) and Gentry and Hubbard (2004) definitions respectively.

Table B-2: fraction of entrepreneurs in total population

year	Cagetti and De Nardi	Gentry-Hubbard	Our definition
1989	0.076	0.067	0.085
1992	0.081	0.096	0.081
1995	0.067	0.071	0.068
1998	0.074	0.074	0.073
2001	0.078	0.081	0.076
2004	0.075	0.084	0.075
Average	**0.075**	**0.079**	**0.076**

SOURCE: Survey of Consumer Finances (1989-2004)

Table B-3: median net worth of total population and of entrepreneurial household

year	Tot Population	Cagetti and De Nardi	Gentry-Hubbard	Our definition
1989	47060	265000	318680	275500
1992	49600	208680	234250	300100
1995	57650	213300	226820	245801
1998	71700	331650	342600	371800
2001	86610	458000	495400	528900
2004	93001	536000	562500	606160
average	**67603.5**	**335438.3**	**363375**	**388043.5**

SOURCE: Survey of Consumer Finances (1989-2004) the number of employee. We can not apply the our definition. In the literature on entrepreneurship that uses PSID, Quadrini (2000), two definitions are adopted. According to the first an entrepreneur is someone who declares himself self employed (SELF). According to the second an entrepreneur is someone who owns a business (OWN). Both these definitions are less stringent the one adopted above. Column 2 and 3 of table B-4 report the fraction of entrepreneurs in PSID according to these definition. The first yields and average fraction of entrepreneurs of 11% while the second of 13%. This is much higher than the figure for SCF data. Therefore we also use a third definition which is more restrictive: an agent is an entrepreneur if both he owns a business and is self employed. This yield a lower fraction of entrepreneurs, equal to 8%.

Table B-4: fraction of entrepreneurs

YEAR	SELF	OWN	BOTH
1969	0.11	0.08	0.06
1970	0.10	0.09	0.06
1971	0.10	0.09	0.06
1972	0.10	0.09	0.05
1973	0.10	0.09	0.06
1974	0.10	0.08	0.05
1975	0.10	0.08	0.06
1976	0.10	0.09	0.07
1977	0.10	0.09	0.06
1978	0.10	0.10	0.06
1979	0.10	0.10	0.06
1980	0.10	0.09	0.07
1981	0.10	0.10	0.06
1982	0.11	0.10	0.07
1983	0.11	0.11	0.07
1984	0.12	0.12	0.08
1985	0.13	0.14	0.09
1986	0.12	0.15	0.09
1987	0.13	0.15	0.09
1988	0.13	0.16	0.10
1989	0.13	0.15	0.09
1990	0.13	0.14	0.09
1991	0.13	0.14	0.09
1992	0.13	0.15	0.09
1993	0.13	0.13	0.08
1994	0.13	0.14	0.08
1995	0.12	0.13	0.08
1996	0.12	0.16	0.09
1997	0.13	0.17	0.09
average	**0.11**	**0.12**	**0.08**

SOURCE: PSID (1969-1997)

Given this discrepancy we avoid using PSID data unless is strictly necessary. As a check of the SBA data we calculate the exit and entry rates according to the 3 definitions above. Entry rate in period t is defined as the ratio of the number of total household in the sample who were workers in period $t-1$ and were entrepreneurs in period t over the total number of workers in period $t-1$. Exit rate in period t is the ratio of those who were entrepreneurs in period $t-1$ and are worker in period t over the total number of entrepreneurs in period $t-1$. Results are reported in table A5.

Table B-5: exit and entry rates (different definitions of entrepreneur)

	EXIT			ENTRY		
YEAR	own	self	both	own	self	both
1970	0.17	0.13	0.13	0.02	0.02	0.01
1971	0.16	0.11	0.13	0.02	0.02	0.01
1972	0.19	0.15	0.18	0.02	0.02	0.01
1973	0.22	0.14	0.15	0.03	0.02	0.02
1974	0.28	0.13	0.21	0.02	0.02	0.01
1975	0.22	0.10	0.14	0.02	0.02	0.02
1976	0.15	0.08	0.11	0.03	0.01	0.02
1977	0.20	0.12	0.21	0.03	0.02	0.01
1978	0.22	0.10	0.13	0.03	0.02	0.02
1979	0.18	0.11	0.15	0.03	0.02	0.01
1980	0.27	0.10	0.12	0.02	0.01	0.01
1981	0.22	0.10	0.16	0.03	0.01	0.01
1982	0.23	0.07	0.14	0.03	0.02	0.02
1983	0.16	0.09	0.11	0.03	0.02	0.01
1984	0.20	0.11	0.13	0.03	0.01	0.01
1985	0.18	0.12	0.13	0.04	0.03	0.02
1986	0.20	0.14	0.13	0.04	0.02	0.02
1987	0.18	0.12	0.11	0.04	0.02	0.01
1988	0.20	0.13	0.13	0.05	0.03	0.02
1989	0.24	0.15	0.16	0.04	0.02	0.02
1990	0.20	0.13	0.15	0.04	0.02	0.02
1991	0.22	0.11	0.15	0.04	0.03	0.02
1992	0.23	0.12	0.17	0.05	0.02	0.02
1993	0.25	0.13	0.20	0.03	0.02	0.02
1994	0.22	0.15	0.21	0.04	0.02	0.02
1995	0.25	0.13	0.18	0.04	0.02	0.02
1996	0.19	0.10	0.12	0.04	0.02	0.02
1997	0.16	0.09	0.15	0.03	0.02	0.01
average	0.21	0.12	0.15	0.03	0.02	0.02

SOURCE: PSID (1969-1997)

These numbers are much higher than the number from the number of SBA. The reason is that the PSID undersamples rich household. Since successful are richer and do not exit this could bias the results. Therefore we choose as the target for the exit rate 9.3%.

Quadrini (2000) points out that the entry rate of workers who has some entrepreneurial experience in the past is much higher than the entry rate of those who has not got any experience. Using the PSID data we replicate his results. An agent is defined as "experienced" worker in $t-1$ if is a worker in period t-1 and has been an entrepreneur in any of the three periods before ($t-2,\ t-3,\ t-4$). All the remaining workers in period $t-1$ are defined as non-experienced. The entry rate for experienced and non experienced, as well as the overall entry rate are reported in table B-6.

Table B-6: entry rates (experienced and non experienced)

YEAR	TOTAL POP	NON-EXP	EXP
1974	0.015	0.009	0.313
1975	0.017	0.012	0.298
1976	0.014	0.010	0.280
1977	0.018	0.012	0.311
1978	0.014	0.009	0.216
1979	0.013	0.010	0.171
1980	0.011	0.008	0.190
1981	0.015	0.010	0.268
1982	0.014	0.010	0.197
1983	0.014	0.009	0.265
1984	0.023	0.017	0.324
1985	0.019	0.014	0.264
1986	0.014	0.010	0.182
1987	0.020	0.017	0.136
1988	0.017	0.012	0.192
1989	0.018	0.013	0.140
1990	0.017	0.013	0.167
1991	0.019	0.013	0.196
1992	0.017	0.012	0.185
1993	0.018	0.010	0.230
1994	0.019	0.011	0.247
1995	0.017	0.011	0.200
1996	0.012	0.008	0.167
average	**0.016**	**0.011**	**0.223**

SOURCE: PSID (1969-1997)

Entry rate of experienced workers is 14 times higher than that of total population.[39]

C Formal definition of equilibrium

In our model the state space is given by 4 elements: the asset level a, the entrepreneurial productivity θ, the worker productivity φ and the credit status S. We discretize the

[39] If we restrict the sample to 1989 to 1996, to be compatible with other data sources the ratio falls to 11. We set this as the target.

assets level, assuming that assets can values on a grid of n_a elements $G_a \subseteq \Re_+^{n_a}$. Given the Markov approximation for the productivities processes we have that θ can takes $n_\theta = 2$ values, $\theta \in \Theta \equiv \left\{0, \theta^H\right\}$, and φ can take n_φ values $\varphi \in \{\varphi_1, \varphi_2\} \equiv \Gamma$. Moreover $S \in \{BC, UN\} \equiv \Xi$. Following Huggett (1993), we can define the state space for the households as $\Omega = G_a \times \Theta \times \Phi \times \Xi$. Letting σ_Ω be the Borel σ-algebra on Ω and letting the optimal policy functions $PF(\omega), \omega \in \Omega$,(assets decisions, occupational choice, capital demand, bankruptcy decision) we have that the policy functions and the exogenous stochastic process imply a **transition function** $T(\omega, \varsigma), \forall \varsigma \in \sigma_\Omega$ on the measurable space (Ω, ω). This transition function implies a stationary probability measure $\mu(\varsigma), \forall \varsigma \in \sigma_\Omega$ that describe the distribution of household on assets holdings, productivity levels, and credit status. Stationarity implies

$$\mu(\varsigma) = \int_\Omega T(\omega, \varsigma)\, d\mu$$

After this bit of notation we can formally state the following definition of stationary equilibrium:

Definition 2 *A* ***stationary equilibrium*** *of the model is a four-tuple* $\{PF(\omega), \mu(\varsigma), (r, w), r(\omega)\}$ *such as:*

1. $PF(\omega)$ *is optimal for given* (r, w)
2. $\mu(\varsigma)$ *is the stationary distribution associated with transition function generated by* $PF(\omega)$*, given* (r, w)
3. *The corporate sector representative firm is optimizing, given* (r, w)

$$r = \xi A K_c^{\xi-1} L_c^{1-\xi} = \xi A \left(\frac{K_c}{L_c}\right)^{\xi-1} \tag{C-5}$$

$$w = (1-\xi) A K_c^{\xi} L_c^{-\xi} = (1-\xi) A \left(\frac{K_c}{L_c}\right)^{\xi} \tag{C-6}$$

4. $r(\omega)$ *reflects the zero profit condition for the banking sector*
5. *Labor market and capital market clears.*

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