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Personal bankruptcy law, debt portfolios, and entrepreneurship

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Non-technical summary

Research Question

Personal bankruptcy provides entrepreneurs with insurance against the financial consequences of business failures. This insurance comes at the cost of worsened credit conditions: higher interest rates and potentially credit rationing. This trade-off also depends on the wealth held by each entrepreneur and the availability of other forms of credit, in particular secured credit.

Contribution

We construct a quantitative general equilibrium model of occupational choice, where agents decide to become entrepreneurs or workers. We calibrate it to the U.S. economy and show that the presence of secured credit in addition to unsecured credit substantially alters the trade-off between insurance and credit conditions.

Results

A lenient bankruptcy law always worsens credit conditions, in particular for poor entrepreneurs. If secured credit is not available, their credit conditions are so bad that many prefer to become workers. In that case, we show that the optimal bankruptcy law is very harsh because the benefits from better credit conditions dominate the worsened insurance. However, if secured credit is available, entrepreneurs who might be rationed out of the unsecured credit market can still obtain secured credit. Therefore, they can run larger firms, which makes entrepreneurship more attractive.

The presence of secured credit lowers the cost of a generous bankruptcy law, we find that the optimal law is lenient in this case; exactly the opposite result as obtained in the model version without secured credit.

Nichttechnische Zusammenfassung

Fragestellung

Die Privatinsolvenz sichert Unternehmer gegen die finanziellen Folgen eines Konkurses ihrer Firma ab. Diese Absicherung hat allerdings einen Preis: strengere Kreditvergabebedingungen in Form höherer Zinsen und einer möglichen Kreditrationierung. Inwieweit diese Wechselwirkung zum Tragen kommt, hängt aber auch vom Vermögen des Unternehmers und der Verfügbarkeit anderer Darlehensformen, vor allem besicherter Kredite, ab.

Beitrag

Es wird ein quantitatives allgemeines Gleichgewichtsmodell der Berufswahl konstruiert, in dem sich die Akteure entscheiden, entweder Unternehmer zu werden oder ein Angestelltenverhältnis einzugehen. Das Modell ist für die Vereinigten Staaten kalibriert. Es wird gezeigt, dass die mögliche Aufnahme besicherter Kredite (zusätzlich zu unbesicherten Darlehen) die Abwägung zwischen Absicherung und Kreditkonditionen erheblich beeinflusst.

Ergebnisse

Ein großzügiges Konkursrecht führt, insbesondere bei Unternehmern, die über wenig eigenes Vermögen verfügen, immer zu einer Verschärfung der Kreditkonditionen. Ist die Aufnahme eines besicherten Kredits nicht möglich, entschließen sich viele Akteure aufgrund der schlechten Kreditbedingungen dazu, ein Angestelltenverhältnis einzugehen. Für diesen Fall wird aufgezeigt, dass das optimale Konkursrecht sehr strikt sein sollte, da so die Vorteile durch bessere Kreditbedingungen die Nachteile der verschlechterten Absicherung durch Privatinsolvenz überwiegen. Allerdings können Unternehmer, die aufgrund einer Kreditrationierung kein unbesichertes Darlehen erhalten, gegebenenfalls immer noch einen besicherten Kredit aufnehmen. So können sie größere Firmen aufbauen, was die Unternehmensgründung attraktiver macht.

Kann ein besicherter Kredit aufgenommen werden, so verringert dies die Kosten eines großzügigen Konkursrechts. Wir kommen zu dem Ergebnis, dass die entsprechenden Gesetze in diesem Fall optimalerweise nachsichtig sein sollten, genau das Gegenteil dessen, was aus der Modellversion ohne besicherte Kredite resultiert.

Bundesbank Discussion Paper No 28/2015

Personal Bankruptcy Law, Debt Portfolios, and Entrepreneurship*

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Abstract

Every year 400,000 entrepreneurs fail and 60,000 file for personal bankruptcy. The option to declare bankruptcy provides entrepreneurs with insurance against the financial consequences of business failures. However, it comes at the cost of worsened credit market conditions. In this paper, we construct a quantitative general equilibrium model of entrepreneurship to show that the presence of secured credit in addition to unsecured credit substantially alters the trade-off between insurance and credit conditions. A lenient bankruptcy law always worsens credit conditions, in particular for poor entrepreneurs. If secured credit is not available, their credit conditions are so bad that many prefer to become workers. In that case, we show that the optimal bankruptcy law is very harsh because the benefits from better credit conditions dominate the worsened insurance. However, if secured credit is available, entrepreneurs who might be rationed out of the unsecured credit market can still obtain secured credit. Therefore, they can run larger firms, which makes entrepreneurship more attractive. Since the presence of secured credit lowers the cost of a generous bankruptcy law, we find that the optimal law is lenient in this case; exactly the opposite result as obtained in the model version without secured credit.

Keywords: Personal Bankruptcy, Entrepreneurship, Occupational Choice

JEL classification: M13, K10, O41, E20

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1 Introduction

In recent years, many countries have changed their personal bankruptcy laws. In Europe, where the bankruptcy law is much harsher than in the U.S., many countries, for example Germany, the Netherlands, and the UK, have made the bankruptcy law more lenient with the explicit aim of fostering entrepreneurship. The U.S. moved in the opposite direction. The "Bankruptcy Abuse Prevention and Consumer Protection Act" of 2005 made it more costly to declare bankruptcy. We contribute to this debate on two levels. First, we examine the role of the personal bankruptcy law for entrepreneurs and its macroeconomic implications. Personal bankruptcy law affects entrepreneurs because if an entrepreneur's firm is not incorporated, the entrepreneur is personally liable for all the unsecured debts of the firm. However, despite the fact that entrepreneurs can default on unsecured debt, they overwhelmingly borrow secured. Thus our second, and most important, contribution is to show that the presence of secured credit in a model of unsecured credit and default alters all positive and normative implications dramatically. In a version of the model without secured credit, the optimal bankruptcy law is very harsh. The opposite happens when secured credit is available.

The possibility of filing for bankruptcy introduces some contingency in a world of incomplete credit markets where only simple debt contracts are available. This contingency provides insurance against entrepreneurial failure at the cost of worsening credit conditions. If the bankruptcy law is very generous to defaulters, borrowers are insured against bad outcomes. But in order to compensate for the default risk, banks have to charge high interest rates or ration credit altogether. Allowing for secured credit modifies this trade-off between insurance and credit conditions by allowing agents to obtain cheap credit even under a very generous bankruptcy law. Poor agents are rationed out of the unsecured credit market, independently of the availability of secured credit. But if secured credit is not allowed, these agents will have to self-finance, and therefore will have only very small firms. In contrast, if secured credit is available, these agents can obtain secured credit and therefore are able to have bigger firms. Thus, secured credit weakens the negative effect of a generous bankruptcy law.

We build an infinite horizon heterogeneous agents model with occupational choice to quantify this trade-off. Each period, an agent decides whether to become an entrepreneur or a worker. An entrepreneur can obtain both secured and unsecured credit. As in Kiyotaki and Moore (1997), an entrepreneur can borrow secured by pledging their future output and the capital of their firm as collateral. Credit is provided by perfectly competitive financial intermediaries. Conditions for unsecured credit reflect the risk profile of each individual entrepreneur. After uncertainty in production has realized each entrepreneur can decide whether to file for bankruptcy. The bankruptcy law is modeled on U.S. Chapter 7: debt is immediately discharged and after repaying secured debt, all assets in excess of an exemption level are liquidated. The proceeds are used to (partially) repay the unsecured creditors. The most important feature of secured credit for bankruptcy proceedings is that it has priority over unsecured debt and it is not subject to bankruptcy exemptions.

We solve for two versions of the model which are identical in all respects with the only exception being the availability of secured credit. Both models are calibrated independently to replicate the same important macroeconomic facts — the fraction of en-

trepreneurs, their exit rate and bankruptcy filings, and the wealth distribution — of the U.S. economy. With both models the same policy experiment is conducted: we change the severity of bankruptcy law, using wealth exemptions as a proxy. The main result of the paper is that the presence of secured credit is critical for all positive and normative results. On the one hand, if secured credit is not available, a very harsh law would induce high entrepreneurship and maximize welfare. On the other hand, if secured credit is available, a very lenient law would be optimal and would increase entrepreneurship.

The reason for this complete reversal is that the negative effects of a lenient bankruptcy law — more expansive credit and potential credit rationing of poor agents — are significantly weaker if these agents can borrow secured. This result is general and, most likely, carries over to other models of default with unsecured credit. In these models the biggest negative effect of a generous bankruptcy law is that it makes unsecured credit expensive for poor agents so that they are priced out of the credit market. If agents still can borrow secured, they only lose the insurance value of the default possibility but at least they can obtain credit. Thus, the loss to poor agents is significantly reduced.

In our model with secured credit there are significant welfare gains from increasing the current exemption level to the optimal one: entrepreneurship would increase from 7.3% of the population to 7.6%. This is due to the increased insurance effect, which mainly works through a *fresh start* effect: if the exemption level is high, entrepreneurs who have defaulted can keep a significant amount of wealth which enables them to start another entrepreneurial project soon afterward. Thus, they enjoy a fresh start. We also show that the optimal exemption level is only slightly lower when we include the transition period in our welfare calculations.

The available empirical evidence (Fan and White, 2003) show that entrepreneurship is higher in states with a more lenient bankruptcy law. Data from the Kauffman Foundation for 1996-1998, suggests an hump-shaped relationship between between bankruptcy exemptions and average self employment rate across US-states (Figure 1). Our model is the only one consistent with existing empirical evidence on the relationship between bankruptcy exemptions and entrepreneurship.

The costs of a generous bankruptcy system, in terms of higher interest rates, depend mainly on the elasticity of intertemporal substitution, while the benefits, in terms of insurance, depend on risk aversion. In contrast to the previous literature, we examine these effects separately by assuming Epstein-Zin preferences. We find that the optimal exemption level increases with the elasticity of intertemporal substitution. This result is intuitive, since agents who are more willing to substitute consumption across time are less affected by the higher borrowing rates resulting from higher exemption levels. We also find that the optimal exemption level increases with risk aversion. The more risk averse are the agents, the more they value insurance. The optimal exemption level is high for all values of the preference parameters, showing the robustness of our main result to changes in preferences.

The main contribution of our paper is to analyze the effects of allowing for secured credit in quantitative models of default on unsecured credit, with a focus on the effects of the personal bankruptcy law.

Livshits, MacGee, and Tertilt (2007) and Chatterjee, Corbae, Nakajima, and Rios-Rull (2007) among many others investigate the consequences of the personal bankruptcy law on consumer credit. These papers abstract entirely from secured credit, thereby overstating

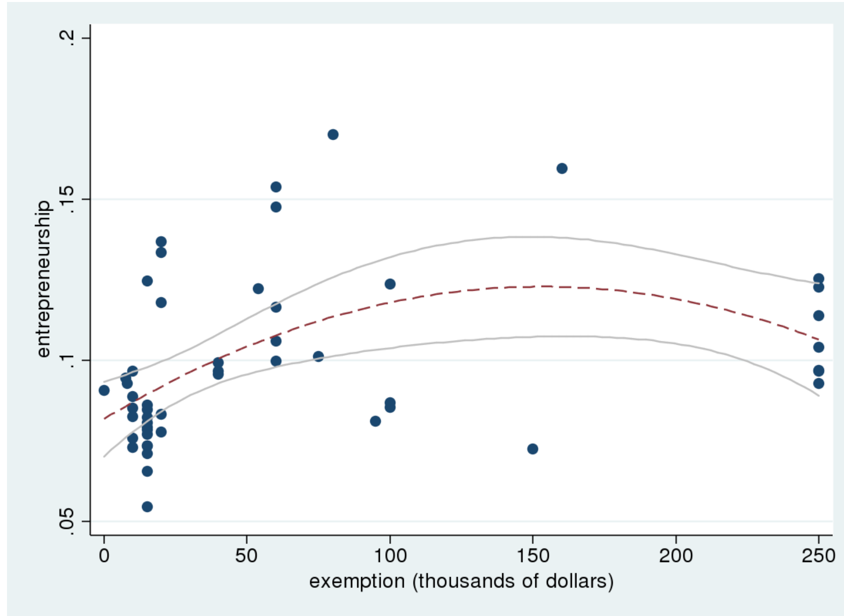


Figure 1: Entrepreneurship and bankruptcy exemption across U.S. states. The figure shows the relationship between exemption levels, which differ across U.S. states and the entrepreneurship rate (self-employment rate). The data are from the Kauffman foundation for 1996-1998.

the negative effects of a generous bankruptcy law. Hintermaier and Koeniger (2011), and Pavan (2008) analyze models with a durable good which can be used as collateral for secured credit. Li and Sarte (2006) allow for both debt and assets in a general equilibrium model but they abstract from secured debt and find that the bankruptcy law should be harsher. Athreya (2006), like us, abstracts from durable goods but allows households to borrow secured up to an exogenous limit. Athreya (2006) and Hintermaier and Koeniger (2011) also find that a lenient bankruptcy law is optimal. However, none of these papers explicitly compares the same model with and without secured credit. Therefore, we are the first to identify and explain the mechanism through which secured credit affects the trade-off between insurance and credit market conditions.

Our paper contributes to the literature on entrepreneurship and personal bankruptcy.[1] Akyol and Athreya (2011) use a life cycle model which includes human capital to investigate the optimal exemption level. Meh and Terajima (2008) study the same question when also consumers can default. In contrast to us, both papers find that the current system is too generous. However none of these papers includes secured credit in the analysis, but in the U.S. data about 87% of entrepreneurial borrowing is secured. Our results, like theirs, are consistent with the empirical finding of Berkowitz and White (2004), who show that in states with higher exemption levels, credit conditions are worse. But, our paper is the only one that is also consistent with the findings of Fan and White (2003), who show that entrepreneurship is higher in states with a more lenient bankruptcy law and with the results in Figure 1. Jia (2010) compares the U.S. bankruptcy regime with European

[1] Our paper is related to the broader quantitative literature of entrepreneurship in models of occupational choice, as for example Quadrini (2000) and Cagetti and De Nardi (2006). However, all these papers abstract from risky debt and default which are central to our model.

ones and finds that the more lenient system in the U.S. encourages entrepreneurship. All these papers use partial equilibrium models. We use a general equilibrium model and also study the transitional dynamics. Glover and Short (2011) and Herranz, Krasa, and Villamil (2008) innovate by allowing entrepreneurs to incorporate their firms, thereby shielding their private assets from a business failure. However, since a significant fraction of incorporated entrepreneurs have to use private assets as collateral to obtain credit (Berkowitz and White, 2004), the distinction between incorporated and non-incorporated firms is not that clear and we abstract from this interesting issue.[2]

The present paper is organized as follows. Section 2 provides an overview of U.S. bankruptcy law and presents data on entrepreneurship and secured credit. Section 3 includes our model and discusses the equilibrium conditions. Section 4 explains the main mechanism of the model. Section 5 presents the results of our main policy experiment and explains the role of secured credit. Section 6 shows the robustness of our results towards different modeling choices. Section 7 concludes. The Appendix includes some additional results and describes our computational strategy and our data in more detail.

2 Personal bankruptcy, entrepreneurship and secured credit in the U.S.

Our paper focuses on the effect of the personal bankruptcy law on entrepreneurship for two reasons. The first is that the current personal bankruptcy law already differentiates between entrepreneurial debt and consumer debt. The second reason is that the risks involved and their economic implications are different for entrepreneurs and consumers. Entrepreneurial production risks affect allocative efficiency, by determining the number of entrepreneurs (*extensive margin*) and firm size (*intensive margin*). Instead consumers risks (e.g. health shocks, divorce, unemployment) mainly affect consumption smoothing. Since the risks involved differ and the law already features differential treatment, we chose to focus on entrepreneurial borrowing and default in order to be able to build a tractable and transparent model.[3] This section describes the institutional details of personal bankruptcy an then presents evidence on entrepreneurship and secured credit.

Personal Bankruptcy Personal bankruptcy law in the U.S. consists of two different procedures: Chapter 7 and Chapter 13. Under Chapter 7, all unsecured debt is discharged immediately, while a secured creditor can fully seize the assets pledged as collateral. 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. 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

[2]Moreover, incorporating a firm leads to more difficult access to credit, since private assets are shielded after the incorporation. This is beneficial only for relatively rich entrepreneurs. Our main results comes through the effects on the the relatively poor entrepreneurs. Thus, it is unlikely that it would be overturned by including the incorporation margin.

[3]We examine the robustness of our results by adding consumer default in Section 6 where we show that our results do not depend on this assumption.

discharged immediately, and they can start a new business right away, since their income will not be subject to garnishment (see White, 2007). Indeed 70% of total bankruptcy cases involving entrepreneurs are under Chapter 7. Therefore we will focus on Chapter 7 only.

The main parameter in the model representing the Chapter 7 procedure is the exemption level,[4] which varies across U.S. states, ranging from $11,000 in Maryland to an unlimited exemption for housing wealth in some states, for example Florida. To calibrate this parameter, we calculate the population-weighted median across states. The resulting exemption level is $47,800 in 1993.

A person can file for bankruptcy only once every six years. The bankruptcy filing remains public information for ten years. Therefore, while secured (i.e., collateralized) credit is always available, agents might have difficulties obtaining unsecured credit for some time after having defaulted. In the model we capture this possibility by assuming that defaulting entrepreneurs are excluded from unsecured credit for six years.

The current personal bankruptcy law already differentiates between entrepreneurial debt and consumer debt. U.S. courts have to classify each personal bankruptcy case as either being a *business debt* case or a *consumer debt* case. Thus, this distinction between the two cases is already made. Even though the wealth exemption level is uniform for both cases, a differential treatment already exists in another dimension. The 'Bankruptcy Abuse Prevention and Consumer Protection Act' (BAPCPA) has introduced means testing. Households can file under Chapter 7 and keep assets up to the exemption level only if their income is below the median income in the state where they are filing. This means test applies only to consumers (workers) but not to entrepreneurs, see Elias and Laurance (2010).

Bankruptcy exemptions and entrepreneurship One of our main results is that allowing for secured borrowing affects the relationship between bankruptcy law and entrepreneurship. If only unsecured debt is allowed, welfare and entrepreneurship decrease with exemption levels. If secured credit is also allowed, we find that welfare and entrepreneurship have a hump-shaped relationship with exemption levels: they first increase with the exemption level and then decrease.

The heterogeneity of exemption across US states allows us, with all the limits of cross states empirical analysis, to confront the predictions of the two different models about the relationship between bankruptcy exemptions and entrepreneurship with the data. Using data form the Survey of Income and Program Participation (SIPP) panels, Fan and White (2003) show that entrepreneurship (measured as the probability of households owning businesses) is higher in states with unlimited rather than low exemptions. We complement these results using data from the Kauffman Foundation for 1996-1998, albeit with a different definition of entrepreneurs. In Figure 1 we report the relationship between bankruptcy exemptions and average self employment rate across U.S. states, together with a quadratic fit. The relationship is increasing for low exemptions and then decreasing.[5]

[4] Since our data are from before 2005, we model Chapter 7 as it was prior to the changes made by the BAPCPA in 2005.

[5] The exact exemption level where the turning point happens depends on the way we top-code the *unlimited exemption* However all the evidence we present is robust to different ways of top coding and to the exclusion of states with *unlimited exemption*.

Therefore the empirical evidence is consistent only with our model that allows also secured credit, but not with the model that allows only unsecured one.[6]

Entrepreneurial failure The U.S. Small Business Administration reports that according to the official data from the Administrative Office of the Courts for the period 1990–2005, on average about 1% of all entrepreneurs file for bankruptcy each year.[7] 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 large. 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.[8] In the baseline calibration, therefore, we set the default rate of entrepreneurs to 2.25%.

Secured credit The entrepreneur in our model obtains secured credit by pledging his business assets as collateral. As soon as an asset is pledged as collateral to secure a credit, the asset can neither be used to repay unsecured creditors nor be kept as an exempt asset. Using data from the Survey of Small Business Finances (SSBF) for 2003 we document some facts about the use of secured credit by small business in the US.[9] On average about 87% of total credit is backed by some kind of guarantee, either personal guarantees or real collateral. Focusing on real collateral we find that about 83% of total credit is backed by some real collateral (while about 43% has only real collateral without any personal guarantee). Then, we split the sample according to quintiles of firms' size (measured as total assets). For each quintile we measure the share of secured credit in total credit. While the use of secured credit is substantial along the whole size distribution (the lowest share is about 55% for middle sized firms), it is particularly important for the biggest

[6] A similar pattern emerges when estimating a non linear relationship, at the individual level, between self-employment status and exemptions controlling for all available individual characteristics. The results are reported in Table 4 in the Appendix.

[7] The U.S. Small Business Administration divides small firms into employer (i.e., with at least one employee) and non-employer firms. Since in the present paper we focus on entrepreneurs who own and manage the firm, we use only the data for employer firms. To ensure consistency between our three databases, when we use data from the Survey of Consumer Finances (SCF) and the Panel Study of Income Dynamics (PSID), we define entrepreneurs as business owners who manage a firm with at least one employee. See the data appendix for more details.

[8] Dun & Bradstreet (D&B) is a credit reporting and business information firm that 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 had 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 under report business bankruptcy cases at least by a factor of two.

[9] We restrict the sample to unlimited liability Proprietorships and Partnerships, but the results do not depend on this sample selection.

non-incorporated firms (92%) and, to a lesser extent for the smaller ones (67%). This empirical evidence underlines the substantial role for secured credit in small businesses financing. Therefore, we allow entrepreneurs in the model to obtain both unsecured and secured credit.

Secured credit in the model is backed only by firms' assets. This choice is motivated by the fact that in the data most of real assets used as collateral are business assets. Using again the SSBF survey we classify assets used as collateral as either owners private assets (owners real estate or other assets) or business assets (inventory or account receivables, vehicles or other business equipment, business securities or deposits, business real estate). Of the total credit backed by some real collateral about 80% is backed by some business assets and about 73% is backed by business assets but not by personal assets.[10]

3 The model

Our economy is populated by a unit mass of infinitely lived heterogeneous agents. At the beginning of every period, agents decide whether to become workers or entrepreneurs. An entrepreneur must decide how much to invest, how much to borrow secured and, if allowed to, how much to borrow unsecured. An entrepreneur who has defaulted on unsecured credit is excluded from unsecured credit for six years but is allowed to obtain secured credit. Since we focus on the implications of personal bankruptcy for entrepreneurs, workers are not allowed to borrow.[11]

Agents face idiosyncratic uncertainty, but there is no aggregate uncertainty. Agents' productivities evolve over time and entrepreneurs are subject to uninsurable production risk. After the shocks are realized, production takes place. At the end of the period, unsecured borrowers decide whether to repay or default and how much to consume and save. Anticipating entrepreneurs' behavior, banks set the interest rate for each unsecured loan taking into account the individual borrower's default probability. The remainder of this section presents the details of the model.

3.1 Credit and bankruptcy law

Agents can get two types of credit: secured and unsecured. Both types of credit are subject to a limited commitment problem.[12] After obtaining credit, all borrowers have two options: either start the entrepreneurial activity, or run away with a fraction λ of their liquid assets (that is, their own wealth plus the amount borrowed). If the agents start the entrepreneurial activity, the difference between the two kinds of credit is that secured

[10] Another source of collateral is the private home of an entrepreneur. An entrepreneur can take out a mortgage on his house and use the proceeds to invest in his company. We do not have durables in the model. But one can reinterpret the generic asset in the model as net wealth, which includes housing wealth, as long as there are no transaction costs for mortgages and house sales. If the entrepreneur has invested the proceeds of a mortgage on his house and is hit by a bad shock, he might have to sell the house to honor the mortgage debt. This reduces his net wealth by the same amount as if he had financed his business assets entirely with non-housing wealth.

[11] In Section 6 we show that our results are robust towards consumer borrowing.

[12] We introduce this limited commitment problem to obtain reasonable leverage ratios. We discuss its role in section 6.1.

credit must be repaid, while unsecured credit is subject to Chapter 7 bankruptcy procedure if the agent exercises their default option. In the event of a default, therefore, the agent still must repay their secured debt, while their unsecured debt is discharged. After repaying the secured debt, any assets in excess of the exemption level X are liquidated and the proceeds are collected by the creditors.

An agent who has defaulted in the past is excluded from the market for unsecured credit for a certain period of time, during which secured credit can still be obtained and the agent can thus become an entrepreneur. We call such an agent borrowing constrained and we denote such a credit status as BC. To avoid an additional discrete state variable, we model the exclusion period in a probabilistic way.[13] At the end of the period, every borrowing constrained agent, whether worker or entrepreneur, faces a credit status shock. With probability $(1 - \varrho)$, the agent remains borrowing constrained. With probability ϱ, the agent regain access to unsecured credit and becomes an unconstrained agent, with credit status UN.

3.2 Households

Our economy is populated by a unit mass of infinitely lived heterogeneous agents. Agents differ in their level of assets a, their entrepreneurial productivity θ, their working productivity φ, and their credit market status $S \in \{UN, BC\}$.

Preferences For simplicity, we abstract from the labor–leisure choice. All agents supply their unit of labor inelastically, either as workers or as entrepreneurs. In order to disentangle the effects of risk aversion from that of the elasticity of intertemporal substitution, we assume that agents have Epstein-Zin preferences. A stochastic consumption stream $\{c_t\}_{t=0}^{\infty}$ generates a utility $\{u_t\}_{t=0}^{\infty}$ according to

$$u_t = U(c_t) + \beta U\left(\mathbb{CE}_t\left[U^{-1}(u_{t+1})\right]\right),$$

where β is the discount rate and $\mathbb{CE}_t\left[U^{-1}(u_{t+1})\right] \equiv \Gamma^{-1}\left[\mathbb{E}_t\Gamma(u_{t+1})\right]$ is the consumption equivalent of u_{t+1} given information at period t. The utility function $U(c) = c^{1-\frac{1}{\psi}}/\left(1-\frac{1}{\psi}\right)$ aggregates utility over time and ψ is the intertemporal elasticity of substitution. The utility function $\Gamma(c) = c^{1-\gamma}/(1-\gamma)$ aggregates utility across states and γ is the coefficient of relative risk aversion.

Productivities Each agent is endowed with two stochastic productivity levels which are known at the beginning of the period: one as an entrepreneur θ, and one as a worker φ. We make the simplifying assumption that the working and entrepreneurial ability processes are uncorrelated.

Following the literature, we assume that labor productivity follows the AR(1) process

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

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

[13] This procedure is standard in the literature, see Athreya (2002) and Chatterjee et al. (2007).

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 assume a parsimonious specification in which entrepreneurial productivity follows a 2-state Markov process with $\theta^L = 0$ and $\theta^H > 0$ and transition matrix

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

in which there are three parameters, θ^H, p^{HH}, and p^{LL}, which are to be calibrated.

3.3 Technology

The entrepreneurial sector Each agent in the economy has access to a productive technology that, depending on that agent's particular entrepreneurial productivity θ, produces output according to the production function

$$\begin{aligned} Y &= \theta k^\nu \\ k &= \chi I \end{aligned}$$

where θ is the agent's persistent entrepreneurial productivity described above.

We assume that investment is subject to an *iid* idiosyncratic shock. Each unit of the *numeraire* good which is invested in the entrepreneurial activity is transformed into χ units of capital, with $log\chi \sim N(0, \sigma_\chi)$. This *iid* shock represents the possibility that an inherently talented entrepreneur (i.e., an agent with a high and persistent θ) 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 the total population. If their firms fail, they are very likely to start a new firm within a few years.

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 the capital and labor employed in this sector. Given perfect competition and constant returns to scale, the corporate sector does not generate any profits. Capital depreciates at the rate δ in both sectors.

3.4 Credit market

We assume that there is perfect competition and free entry to the credit market. Therefore, banks must make zero expected profits on any contract. The opportunity cost of lending to entrepreneurs is the rate of return on capital in the corporate sector. This is

also equal to the deposit rate.[14] Agents can get two types of credit: secured and unsecured. Secured credit represents collateralized borrowing. Thus, it is available at the risk free rate plus a small transaction cost ($r^s = r^d + \tau^s$). If the agent saves, secured credit is negative and ($r^s = r^d$). Unsecured credit incurs higher transaction costs ($\tau^u > \tau^s$), which reflect the higher costs of information acquisition. Both types of contracts are subject to the limited commitment constraint, and banks will never lend an amount so large that the agent would then certainly prefer to run.

There are no information asymmetries in the credit market: banks know the agent's assets, the amount that has been borrowed secured, and the agent's productivity. For any given value of (a, s, θ, φ) and for any amount of unsecured credit b, banks are able to calculate the probability of default and the recovery rate in case of default by anticipating the behavior of the entrepreneur. Perfect competition implies that they set the interest rate, $r(a, s, \theta, \varphi, b)$, so that they expect to 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, banks offer a menu of one period debt contracts which consist of an amount lent b and a corresponding interest rate $r(a, s, \theta, \varphi, b)$ to each agent with characteristics (a, s, θ, φ).

3.5 Timing

Figure 2 shows the timing of the model. Entrepreneurs' borrowing and default decisions are taken within the period. At the beginning of the period, all agents face the occupational choice of whether to become entrepreneurs or workers. Agents know their current productivities (φ, θ).

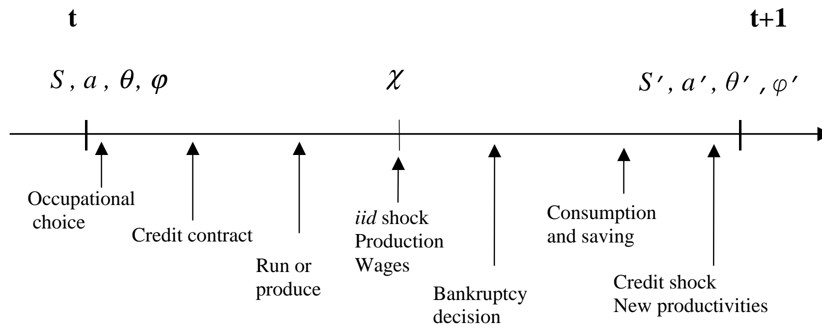


Figure 2: Timing of the model

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

The borrowing constrained entrepreneur chooses how much secured credit or whether to save and then decides whether to engage in production or run away with the liquid

[14] In our model, banks are equivalent to a bond market in which each agent has the possibility of issuing debt.

assets. All these decisions are taken before the *iid* shock χ is realized. After χ is realized and production has taken place, the entrepreneur chooses consumption and savings and at the end of the period receives the credit status shock.

The unconstrained entrepreneur can obtain secured credit s and unsecured credit b, and chooses capital stock before knowing χ, by deciding how much to borrow (or invest at rate r^d). Secured credit s can be obtained at the interest rate r^s and unsecured borrowing is done by choosing from the menu $\{b, r(a, \theta, \varphi, s, b)\}$ offered by the the banks. Similarly to the borrowing constrained entrepreneur, the unconstrained entrepreneur can take $a + b + s$ and run. And as before, banks will never lend an amount so large that the agent would then certainly prefer to run. After χ is realized and production has taken place, the entrepreneur must first repay the secured debt and then decide whether to repay the unsecured debt as well and be unconstrained in the next period (i.e., $S' = UN$) or whether to declare bankruptcy and be borrowing constrained for the next period (i.e., $S' = BC$). The choice of consumption and savings then comes after that.

Since the credit status S can take one of only two states BC and UN, we define the individual state variable to be (a, θ, φ), and solve for the two value functions $V^{UN}(a, \theta, \varphi)$ and $V^{BC}(a, \theta, \varphi)$, one for each credit status.

3.6 The problem of the borrowing constrained agent

The borrowing constrained agent can only obtain secured credit subject to the limited commitment constraint. At the beginning of the period such an agent can choose whether to become an entrepreneur, which yields utility $N^{BC}(a, \theta, \varphi)$, or a worker, which yields utility $W^{BC}(a, \theta, \varphi)$. Therefore the value of being a borrowing constrained agent with state (a, θ, φ) is

$$V^{BC}(a, \theta, \varphi) = \max\left\{N^{BC}(a, \theta, \varphi), W^{BC}(a, \theta, \varphi)\right\},$$

where the "max" operator reflects the occupational choice.

Workers At the beginning of the period borrowing constrained workers deposit all their wealth at the bank and receive labor income $w\varphi$. Consumption and saving is chosen at the end of the period, taking into account the future reception of a credit status shock in addition to productivity shocks. With probability ϱ such a worker will still be borrowing constrained in the next period, which yields utility $V^{BC}(a', \theta', \varphi')$, while the probability of becoming unconstrained is $(1 - \varrho)$, which yields utility $V^{UN}(a', \theta', \varphi')$. The saving problem is, then, the following[15]

[15] As discussed at the beginning of this section, our paper focuses on the role of Chapter 7 for entrepreneurs. Therefore, we do not allow agents to have negative assets across periods. Otherwise, it would become possible for a worker to accumulate debt and then become an entrepreneur only in order to obtain the possibility of defaulting. We examine we show that our results do not depend on this assumption in Section 6.

$$\begin{aligned} W^{BC}(a,\theta,\varphi) &= \max_{c,a'} \left\{ U(c) + \beta U\left(\mathbb{CE}\left[\varrho V^{BC}(a',\theta',\varphi') + (1-\varrho) V^{UN}(a',\theta',\varphi') \right] \right) \right\} \\ s.t.\ c + a' &= w\varphi + \left(1 + r^d\right) a \\ a' &\geq 0 \end{aligned}$$

Entrepreneurs At the beginning of the period, the borrowing constrained entrepreneur decides how much to borrow secured, and so, how much to invest in their firm $I = a + s$. Each unit of investment is transformed into $k = \chi I$ units of capital. The entrepreneur could take the money and run away with the fraction λ. If so, the utility is then given by[16]

$$\begin{aligned} \Upsilon[I,\theta,\varphi] &= \max_{c,a'} \left\{ U(c) + \beta U\left(\mathbb{CE}\left[V^{BC}(a',\theta',\varphi') \right] \right) \right\} \\ s.t.\ c + a' &= \lambda I \\ a' &\geq 0. \end{aligned}$$

After the shock χ is realized, the decision how to allocate the resources among consumption and savings will be made, and the consequent saving problem, after uncertainty is resolved,[17] is

$$\begin{aligned} \tilde{N}^{BC}(a,\theta,\varphi,\chi,s) &= \max_{a',c} \left\{ U(c) + \beta U\left(\mathbb{CE}\left[\varrho V^{BC}(a',\theta',\varphi') + (1-\varrho) V^{UN}(a',\theta',\varphi') \right] \right) \right\} \\ s.t.\ c + a' &= \left[\chi(a+s)\right]^{\nu} \theta + (1-\delta)\chi(a+s) - (1+r^s)s \\ a' &\geq 0. \end{aligned}$$

Therefore the optimal investment decision of the agent at the beginning of the period is

$$\begin{aligned} N^{BC}(a,\theta,\varphi) &= \max_{s} \left\{ U\left(\mathbb{CE}\left[\tilde{N}^{BC}(a,\theta,\varphi,\chi,s) \right] \right) \right\} \\ s.t.\ N^{BC}(a,\theta,\varphi) &\geq \Upsilon[a+s,\theta,\varphi], \end{aligned}$$

where the constraint is imposed by the banks. As discussed before, they would never offer a credit contract that violates the incentive compatibility constraint.

3.7 The problem of the unconstrained agent

At the beginning of the period, the unconstrained agent faces the occupational choice

$$V^{UN}(a,\theta,\varphi) = \max\left\{ W^{UN}(a,\theta,\varphi), N^{UN}(a,\theta,\varphi) \right\}$$

where $W^{UN}(a,\theta,\varphi)$ is the utility of becoming a worker and $N^{UN}(a,\theta,\varphi)$, that of becoming an entrepreneur.

[16] This outside option is available to the unconstrained entrepreneur as well.

[17] A value function superscribed by a tilde denotes that function after the uncertainty about χ is resolved. The value functions without a tilde are those before the uncertainty is resolved.

Workers 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. The saving problem is then

$$\begin{aligned} W^{UN}(a,\theta,\varphi) &= \max_{c,a'} \left\{ U(c) + \beta U \left(\mathbb{CE}_t \left[V^{UN}(a',\theta',\varphi') \right] \right) \right\} \\ s.t.\ c + a' &= w\varphi + \left(1 + r^d\right) a \\ a' &\geq 0. \end{aligned}$$

Entrepreneurs The unconstrained entrepreneur decides how much to invest, $I = a + b + s$, by choosing how much to borrow secured (or how much to save) and how much to borrow unsecured. If borrowing unsecured credit, the menu $\{b, r(a,\theta,\varphi,b,s)\}$ is offered by competitive banks. After the shock χ is realized, the choice is between whether to declare bankruptcy (default) or whether to repay, and how much to consume and save. This problem is solved backwards. If repaying the unsecured debt, the choice is how to allocate resources between consumption and savings. Given that the decision of repaying is taken when current productivities (θ,φ) and the shock χ are known, the utility from repaying is

$$\begin{aligned} \tilde{N}^{pay}(a,b,s,\theta,\varphi,\chi) &= \max_{c,a'} \left\{ U(c) + \beta U \left(\mathbb{CE} \left[V^{UN}(a',\theta',\varphi') \right] \right) \right\} \\ s.t.\ a' + c &= \theta \left[(a+b+s)\chi \right]^{\nu} + (1-\delta)(a+b+s)\chi - \cdots \\ &\quad -b\left[1 + r(a,\theta,\varphi,b,s,X)\right] - (1+r^s)s \\ a' &\geq 0 \end{aligned}$$

If defaulting, the unsecured debt is discharged, but the secured debt must be repaid and all assets in excess of the exemption level X are lost. Moreover, if defaulting, the agent's credit status will change to $(S' = BC)$, and any borrowing in the next period will be secured borrowing only. Therefore by declaring bankruptcy,

$$\begin{aligned} \tilde{N}^{bankr}(a,b,s,\theta,\varphi,\chi) &= \max_{c,a'} \left\{ U(c) + \beta U \left(\mathbb{CE} \left[V^{BC}(a',\theta',\varphi') \right] \right) \right\} \\ s.t.\ a' + c &= \min\left\{ \theta \left[(a+b+s)\chi \right]^{\nu} + (1-\delta)(a+b+s)\chi - (1+r^s)s, X \right\} \\ a' &\geq 0 \end{aligned}$$

is received.

Bankruptcy will be declared if $N^{bankr}(a,b,s,\theta,\varphi\,\chi) > N^{pay}(a,b,s,\theta,\varphi,\chi)$, and vice versa. Thus, at the beginning of the period, the agents choose the optimal amount of b from the menu $\{b, r(a,\theta,\varphi,b)\}$ and the optimal s anticipating their future behavior. Therefore their utilities are given by

$$\begin{aligned} N^{UN}(a,\theta,\varphi) &= \max_{b,s} \left\{ U \left(\mathbb{CE} \left[\max \left\{ \tilde{N}^{pay}(a,b,s,\theta,\varphi,\chi), \tilde{N}^{bankr}(a,b,s,\theta,\varphi,\chi) \right\} \right] \right) \right\} \\ s.t.\ N^{UN}(a,\theta,\varphi) &\geq \Upsilon\left[a + s + b, \theta, \varphi\right] \end{aligned}$$

where the “max” operator inside the square brackets reflects the bankruptcy decision, and the “max” operator outside the square brackets reflects the borrowing decision. The last equation represents the limited commitment constraint.

3.8 The zero profit condition of the banks

Banks observe the state variables (a, θ, φ) at the moment of offering the contract. There is perfect competition (free entry) in the credit market, and therefore the banks make zero profit on each secured and unsecured loan contract. The bank is, therefore, indifferent between issuing secured and unsecured loans. For each unit of secured credit, the bank knows that the agent will repay for sure: free entry will push the interest rate on secured credit to the risk free rate plus the transaction cost τ^s. For any given state (a, θ, φ) and for any given amount of secured borrowing s and for any unsecured loan b, the bank knows in which states of the world the agent will file for bankruptcy. Therefore, it is able to calculate the probability that a certain agent with characteristics (a, θ, φ), and secured loan s, will default for any given amount b. This default probability, $\pi(a, \theta, \varphi, b, s)$, depends on the exemption level X, since this directly affects the incentive to default.

If the agent repays, the bank receives the outstanding repayment. If the agent defaults, the bank obtains all assets in excess of the exemption level, however, not more than the amount borrowed. If these assets are below the exemption level, the bank obtains nothing. Thus, the zero profit condition of the banks is

$$\left(\begin{array}{c} \left[1 - \pi(a, \theta, \varphi, b, s)\right]\left[1 + r(a, \theta, \varphi, b, s)\right] b + \\ + \pi(a, \theta, \varphi, b, s) \\ \min\left[b, \max\left\{\theta\left[\chi I\right]^{\nu} + (1-\delta)\chi I - \left(1 + r^d\right) s - X, 0\right\}\right] \end{array} \right) = (1 + r^d + \tau^u) b,$$

where $I = a + b + s$.[18]

3.9 Equilibrium

Suppose $\eta = (a, \theta, \varphi, S)$ is a state vector for an individual, where a denotes the assets, θ the entrepreneurial productivity, φ the working productivity, and S the credit status. From the optimal policy functions (occupational choice, savings, capital demand, and 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 space, provides the next period distribution $\mu'(\eta)$. A stationary equilibrium is then given by

- a deposit rate of return r^d and a wage rate w;
- an interest rate function;
- a set of policy functions $g(\eta)$ (consumption and saving, secured and unsecured borrowing, capital demand, bankruptcy decisions, and occupational choice);

[18] We also assume that banks impose an endogenous borrowing limit that prevents entrepreneurs from signing credit contracts which would imply a default probability of 100%.

- a constant distribution over the state space η, $\mu^*(\eta)$;

such that, given r^d and w and a bankruptcy regime (X, ϱ):

- $g(\eta)$ solves the maximization problem of the agents;
- the corporate sector representative firm is optimizing;
- capital, labor and goods market clear:
  - capital demand comes from both entrepreneurs and the corporate sector, while supply comes from the saving decisions of the agents;
  - labor demand comes from the corporate sector, while labor supply comes from the occupational choices of the agents;
- the interest rate function 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 is presented in the Appendix.

4 Results

4.1 Parametrization

Preference parameters In the baseline model, the coefficient of relative risk aversion σ is set to 2 and the elasticity of intertemporal substitution ψ is set to 0.9.[19] Panel A of Table 1 summarizes the preferences parameters.

Bankruptcy parameters In the model, the U.S. bankruptcy system is characterized by two parameters: the exemption level X and the probability ϱ of being able to obtain unsecured credit again. Following the discussion in Section 2, we set $X = \$47,800$. Given that the average household labor income is \$48,600, this corresponds to a value of 0.98 for the ratio of exemption to average labor income. Individuals can file for Chapter 7 bankruptcy only once every six years. Therefore, we set $\varrho = 1/6$. Panel B of Table 1 summarizes the bankruptcy parameters.

[19] We investigate the robustness of our results to values of σ ranging from 3 to 5 and ψ ranging from 0.75 to 1.1 in Section 5.3 below.

Table 1: Fixed parameters

Panel A: Preferences

Parameter	**Symbol**	**Value**
CRRA	σ	2
IES	ψ	0.9

Panel B: Bankruptcy

Parameter	**Symbol**	**Value**
Exemption/wage	X/w	0.98
Unsecured credit exclusion (expressed as probability)	ϱ	1/6

Panel C: Other parameters

Parameter	**Symbol**	**Value**
TFP	A	1 (normalization)
Share of capital	ξ	0.36
Transaction cost secured credit	τ^s	0.01
Transaction cost unsecured credit	τ^u	0.04
Depreciation rate	δ	0.08
Earnings: autocorrelation	ρ	0.95
Earnings: variance of innovation	σ_ε^2	0.08125

The preference parameters are standard values. Different values are examined in Section 5.3. The bankruptcy related parameters are based on Chapter 7 of the U.S. bankruptcy code. Production parameters are standard. Earnings parameters are based on Storesletten, Telmer, and Yaron (2004). The cost of credit are based on Evans and Schmalensee (1999)

Other fixed parameters Following the standard practice in the literature, we try to minimize the number of parameters we match to the data using the model. We therefore select parameter values from estimates in the literature whenever possible. The total factor productivity A is normalized to 1. The share of capital in the Cobb–Douglas technology for the corporate sector ξ is set to 0.36. The depreciation rate δ is set to 0.08. We choose the auto-regressive coefficient of the workers' earnings process ρ to be 0.95.[20] The variance of the innovation in the earnings process is chosen to match the Gini index of labor income as observed in the PSID, which is 0.38.[21] The process is approximated using a four state Markov chain, using the Tauchen (1986) method as suggested by Adda and Cooper (2003). The intermediation cost of unsecured credit τ^u is set to 4%. This is based on evidence of credit card borrowing by Evans and Schmalensee (1999). The intermediation cost of secured credit τ^s is set to 1%.[22] These parameters are summarized in Panel C of Table 1.

Calibrated parameters The remaining seven parameters are chosen jointly so that the model matches seven moments of the U.S. economy as to entrepreneurship, default, and the wealth distribution. The discount factor β helps to match the capital–output ratio of the U.S. economy, which is 3.1. The persistence of the low entrepreneurial productivity state p^{LL} captures the fraction of entrepreneurs in the total population, which is 7.3% in the Survey of Consumers Finances.[23] The persistence of the high entrepreneurial productivity state p^{HH} helps to match the exit rate of entrepreneurs, which is equal to 15% in the PSID. The fraction of cash on hand with which an agent can run away, λ, helps to match the median leverage ratio of entrepreneurs of 37.4%.[24]

The variance of the transitory shock σ_χ helps to match the default rate of entrepreneurs. Given the discussion in Section 2, we set this equal to 0.164% of the total population. The high value of entrepreneurial productivity θ^H and the concavity of the entrepreneurial production function ν are important for matching some characteristics of the wealth distribution, since the benefits of bankruptcy depend crucially on the wealth of the agent. The U.S. wealth distribution is extremely skewed: we match the share of total wealth held by the 40% richest households, which is about 94%. Moreover, entrepreneurs are significantly richer than workers: we match the ratio of the median wealth of entrepreneurs to the median wealth in the whole population, which is 6.3 in the SCF. Panel A in Table 2 gives the values of the calibrated parameters in the baseline specification of the model. The targets are summarized in the third column of Panel B in Table 2.

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

[21] 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.

[22] This corresponds to the difference between the one year mortgage and the one year Treasury Bill rate during the 1990s, Federal Reserve Economic Data.

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

[24] This corresponds to the average of the value in the SCF and the SSBF.

Table 2: Calibration

Panel A: Calibrated parameters

Parameter	**Symbol**	**Value**
High entrepreneurial productivity	θ^H	0.693
Entrepreneurial productivity transition	p^{HH}, p^{LL}	0.878 , 0.988
Concavity of entrepreneurial technology	ν	0.849
Fraction with which agent can run	λ	0.943
Discount factor	β	0.883
Variance of transitory shock	σ_χ	0.269

Panel B: Baseline calibration targets

Parameter	**Data**	**Model**
Fraction of Entrepreneurs (in %)	7.3	7.3
Ratio of medians	6.3	6.3
Share of net worth of top 40%	94.0	96.6
Capital–Output ratio	3.1	3.1
Exit Rate (in %)	15.0	15.5
Bankruptcy Rate (in %)	0.164	0.164
Median leverage (in %)	37.4	37.6

The data targets for the fraction of entrepreneur, ratio of medians and share of net worth are from the Survey of Consumer Finances. The exit rate is based on the Panel Study on Income Dynamic, while the bankruptcy rate is from the U.S. Small Business Administration. Finally, leverage is from the Survey of Consumer Finances and the Survey of Small Business Finances.

4.2 Baseline calibration results

Panel B in Table 2 has the values of the targets from the data and the actual results achieved in the baseline specification of the model. Overall, the model matches the targets very well.

The model captures several other features of the U.S. economy that were not explicitly targeted, in particular concerning entrepreneurship and credit. The marginal product of capital in the corporate sector (r^d) is 3.8%, which is close to the 4.0% reported by McGrattan and Prescott (2001). Quadrini (2000) reports that about 35%–40% of total capital is invested in the entrepreneurial sector. In our baseline specification, this fraction is slightly higher, around 42.9%.

The model captures two important features concerning the wealth distribution: entrepreneurs are several times richer than workers, and most of the wealth is held by the richest agents. The Gini coefficient for wealth is 0.88, a bit higher than in the data where it is 0.8.[25] However, for the purpose of our policy experiments, it is important that the model replicates the middle and lower part of the wealth distribution, since the personal bankruptcy law mainly affects these agents.[26] Slightly more than 50% of the agents have assets less than 2. For agents with high entrepreneurial ability, this fraction is only 25%, smaller but still significant. In the model, the fraction of agents with zero wealth is 12.8%, while it is 9.8% in the data. Moreover, entrepreneurs, in the model, hold 37.7% of the wealth, close to the 36.6% they hold in the data.

About 98.2% of the entrepreneurs in the model borrow, whereas in the data, 86.1% do so. In the model, about 99% of borrowing is secured credit, whereas in the data, 87% is secured credit.[27] The shocks hitting entrepreneurs must have a high variance in order to generate the defaults in the model. This implies a wide dispersion of income and large capital gains and losses. The median debt to income ratio in the model is 1.04, while in the data, it is only 0.78. The median income to net worth ratio in the data is 0.15. The corresponding ratio in the model is 0.09 if capital gains are not counted as income and 0.35 if they are included.

4.3 Investigating the model's mechanisms

The behavior of the unconstrained agents Figure 3 shows the decisions of unconstrained agents.[28] The top panel shows the demand for unsecured debt.[29] The second panel shows the demand for secured debt. The third panel shows the corresponding price of unsecured credit. The bottom panel shows the resulting firm size.

In the model, otherwise identical agents choose different occupations, according to their wealth: poor agents become workers, as those in region (1) in Figure 3, while richer

[25] If not otherwise stated, the empirical moments are from the SCF and described in detail in the data appendix.

[26] We show a graph of the cumulative wealth distribution of the model in the Appendix.

[27] The share of secured credit in the model is so high because the cost difference between unsecured and secured credit is three percentage points. A smaller cost difference would lead to a higher fraction of unsecured credit because this would then become cheaper.

[28] These agents have high entrepreneurial productivity and low labor productivity.

[29] The discretization of the shock process leads to spikes in the policy functions. Since these spikes are not informative, we show smoothed policy functions in Figure 3. The unsmoothed policy functions can be found in the appendix.

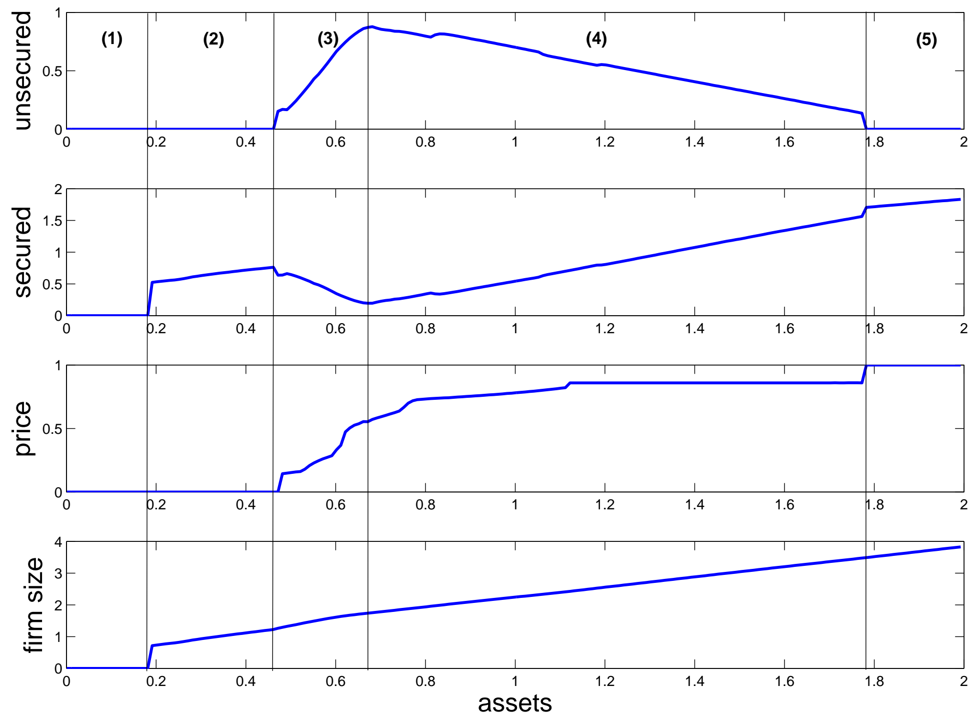


Figure 3: Decision of the unconstrained agent ($\theta = \theta^H$,$\varphi = \varphi_1$). The figure shows the policy functions of an agent who has not defaulted. The top two panels show the amount he borrows unsecured b and secured s, respectively. The third panel shows the price at which he borrows unsecured. The last shows the firm size k, which is $k = a + b + s$.

agents become entrepreneurs, regions (2)–(5).[30] The main reason is that poor agents face worse credit conditions as they are more likely to default. This leads them to have small firms, so that they prefer to be workers.

Regions (2) to (4) are the key innovation of our paper. In region (2), entrepreneurs are poor and therefore have a strong incentive to default. Their default incentive is high because even in good states it is likely that they would benefit from filing for bankruptcy since all or most of their assets are below the exemption level. This high default incentive increases the cost of credit so much that they are effectively rationed out of the unsecured credit market. In models with only unsecured credit, this would imply that they can only self-finance, leading in turn to their firms' being too small, so that most of them would prefer to become workers.

Since we also allow for secured credit, this does not happen. Instead, they borrow secured, which leads to larger firms, which in turn makes entrepreneurship more attractive to them. Borrowing secured is not as good as borrowing unsecured, since secured credit does not provide any insurance. But it is better than not borrowing at all and only having a small firm. In region (2), secured borrowing allows agents to have bigger firms and therefore they choose to become entrepreneurs.

Entrepreneurs in region (3) are richer, and therefore have a lower default incentive. Thus, they can obtain some unsecured credit. They will default on this debt when they are hit by a sufficiently bad shock. In order to break even, the bank charges a higher interest rate and unsecured credit is more expensive. The interest rate depends negatively on the assets of the entrepreneur because in the event of a default, the bank will be able to seize the difference between the assets of the entrepreneur and the exemption level. The capital demand of these entrepreneurs is increasing because their cost of borrowing is declining, as can be seen in the third panel of Figure 3.

The richer are the agents in region (3), the more they borrow overall. But they also replace secured credit by unsecured credit even though the latter is more expensive. This is because unsecured credit provides them with valuable insurance against bad outcomes. Thus, the portfolio share of unsecured credit increases. Unsecured credit reaches its maximum at the border with region (4), where agents reverse this debt portfolio composition because default becomes ever more costly to them since they have to give up their wealth above the exemption level in the case of a default. The share of unsecured credit declines continuously within region (4). The very rich entrepreneurs in region (5) will never find it profitable to default. Their wealth is so high that defaulting is too costly for them. Therefore they borrow only secured, since it is cheaper than unsecured.

The importance of these policy functions depends on the mass of agents in this part of the state space. As mentioned above, 25% of the agents with high entrepreneurial productivity have assets between 0 and 2.[31] In addition, 57% of agents who have currently a low entrepreneurial productivity ability level but who might receive a positive shock next period also have assets between 0 and 2. Thus, more than one half of the population is in the relevant part of the state space.

[30] This is a standard result in the literature about occupational choice under credit market imperfections (e.g. Banerjee and Newman, 1993).

[31] While Figure 3 pertains to agents with labor productivity $\varphi = \varphi_1$, Figure 4 shows that this matters at $\varphi = \varphi_2$ as well.

The role of bankruptcy Bankruptcy affects the problem of the unconstrained agents, because it changes credit conditions and the amount of insurance available. We examine these effects with the following experiment: we compare the behavior of the unconstrained agents in two different situations, the baseline calibration and one in which exemption is zero so bankruptcy is so costly that nobody defaults. Figure 4 shows the policy functions in these situations.

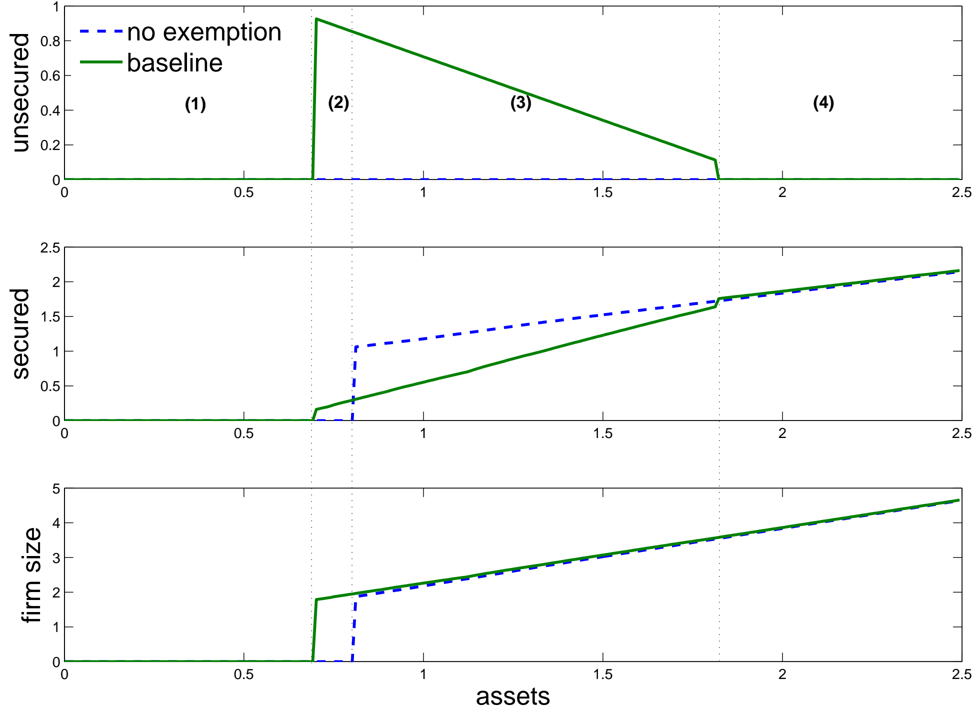


Figure 4: Effects of bankruptcy ($S = UN, \theta = \theta^H, \varphi = \varphi_2$). The figure shows the policy functions of an agent who has not defaulted under two different exemption levels. When the exemption level is zero, the agent does not borrow unsecured. When the exemption level is positive, unsecured credit is available and the agent chooses entrepreneurship already at lower asset levels.

The effects of bankruptcy depend on the wealth of the agent. First, the default behavior of rich agents, as in region (4) of Figure 4, 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, a more generous bankruptcy affects the behavior of the less rich agents, region (3). They are entrepreneurs in both situations. But when bankruptcy is not too costly, they replace part of their secured borrowing by unsecured borrowing. If they are hit by a bad shock, they default, and can keep assets up to the exemption level. This partial wealth insurance can enable them to remain entrepreneurs in the next period. Even though they are excluded from the unsecured credit market now, they might be left with sufficient wealth to remain entrepreneurs. This is the *fresh start* effect of Chapter 7, and

is explored further in the following sections.

Third, the occupational choice of even less rich agents, region (2), is also affected. When bankruptcy is too costly, they are not insured against bad outcomes. Therefore they do not want to borrow, even though they could borrow at the rate for secured credit. They become workers instead. When bankruptcy is feasible, they are insured against bad outcomes and they borrow, even though they have to pay a high interest rate. This increases the rewards of entrepreneurship enough to change their occupational choice.

Fourth, the occupational choice of the very poor agents, region (1) is not affected: they are workers in both situations.

In this particular experiment, a harsh bankruptcy law 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.[32]

5 The policy experiment and the role of secured credit

In this section, we first present the results of changing the exemption level in the baseline model where secured credit is available. We find that the optimal wealth exemption level is high. In subsection 5.2, we show that this results depends crucially on the presence of secured credit. If secured credit was not available, the optimal exemption level would be low. In subsection 5.3 we discuss the role of preferences and, finally, in subsection 6, we also discuss some of our modeling choices and show that our results do not change when we also include consumer borrowing and default.

5.1 The policy experiment

Our main policy experiment is to analyze the effects of changing the exemption level on the steady state equilibrium of the model. The aggregate effects of changing the exemption level are shown in Figure 5. In addition, Table 3 shows the results for five values of the exemption level.

Welfare Welfare is measured as the change in consumption equivalent[33] and is shown in the top left panel. The solid line in the top left panel of Figure 5 shows the steady-state comparison. The current exemption level in the U.S. is too low. Increasing the exemption increases welfare as the insurance effect dominates the effects of the worsening credit market condition. More agents become entrepreneurs (middle left panel) and welfare increases. However, increasing the exemption level beyond $X = 7.1$ reduces welfare. The welfare gains from increasing the exemption level to the optimal are substantial: about 1.2% of annual consumption.

Welfare increases for the rich, measured as the top quartile of the wealth distribution, and the poor, measured as the bottom quartile, as can be seen in the last two rows of

[32] However, the general equilibrium effects depends also on the steady state distribution and can not be derived from this graph.

[33] This means, for example, that reducing the exemption level to zero lowers welfare as much as a decrease in annual consumption of 0.15%.

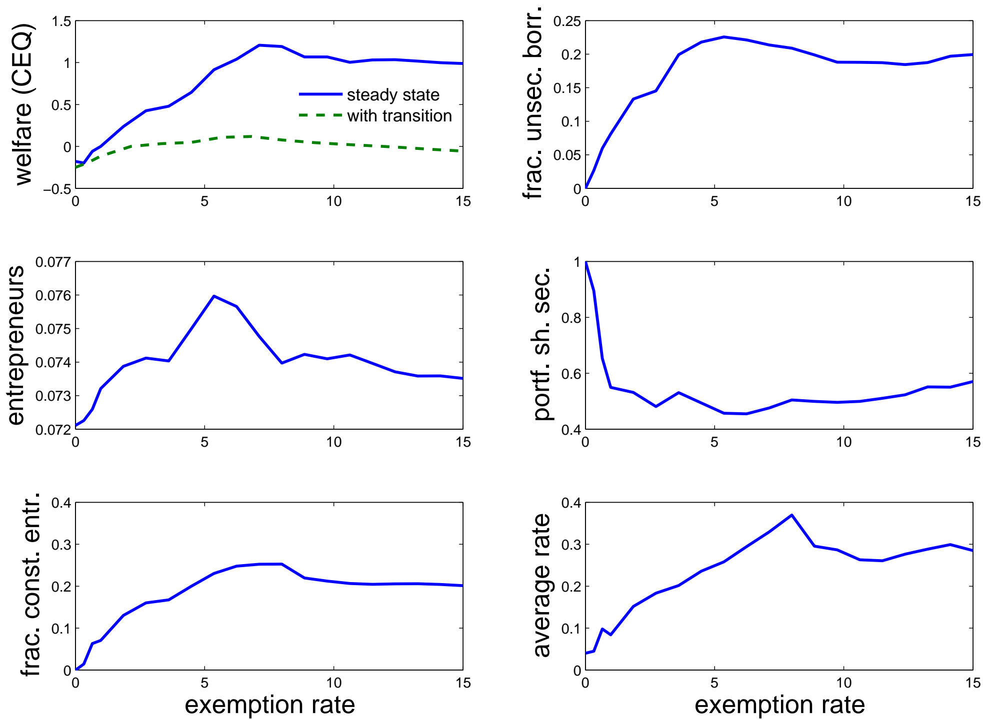


Figure 5: Changes in the exemption levels. The figure shows how several important variables vary with the exemption level. Welfare and the fraction of entrepreneurs are both hump-shaped in the exemption level.

Table 3. However, the bulk of the welfare gains accrue to the rich because at higher exemption levels, richer agents will use the default option to partially insure their wealth.

Table 3: Effects of changes in the exemption level

X/W	**0**	**0.98**	**4.485**	**7.11**	**10.619**
Exit rate	16.05	15.49	15.23	14.39	15.5
Fraction of entrepreneurs	7.211	7.321	7.499	7.476	7.421
Default rate	0	0.164	0.472	0.564	0.456
Capital-output ratio	3.09	3.09	3.08	3.083	3.08
Ratio of medians	6.5	6.3	6.2	7.1	7.9
Share of capital in entr. sector	42.82	42.86	43.21	43.51	43.49
Min. wealth for entr: $\varphi = \varphi_1$	0.2312	0.1912	0.2112	0.2212	0.2312
Min. wealth for entr: $\varphi = \varphi_3$	1.733	1.713	1.572	1.662	1.673
Welfare poor	-0.32	0	0.23	0.46	0.18
Welfare rich	-0.010	0	0.932	2.46	2.42

This table shows the main policy experiment. The baseline value for the exemption level is 0.98.

In order to investigate how far these welfare changes depend on general equilibrium effects or the absence of transitional dynamics, we investigate two further scenarios. First, we repeated the same policy experiment without imposing capital market clearing, therefore leaving the marginal product of capital constant. Welfare is almost identical to the steady state scenario and is not shown in the graph.

Second, following Domeij and Heathcote (2004), we computed welfare taking into account the transition phase from the old to the new steady state. This changes the size of the welfare effects significantly, as shown by the broken line in the top left panel of Figure 5. The welfare gain falls significantly to 0.12% of annual consumption.[34] However, and most importantly, the optimal exemption level is hardly affected. It falls only to $X = 6.8$.

However, the fact that the poor do not lose from a higher exemption level is in contrast to the literature, for example Akyol and Athreya (2011). Typically, a more generous exemption level leads to credit rationing of poor agents. However, if secured credit is available, they are not rationed out of all borrowing, only out of the unsecured credit market. Losing access to all credit imposes a first order welfare loss, losing only the insurance value of the default option but still obtaining (secured) credit is only a second order welfare loss. Further evidence for the importance of secured credit will be discussed in Section 5.2.

Entrepreneurship and the credit market Increasing the exemption level to the optimal level increases the fraction of entrepreneurs by 0.31 percentage points. Thus, there is a positive extensive margin, as can be seen in the middle left panel of Figure 5.

[34] Welfare gains are smaller because the many poor agents fare a lot worse than the few rich during the transition. In the final steady state, the capital-output ratio is higher. This implies that capital is accumulated during the transition, i.e. interest rates increase and wages decrease during the transition. These changes in factor prices benefit only those who were rich in the initial steady state and are detrimental to the poor whose main source of income is labor income.

There is a related important effect of Chapter 7 bankruptcy: the *fresh start* effect: by allowing defaulters to keep more of their wealth, Chapter 7 makes it easier for agents to remain in entrepreneurship in the following periods. The quantitative importance of this effect is shown in the bottom left panel of Figure 5. The fraction of entrepreneurs who have defaulted in the past increases from zero to more than 20% of all entrepreneurs.

This evidence is further corroborated by the top right panel of Figure 5, which shows that the fraction of entrepreneurs who borrow unsecured first increases and then levels off. This implies that an increasing fraction of entrepreneurs gain the benefit of partial wealth insurance. The middle right panel shows that out of those entrepreneurs who borrow unsecured, the debt portfolio share is relatively constant, at about one half. As the exemption level is increased, more entrepreneurs borrow unsecured at a constant fraction. If they default, they can keep more of their assets. Therefore, an increasing fraction of failed entrepreneurs who have defaulted can remain entrepreneurs.

However, as can be seen by comparing the top left and the middle left panels of Figure 5, the entrepreneurship rate peaks earlier than welfare. This implies that also the intensive margin is important in explaining the welfare results. Indeed, the sixth row of Table 3 shows that the fraction of capital employed in the entrepreneurial sector peaks at the optimal exemption level.

The default rate, third row of Table 3, is hump-shaped in the exemption level, as is the mean interest rate, bottom left panel of Figure 5. The exit rate, however, is U-shaped, fourth row of Table 3. The reason for the declining part is the *fresh start* effect. Agents who have defaulted keep enough assets to remain entrepreneurs despite being excluded from the unsecured credit market. The increasing part at very high exemption levels is due to the fact that now more entrepreneurs are excluded from the unsecured credit market since their default incentive is too high. This is consistent with the decline in the default rate in columns six and seven of the third row in Table 3. If those entrepreneurs who are excluded from the unsecured credit market are hit by a bad shock, their wealth is not insured. Thus, they have insufficient wealth in the next period to remain entrepreneurs, and therefore they exit.

5.2 The role of secured credit

Almost all papers in the personal bankruptcy literature allow only unsecured borrowing.[35] Notable exceptions are Athreya (2006), Pavan (2008), and Hintermaier and Koeniger (2011) in the consumption literature: the latter two papers introduce a durable good which can be used as collateral and focus on this; Athreya (2006), like us, has only one good and allows agents to borrow secured up to an exogenous limit whereas in our model the limit is endogenous. It is the amount of pledgeable end of period income and assets. However, none of these papers identifies how the presence of secured credit alters the trade-off between insurance and credit market conditions.

In this section, we report the results from a model identical to the one discussed so far except that there is no secured credit available, neither for the borrowing constrained nor for the unconstrained entrepreneur. This implies that the former cannot borrow at all

[35]See for example Akyol and Athreya (2011), Meh and Terajima (2008), Athreya (2002), Livshits et al. (2007), Chatterjee et al. (2007), Athreya and Simpson (2006), Li and Sarte (2006), Mateos-Planas and Seccia (2006).

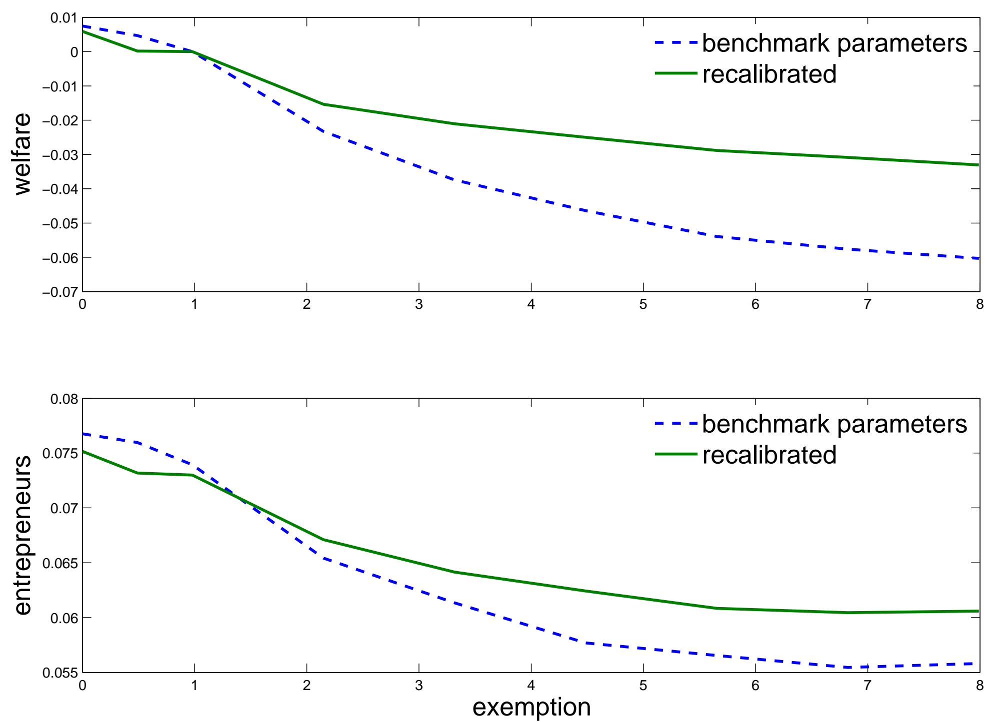


Figure 6: Welfare effects of changes in X if only unsecured credit is available. The figure shows welfare and entrepreneurship in a restricted model without secured credit. It shows two cases: one in which we use the benchmark parameters and one in which we recalibrate all parameters to the same targets. The optimal exemption level is zero in both cases.

and must finance their projects with their own wealth. We will recalibrate the model to exactly the same targets and conduct the same policy experiment as before. The results in Figure 6 (solid lines) are striking. The optimal bankruptcy law now would be to set the exemption level to zero. This would increase welfare and lead to a higher number of entrepreneurs.[36]

Next, we investigate what happens if we take the parameters calibrated for the model without secured borrowing and use them in a model which allows secured borrowing. Since the financial market is now relatively more complete, we see that there the rate of entrepreneurship increases from 7.30% to 7.65% and the default rate of entrepreneurs increases from 2.25% to 2.75%. The reason for these aggregate results can be seen in Panel A of Figure 7, which shows the policy functions in both situations. The solid line corresponds to the situation when only unsecured credit is available. Therefore, secured borrowing is zero in the bottom panel. The broken line, which is computed for the same parameters, corresponds to the situation when both unsecured and secured credit are available. The unconstrained agents in region (1) are workers, whether or not secured credit is available. Similarly, in region (3), they are entrepreneurs. However, agents in region (2) do not obtain sufficient unsecured credit because their default incentive is too high. If secured credit is not available, these agents become workers. However, if secured credit is available, these agents can borrow secured and become entrepreneurs.

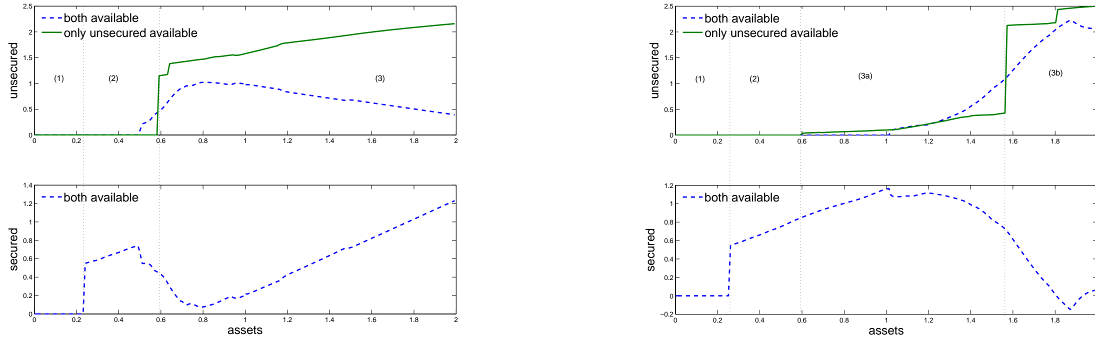
Panel B of Figure 7 shows the effects of increasing the exemption level to $X = 2.15$ in both cases. Without secured credit, the increase in the exemption level worsens the credit conditions for many more agents, region (3a). Thus, agents in this region obtain only a small amount of credit. This leads to a significant decline in firm size, a negative intensive margin. The effects of an increase in the exemption level differ markedly when secured credit is available, the broken lines in Panel B of Figure 7. While unsecured credit behaves similarly, agents now borrow a lot more secured, so that the negative intensive margin is significantly smaller. Thus, the availability of secured credit dampens the negative extensive and intensive margin substantially.

The absence of a negative extensive margin when secured credit is available can also be seen in the third and fourth to last rows in Table 3. These show the critical level of wealth at which agents enter into entrepreneurship. This threshold is increasing in labor productivity because the agents' outside option is increasing in their wage income. However, conditional on labor productivity, this critical threshold does not change much even for large changes in the exemption level.

The two other quantitative general equilibrium models in the entrepreneurial bankruptcy literature (Akyol and Athreya, 2011; Meh and Terajima, 2008) find significant welfare gains from making the bankruptcy law harsher. But none of them includes secured credit. Our results imply that their results might not be robust to including secured borrowing, as ignoring secured credit overstates the negative effects of high exemption levels.

Generally, the main negative effect of a generous bankruptcy law is that it makes credit more expansive. This is particularly true for poor agents who might be priced out of the market entirely. If secured credit is ignored, this leads to an inability to borrow at all, leading to a first-order welfare loss. If secured credit is allowed, this negative effect is

[36] This result is not driven by the recalibration. The broken line in Figure 6 shows the results of the same policy experiment in the model without secured credit using the benchmark parameters from Table 2. Again, it would be optimal to set the exemption level to zero.



(a) Baseline exemption level.

(b) High exemption level.

Figure 7: Policy functions for two exemption levels. The left panel shows that agents enter entrepreneurship at lower levels of wealth when secured credit is available. The right panel shows that entrepreneurs cannot borrow a lot unsecured credit under a high exemption level. However, if secured credit is available, they borrow secured. Therefore, they enter entrepreneurship at a lower wealth level.

substantially weakened because these agents can still borrow secured, even though they loose the insurance benefit. These considerations apply not only to entrepreneurial default but also to consumer default. therefore, we suspect that many positive and normative results in the literature are biased towards a too harsh bankruptcy law.

5.3 The role of preferences

In this subsection, we show the effects of changing the agents' preferences on our main results. We separate the elasticity of intertemporal substitution from the coefficient of relative risk aversion. With a utility function of the CRRA class, one is the inverse of the other. In this case, an increase in risk aversion, as, for example, examined in Athreya (2006), conflates two effects. On the one hand, since agents are more risk averse, they value insurance more, so the optimal exemption level is likely to be higher. On the other hand, with CRRA preferences, an increase in risk aversion simultaneously lowers the elasticity of intertemporal substitution. Thus, agents are less willing to transfer consumption across time. But a higher exemption level will increase the interest rate agents face because banks have to charge higher interest rates in order to break even. Thus, a decrease in the elasticity of intertemporal substitution is likely to lead to a lower optimal exemption level. By not separating the two, one examines only their net effect. It is possible that each of these two effects is big but that they cancel each other so that the net effect is small.

We recalibrate the steady state of the model for different values of both parameters and for each case we solve for the optimal exemption level. First, we vary the coefficient of relative risk aversion (CRRA) while keeping the elasticity of intertemporal substitution (EIS) constant. We find that the more risk averse are the agents, the more they value the insurance coming from a higher exemption level. Thus, for a CRRA equal to 4, the optimal exemption level increases to 7.75, while for CRRA equal to 5, the optimal

exemption level increases further to 9.1. Second, the optimal exemption level is also increasing in the elasticity of intertemporal substitution. The more willing are the agents to substitute consumption over time, the less costly are the higher interest rates coming from a higher exemption level. If we lower the EIS to 0.6, the optimal exemption level decreases to 7.0, while for EIS equal to 1.1, the optimal exemption level increases to 8.6.

6 Discussion and robustness

The main result of the paper is that the optimal bankruptcy exemption level is high when secured credit is available. In this section we show that this result does not depend on the details of the modeling strategy for secured credit (subsection 6.1) and that a high exemption level is still optimal even when consumers can borrow and default too (subsection 6.2).

6.1 Alternative modeling of secured credit

In our baseline model secured credit has two particular features: it is subject to a limited commitment constraint and cannot be defaulted on.[37] We discuss these two assumptions in turn and provide robustness checks that show they are not crucial for our results.

Limited commitment constraints In our model both secured and unsecured credit are subject to a limited commitment problem. The entrepreneur can potentially sell the capital that is pledged as collateral and run with a fraction of it. The limited commitment problem for secured credit is not necessary since the impossibility for the entrepreneur to default on secured credit yields an implicit credit limit for secured credit.[38] Indeed when we assume that the entrepreneur can only run away with unsecured credit but not with secured credit, our results stay qualitatively the same. The optimal exemption level is still higher than the current one. However the optimal exemption level is 5.3 slightly lower than in the baseline. The main reason why the results do not change significantly is that the two constraints are rather similar. Since the entrepreneur has to repay secured debt, there is an endogenous borrowing limit that is not far from the one implied by the limited commitment problem.

The limited commitment problem on unsecured credit is needed to prevent unrealistically large leverage ratios. Heaton and Lucas (2002) show that entrepreneurial models without information asymmetries generate very large leverage ratios. This would happen in our model as well. While it is true that an endogenous borrowing limit arises automatically in models with consumer default, this is not true in our model. The key difference is that for consumers the amount borrowed does not influence their income in the next period. Thus, higher borrowing leads to higher repayment needs which for any

[37]In addition, we allow credit to be secured not only by assets but also by the future income realization for the entrepreneurs. The reason is that under full information banks can predict the behavior of their borrowers conditional on the income realization. Thus, we take the sum of pledgeable assets and income as collateral. However, if we exclude future income and allow credit to be secured only by the assets, our results for the benchmark parameters hardly change. The reason is that income from production is relatively small compared to undepreciated capital.

[38]We are grateful to a referee for pointing this out.

given income can lead to an increase in the incentive to default. Instead, in our model, the income of the entrepreneur depends positively on the amount borrowed. The more he borrows, the more he can repay, at least in good states. Since the exemption level is a fixed amount, he will never default in good states when he has lots of income and assets. Thus, without the limited commitment problem, the entrepreneurs could borrow almost without limit.[39]

Default on secured credit In the baseline we have excluded default on secured credit. We consider this a natural benchmark because our model does not feature aggregate fluctuations in collateral values as those observed in the US housing market during the Great Recession, nor catastrophic shocks which destroy the entire capital stock of a firm. However, as a further robustness check, we have investigated a version of the model where default on secured credit is allowed. We assume that secured credit is subject to a fixed loan to value ratio.[40] We model secured debt as senior to unsecured debt so that in a default secured debt is serviced first using the undepreciated capital stock which served as the collateral for the secured loan. Income is not part of the collateral. However, as in most US states there is full recourse for secured loans, if income exceeds the exemption level, we assume that it first goes towards servicing secured debt holders. Unsecured creditors receive something only if there are resources beyond the exemption level left after repaying all secured debt.

After recalibrating the model, the results are fairly similar to our baseline model. Unconstrained entrepreneurs choose to borrow secured debt on which they will never find it optimal to default. Those entrepreneurs who might default, choose to default on their unsecured borrowing. However, poor constrained entrepreneurs who can only borrow secured are better off when they can default on secured credit. In the model with risk-less secured credit, they had only access to credit which provided no insurance. They would like to trade-off slightly higher cost of credit to obtain some insurance. Risky secured credit provides exactly that. This mechanism reinforces our result that allowing for secured credit alters the trade-off associated with high assets exemption in bankruptcy. Now high assets exemptions are even less costly, as risky secured credit not only provides cheap credit but also some insurance.

Similar to the baseline model, the *fresh start* effect is also important in this model version. Given that the loan to value ratio limits secured borrowing, constrained agents who cannot borrow unsecured, need their own resources to obtain secured credit. A higher exemption level allows them to keep more resources when they were unlucky and therefore they can borrow more and so run larger firms even after a default. Therefore, the optimal steady state exemption level is, at $X = 12$, now even higher than in the baseline. As before, the rich gain most since with a higher exemption level, they borrow more and therefore run larger firms. The situation of poor agents is somewhat different.

[39] In addition to being a feature of the real world, commitment problems of this kind can also be interpreted as a shortcut for information asymmetries. If banks were unable to observe the entrepreneurial talent, they might limit loan sizes in order to sustain a separating equilibrium. If banks would not limit the amount of credit, untalented agents who default with probability one, might want to obtain unsecured credit as well. The introduction of asymmetric information into our model is left for future research.

[40] Empirically, loan to value ratios for firms range from 30% on unfinished materials to $60 - 80\%$ on ready to sell inventories and real estate property. We chose an intermediate value of 60%, also because not all firm expenditures, for example wages, can be collateralized.

They would prefer a lower exemption level since for them the worsening conditions for unsecured credit dominate. However, the option to default on secured credit means that they not only are able to obtain credit but also get partial insurance. Therefore, their welfare declines only mildly at high exemption levels.

6.2 Consumer borrowing and default

The focus of our paper is on the effects of personal bankruptcy on entrepreneurial default. Given that the bankruptcy law already features differential treatment for consumers and entrepreneurs, we abstract from consumer unsecured credit and default in order to be able to build a tractable and transparent model which allows the identification of the most important effects of wealth exemption levels on entrepreneurship.[41] In particular, the underlying economic risks are different for entrepreneurs and consumers. Entrepreneurial production risks affect allocative efficiency, by determining the number of entrepreneurs (*extensive margin*) and firm size (*intensive margin*). Consumers risks such as unemployment, divorce or health expenditure shocks mainly affect consumption smoothing.

In this subsection, we investigate the robustness of our results with respect to allowing consumer credit and consumer default. Therefore, we drop the ad hoc borrowing constraint $a' \geq 0$ across periods and introduce an endogenous borrowing limit resulting from the default option on unsecured credit. Our model has scope for consumer borrowing since it has persistent labor productivity shocks which are an important driver of consumer's borrowing and default decisions. However, it abstracts from some aspects that are also important for consumer default, like unforeseen health, family related expenditure shocks, or unemployment shocks.[42] This generalized model yields relatively similar results when we use our benchmark parameters: for example, the capital-output ratio drops slightly to 3.02, fraction of entrepreneurs drops slightly to 7.18%, only the ratio of median rises somewhat more significantly to 7.8. Roughly 19% of agents borrow in the consumer credit market. This extra borrowing demand increases the cost of credit and therefore crowds out entrepreneurs and also explains the slight decline in the capital-output ratio.[43]

Using this generalized model we examine the robustness of our model prediction along two dimensions. First, we verify that not allowing for consumer borrowing across periods does not bias the default incentives of entrepreneurs in the baseline model. Second, we show that a high exemption level for entrepreneurs is always optimal, whether we change the exemption level for consumers and entrepreneurs together, or whether we vary them

[41] Unsecured consumer credit accounts for a substantial part of total unsecured credit. However some simple back of the envelope calculations using the Fed's Flow of Funds show that also unsecured business debt is an important fraction of all unsecured debt. The outstanding debt of the non-corporate non-financial business sector was about $3,300$ billions dollars in 2006. We have documented that about 87% of this debt is at least partially secured. Thus unsecured business debt is at least about 430 billions dollars. Unsecured consumer debt, as proxied by outstanding household debts (excluding mortgages, car and student loans) was about $1,300$ billions. Therefore, the share of small business in total unsecured credit is at least about 25%.

[42] See Livshits et al. (2007) and Mankart (2014) for the importance of these shocks. A model with all these shocks is beyond the scope of the current paper and adding these features would not affect our result concerning the desirability of a high exemption level for entrepreneurs.

[43] In the following, we keep the model parameters at their baseline values and have one common exemption level for business and consumer credit. Recalibrating the parameters leads to similar conclusions.

independently. Thus, our results are robust towards allowing for consumer borrowing and default.

Consumer borrowing across periods One potential implication of our ad hoc borrowing constraint across periods $a' \geq 0$ could be that this forces unlucky entrepreneurs into default since otherwise their consumption would drop too low. If borrowing across periods was feasible these entrepreneurs might use consumer credit to smooth consumption. If this occurred often, our baseline model would imply too many defaults.[44] Crucially, the default decision of entrepreneurs in the generalized model is unaffected. No entrepreneur who borrows unsecured in the business credit market and is hit by a bad shock uses consumer credit to repay his business loan. Thus, the baseline model does not overestimate the default rate.

The trade-off for an entrepreneur who is hit by a bad shock is to default now or to borrow in the consumer credit market to repay his business loan. The advantage of defaulting now is that his debt gets written off and he can keep his assets up to the exemption level and enter the next period with positive assets. However, this comes at the price of a bad credit status. If he borrows unsecured in order to repay the business loan, he will enter the next period with negative assets but a clean credit record. The advantage is that he can borrow unsecured in the business credit and consumer credit markets in the next period(s).

However, in the generalized model, as in the baseline model (see Table 3), agents enter into entrepreneurship only at strictly positive levels of assets. Thus, someone who enters the period with negative assets will not become an entrepreneur. This means that keeping a clean credit record is not that worthwhile for someone with negative assets. Of course, over time, the agent can and will accumulate assets that lead him above the threshold so that he becomes an entrepreneur again. But that accumulation takes time. On the other hand, the bad credit status does not last very long either. The credit status is returned to a clean state after, on average, six years. On balance, these considerations lead the entrepreneur to be better off defaulting immediately after he has received the bad shock.

However, we observe an interesting difference in the generalized model. Some agents who have borrowed in the secured credit market use consumer credit to sustain a higher level of consumption after a bad shock. This happens for agents with high labor productivity, since they will repay with a high probability and therefore the cost of consumer credit to them is relatively low.

Consumer default and optimal exemption level Next, we investigate the effects of allowing consumer default on the optimal exemption level. As explained in Section 2, while Chapter 7 of the U.S. bankruptcy law distinguishes between business and consumer default when it comes to means testing, the exemption level is uniform. We run two different experiments.

In our first experiment, we follow the law as it is and vary the exemption level uniformly, i.e. we change the exemption levels for consumer credit and for business credit together. The optimal steady state exemption level is the same as before. The reason why

[44] Since the default rate is one of our calibration targets, this would mean that our calibration would be changed. The main parameter related to entrepreneurial defaults is the variance of the shock hitting the entrepreneur. Thus, if we had artificially too many defaults, we would now need a higher variance.

a high level for entrepreneurs is optimal is unchanged. A high exemption level for consumers is optimal because it reduces crowding-out effects. While consumer credit helps to smooth consumption and therefore is valuable, ceteris paribus, to consumers, it also drives up the price of credit. This lowers capital demand in the corporate and non-corporate sectors leading to lower wages and increased interest rates. Given the unequal asset distribution, only the very rich benefit from the higher interest rate, everyone else loses. An increase in the exemption level increases the price of consumer credit and therefore lowers demand for consumer credit. This makes consumption smoothing more difficult but it reduces the crowding-out effect. Thus, while consumer borrowing leads to a welfare loss due to the crowing-out effect (see also Li and Sarte (2006)), a high exemption level for entrepreneurs remains optimal.

This result is confirmed in our second experiment. Here we assume that the exemption levels on entrepreneurial credit and consumer credit can be changed independently. We fix the entrepreneurial exemption level at the optimal one and then change the exemption level for consumer default. Welfare is increasing with the exemption level, up to an exemption level of $X = 2.5$. This level is already so high that no consumer borrows an amount that would make this level binding. Therefore, any further increases lead to no additional changes. This result also obtains in a recent model by one of us, see Mankart (2014) and is also consistent with the data since consumer default cases almost never involve assets above $\$20,000$. Hintermaier and Koeniger (2011) in a consumer default model with durables also find that a high exemption level is optimal for consumer default. Thus, even though, our results are limited by the absence of some important elements of consumer default, it is consistent with recent papers that include these features.

7 Conclusion

In this paper, we quantitatively explored the effects of the personal bankruptcy law on entrepreneurship in a model which includes secured credit in addition to unsecured credit. We developed a dynamic general equilibrium model with heterogeneous agents and occupational choice which explicitly incorporates the U.S. bankruptcy law. The model endogenously generates interest rates that reflect the different default probabilities of the agents. Our model accounts for the main facts about entrepreneurial bankruptcy, entrepreneurship, wealth distribution, and macroeconomic aggregates in the U.S.

We used the model to quantitatively evaluate the effects of changing Chapter 7 exemption levels. The simulation results show that the current exemption level is too low. Increasing the exemption level to the optimal one has positive welfare effects on the order of 1.2% of average consumption if steady-states are compared. These gains fall to 0.12% if transitional dynamics are taken into account, but the optimal exemption level is only slightly lower. While most gains accrue to rich households, the poor would also be better off.

The most important contribution of our paper is to show that secured credit significantly changes the trade-off between insurance and credit market conditions. We showed that analyzing the effects of the bankruptcy law in models without secured credit yields misleading results because it overstates the worsening of credit market conditions. In fact, in these models the optimal law is very harsh. Instead, once we allow for secured credit, the optimal law is a generous one. Models without secured credit, be it in the

entrepreneurial or consumer bankruptcy literature, overstate the negative effects of a generous bankruptcy law.

It is worth noting that we abstracted from several interesting aspects. First, the characteristics of the entrepreneurial projects are exogenous. It would be interesting to see whether a high exemption level would still be optimal if entrepreneurs could choose the riskiness of their projects. Second, and related to the first aspect, we abstracted from leisure for workers and entrepreneurs. A generous bankruptcy law might lead entrepreneurs to under-provide effort. Last, we had only a one-good model. Therefore, we modeled secured credit as pledgeable income and assets. In light of the recent financial crisis, it would be interesting to incorporate durable goods in the form of housing to analyze the impact of frictions and price changes in the housing and mortgage market on entrepreneurship and economic efficiency. We leave these issues for future research.

8 Appendix

8.1 Exemptions and entrepreneurship: regression analysis

In this appendix we report the estimates, obtained from a linear probability model, of individual self employment status and state bankruptcy exemptions. In the first column shows the non-linear relationship between self-employment status and exemptions using individual data without any further control. The estimates in second and third column include individual controls[45], where the third column excludes states with *unlimited exemption*. The estimates confirm the graphical evidence of a hump-shaped relationship, between self-employment and exemptions.[46]

Table 4: Self employment and Exemption

	I	II	III
log_homestead	0.120***	0.054***	0.071***
	(0.005)	(0.008)	(0.011)
log_homestead2	-0.005***	-0.002***	-0.003***
	(0.000)	(0.000)	(0.001)
Individual Controls	NO	YES	YES
Excluding *unlimited exemption* states	NO	NO	YES
R-squared	0.001	0.142	0.142
N	1777465	1417698	1417698
*** p¡0.01, ** p¡0.05, * p¡0.1			

Dependent variable is self-employment status. log_exemption is the logarithm of bankruptcy homestead exemption. log_exemption2 is square of the logarithm of bankruptcy homestead exemption. Individual controls include dummies for age, educational attainment, home ownership, race, marital status, year, region, gender, industry, immigration status, Spanish ethnicity, metropolitan area, central city status. Robust standard errors in parenthesis.

8.2 Computational strategy

The state vector for an individual is given by $\eta = (a, \theta, \varphi, S)$. The aggregate state is a density $\mu(a, \theta, \varphi, S)$ over the individual state variables. Individual asset holdings are discretized with 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:

[45] The controls are age, educational attainment, home ownership, race, marital status, year, region, gender, industry, immigration status, Spanish ethnicity, metropolitan area, central city status.

[46] The results do not depend on the statistical method adopted. Using logit or probit do not change the hump-shaped relationship.

Remark 1.

1. *Assign values to all parameters.*

2. *Guess a value for the marginal product of labor. This is also the rate of return on deposits* r^d*.*

3. *Given* r*, the FOC of the corporate sector uniquely pins down the wage rate* w*. The representative competitive firm in the corporate sector chooses* K_c *and* L_c *such that*

$$\begin{aligned} r^d &= \xi A \left(\frac{K_c^d}{L_c^d}\right)^{\xi-1} \\ w &= (1-\xi) A \left(\frac{K_c^d}{L_c^d}\right)^{\xi}. \end{aligned}$$

   Therefore r^d *uniquely determines the capital–labor ratio in the corporate sector, which, in turn, pins down* w*.*

4. *Given the price vector* (r^d, w)*, solve for the optimal value functions and corresponding policy functions by value function iteration. Within the period, solve backwards in time.*

   (a) *Guess value functions for the agents.*

   (b) *Solve the consumption–savings problem of the constrained and unconstrained agents for a grid of cash on hand.*

   (c) *Approximate the resulting continuation value functions.*

   (d) *Since the worker faces no uncertainty within the period, these value functions yield the values for the workers.*

   (e) *Given the continuation value, solve the problem of the unconstrained entrepreneur:*

   - *Set up a grid for secured credit;*
   - *For each value of secured credit, set up a grid for unsecured credit;*
   - *For each value of unsecured credit, price the credit according to the zero profit condition. Start by offering it at the risk free rate. If the entrepreneur would default, increase the interest rate until an interest rate at which the bank expects to break even is found.*[47]
   - *Identify the optimal grid point and then search around that for first- and second-best points, in order to get a more robust choice of unsecured credit.*

   (f) *The problem of the constrained entrepreneur is solved similarly.*

   (g) *Occupational choice yields the updated value functions.*

   (h) *Iterate until convergence.*

   (i) *In this process, also the policy functions are obtained.*

5. *The policy functions, the exogenous transition matrix for the shocks (both for* θ *and for* φ*), the* iid *investment shock* χ*, and the credit status shock* ϱ*, induce a transition matrix* P_η *over the states* η*.*

[47] Credits that would lead to a default probability of 1 are not allowed.

6. *The transition matrix P_η maps the current density μ_η into a density for the next period μ'_η:*

$$\mu'_\eta = P'_\eta \times \mu_\eta$$

Calculate the steady state density over the state space μ^*_η by solving for

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

7. *From the policy functions and the steady state distribution, check the market clearing conditions.*

8. *If there is no equilibrium, adjust the interest rate and go back to point 3. Repeat this until the capital market clears.*[48]

Table 5: Numerical robustness checks

Parameters	baseline	1	2	3	4	5	6	7	8
Size asset grid final (lower part)	1000	1000	1000	1000	**2000**	1000	1000	1000	1000
Size asset grid final (upper part)	1000	1000	1000	1000	**2000**	1000	1000	1000	1000
Size assets grid preliminary (lower part)	300	300	300	300	300	**1000**	300	300	300
Size assets grid preliminary (upper part)	200	200	200	200	200	**1000**	200	200	200
Size capital and credit grids	200	200	200	**150**	200	200	200	200	200
Number of transitory shocks states	5	5	5	5	5	5	5	5	**7**
Interp. method for intermediate value func.	1	1	1	1	1	1	1	**3**	1
Interp. method for final value func.	0	0	0	0	0	0	**1**	0	0
Tolerance value function iteration	1E-09	1E-09	**1E-07**	1E-09	1E-09	1E-09	1E-09	1E-09	1E-09
Tolerance excess demand for equilibrium	1E-05	**1E-03**	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05	1E-05
% change of results									
Fraction of defaulters	0	0.004	0.004	0.426	0.155	0.141	0.026	0.034	0.614
Fraction of entrepreneurs	0	0.001	0.000	0.007	0.000	0.026	0.035	0.002	0.210
Interest rates	0	0.002	0.000	0.009	0.293	0.004	0.225	0.005	0.867
Wage rate	0	0.002	0.001	0.000	0.052	0.000	0.040	0.002	0.156
Welfare	0	-0.001	0.000	-0.001	-0.004	-0.001	-0.002	0.000	-0.017
Welfare of the poor	0	0.000	0.000	-0.001	-0.007	-0.006	-0.003	0.000	-0.001
Welfare of the rich	0	0.000	0.000	-0.001	-0.006	-0.008	-0.005	0.000	-0.044

8.3 Policy functions and numerical robustness

In this section we consider the non-smoothed policy function and the robustness of our results with respect to changes in the numerical procedures and parameters. Figure 8 is the analogue of Figure 3 in Section 4 of body of the paper, without smoothing out the spikes. The spikes are present because we discretized the shock process with five nodes. An entrepreneur in region (5) will never default. Agents with wealth between 1.15 and 1.78 will default only when the worst shock realization occurs. Agents with wealth between 0.77 and 1.15 will default only when the worst or the second worst shock realization occurs. The kink in the policy functions at 1.15 reflects this switch in default behavior. Something similar happens at wealth levels 0.77 and 0.6. Increasing the number of nodes in the shock process is computationally very costly without affecting the results a lot, as can be seen in column 8 of Table 5.

[48] In the implementation, the *hunt* algorithm is used to find the interest rate that clears the capital market.

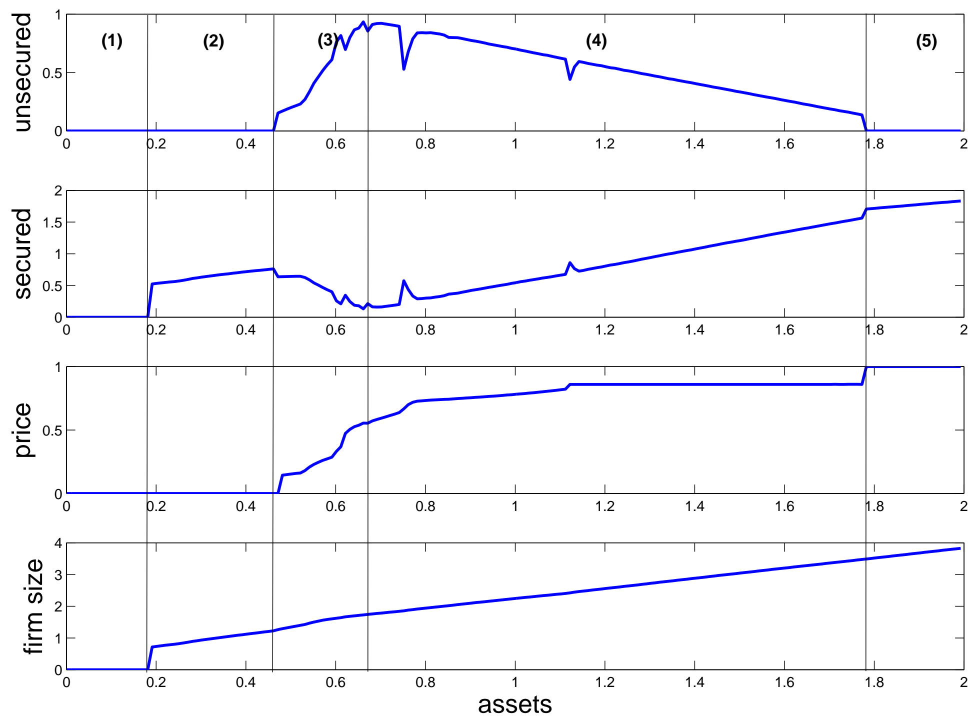


Figure 8: Decision of the unconstrained agent ($\theta = \theta^H$, $\varphi = \varphi_1$), non smoothed

Table 5 shows the results of some numerical robustness checks, one for each column. The table shows the values of the parameters, with the changed one highlighted, as well as the percentage change with respect to the baseline calibration of some of the main results of the model (e.g., welfare, fraction of entrepreneurs, fraction of defaulters). In columns 1–2 we change the tolerance level of some of the iterative procedures in the solution algorithm: the condition for equilibrium in the asset market: excess demand (column 1) and the convergence criterion for the value function iteration (column 2). The bottom panel of Table 5 shows that none of the results is significantly affected. The most affected is the fraction of defaulters, which changes by 0.004% in the worst case (column 1). In columns 3 to 5 we show the effects of changing the size of the main grids used to discretize the continuous choice variables (secured and unsecured credit, column 3) and the continuous state variable (assets) in the final phase (column 4) and in an intermediate phase (column 5). The bottom panel shows that the grids for assets hardly affects any of the results: doubling the size of the grid or eliminating the intermediate phase altogether changes the fraction of defaulters by 0.15% and the interest rate by 0.29%. Reducing the grid for choice variables affects the fraction of defaulters by about 0.4%. Columns 6 and 7 show the effects of changing the interpolation methods in different phases of the solution algorithm (from linear interpolation to splines), but they hardly have any effect. Column 8 shows the effect of having a finer grid to discretize the transitory shock to entrepreneurial production. In this case, the changes are more significant, as expected, given that this is a major change in the numerical solution. But even in this case, none of the changes exceed 1%. It should be noticed that the order of magnitude of the changes in the model outcomes due to all these robustness checks is significantly smaller than the changes due to our policy experiment. For example, the corresponding fraction of entrepreneurs in column 8 is 0.07323 versus a baseline of 0.07321, while the change due to the policy experiment was significantly larger: entrepreneurship increased up to 0.076.

8.4 Wealth distribution in the model

The relevance of the policy functions in the model depends on the wealth distribution. Therefore, Figure 9 shows the lower end of the wealth distribution. As described in the text, 50% of the agents are in the relevant part of the state space between 0 and 2.

8.5 Data

Our definition of entrepreneur is someone who owns a business and whose main occupation is to run this business. We use three data sources: *The Small Business Economy* (2006) by the U.S. Small Business Administration, Office of Advocacy[49], the *Survey of Consumer Finances* (SCF) over the period 1992–2004, and *Panel Study on Income Dynamics* (PSID) for the period 1980–1997.

From the SCF we get the fraction of entrepreneurs in the population, the ratio of the median net worth of entrepreneurial households to the median net worth and the statistics of the wealth distribution. In the SCF, we classify an household as an entrepreneur if the head owns and runs a business and has at least one employee. The average fraction of the

[49] The original sources of the data are: the Bureau of Census and U.S. Department of Commerce for data on employers, and the Administrative Office of the U.S. Courts for business bankruptcy filings.

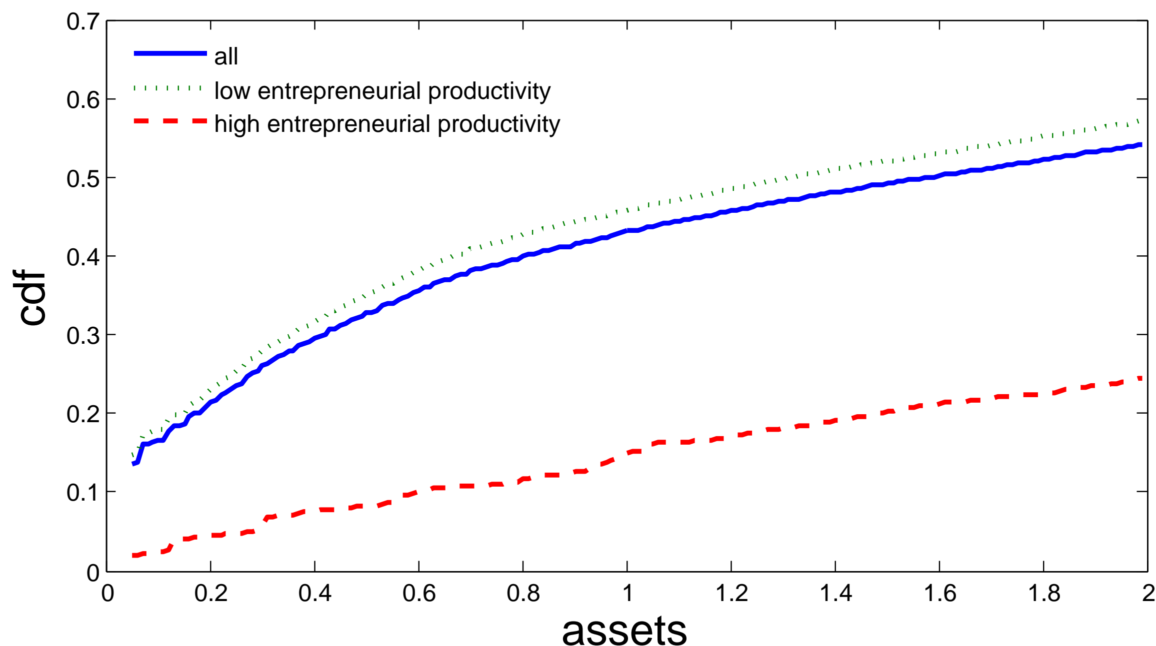


Figure 9: Cumulative wealth distribution in the model

population engaged in entrepreneurial activity is 7.29%.[50] We also find that on average for the period 1992–2004 the ratio of the median net worth of entrepreneurial households to the median net worth for the total population is equal to 6.29.[51] To be sure that our model captures the most relevant features of the wealth distribution, we target the share of net worth held by the top 40%, which in the SCF is on average for our sample period equal to 94%. From the SCF, we also get a measure of the leverage of entrepreneurs. The median leverage for entrepreneurs with some debt in the sample is equal to 14%. However, Heaton and Lucas (2002) find, for the same statistic, a value of 61% from the *Survey of Small Business Finances*. We set the calibration target to the average of the two, i.e., 37.5%.

Since the SCF does not have a longitudinal dimension, it does not allow of calibrating the exit rate. Therefore, we use the PSID, which has already been used in the literature as a source of data on entrepreneurship (Quadrini, 2000). However, the PSID does not report the number of employees per firm. The closest we can get to our definition is to assume that an entrepreneur is an agent who owns a business and declares being self employed. According to this definition we get, for the period 1980–1997, a fraction of entrepreneurs equal to 8%, which is close to our corresponding measure in the SCF. Given this definition, we get an exit rate equal to 0.15[52].

[50]This number is similar to the numbers obtained by using other definitions of entrepreneurship used in the literature. Cagetti and De Nardi (2006) define as entrepreneurial a household whose head owns and runs a business and is self-declared as self employed. Gentry and Hubbard (2004) define as entrepreneurial a household who owns and runs a business with a total market value of at least 5000$. Using these definitions we get on average for the same period a fraction of entrepreneurs of 7.5% and 9.4%, respectively.

[51]Using other definitions of entrepreneurship, the ratio of the median wealth of entrepreneurs is lower: 4.7 and 4.8 when using the definitions of Cagetti and De Nardi (2006) and Gentry and Hubbard (2004), respectively.

[52]Quadrini (2000) who also uses PSID adopts two definitions of entrepreneur: someone who is self-

The bankruptcy target is taken from the U.S. Small Business Administration, Office of Advocacy, and adjusted by the findings of Lawless and Warren (2005) as explained in detail in Section 2.

declared as self employed and someone who owns a business. These definitions yield a fraction of entrepreneurs for the same period of 0.12 and 0.14, respectively. The exit rates are equal to 0.21 for the business owners, 0.12 for the self employed

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