Bankruptcy Reform and Endogeneous Risk-taking by Entrepreneurs

Jochen Mankart
LSE

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Abstract

I show that making the bankruptcy law more lenient does not necessarily increase the willingness of entrepreneurs to take on more risks. This explains the finding by Berkovitz and White (2004) that the interest rate charged by banks is not monotonically increasing in the leniency of the bankruptcy law. If agents can decide each period whether they want to become entrepreneurs or workers, the two associated value functions intersect at a certain level of wealth. The value function around this intersection is not concave and agents are locally risk-loving. Whether entrepreneurs increase their risk taking when the bankruptcy law is changed depends crucially on the slopes of the value functions and the direction in which they change in response to the change in the law.

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1 Introduction

In recent years many European countries have adopted policies to encourage entrepreneurship. One of the policy changes has been to make the bankruptcy law more lenient. For example in Germany, prior to a law change in 1999, a person who was unable to repay a loan was liable for his debt forever. Creditors could garnish part of the income forever. The garnishment period is now reduced to six years. In the UK this period was reduced to three years. A similar law changed was introduced in the Netherlands. Even though these changes apply to all persons, not exclusively to entrepreneurs, all of them were introduced in order to encourage risk-taking by entrepreneurs.

My paper analyses the effect of changes in the bankruptcy law on risk taking by entrepreneurs when risk taking is endogenous. In particular, I investigate whether a more lenient bankruptcy law really encourages risk taking. I show that this is not necessarily the case and that therefore the policy changes in these countries might not have the effects envisioned by policy makers.

It is well understood that making the bankruptcy law more lenient worsens credit market conditions and therefore can lower entrepreneurship rates and / or firm size. However, the possibility to default in bad states of the world provides entrepreneurs with insurance. Mankart and Rodano (2007 and 2009) analyze this trade-off in a quantitative model of the US economy. However in their paper risk-taking is exogenous in the sense that agents can not influence the success probabilities of their projects. In this paper, I allow agents to decide on the success probability of their projects. They can increase the return of their project in the good state by accepting a higher failure probability.

Risk taking behavior of agents when they have an occupational choice has been analyzed by Hopenhayn and Vereshchagina (2009). In their model, agents are self-financed. I allow agents to borrow and, in addition, to default. I show that making bankruptcy law harsher can lead agents to take on more (and not less) risk. The reason for this counter-intuitive result is that the presence of an outside opportunity (becoming a worker) leads to a non-concavity in the value function. Thus, some entrepreneurs are (locally) risk-loving. Changes in the bankruptcy law change the risk taking incentives in a non-monotonic way.

This is an explanation of a finding by Berkowitz and White (2004). They examine the effects of different bankruptcy laws (across US states) on credit conditions for small firms. Their main finding is that the harsher the bankruptcy law, i.e. the more assets the bank can seize in the case of a default, the lower are the interest rates that firms have to pay. However this relationship is non-monotonic and they do not have an explanation for this puzzling non-monotonicity.

In section 2, I develop a theoretical framework that analyzes the effects of changes in the bankruptcy law on risk-taking by entrepreneurs when risk-taking is endogenous and entrepreneurs can become workers. The proofs in this section are mere sketches so far. In section 3, I calibrate the model to reasonable values to investigate whether the results of section 2 are empirically relevant. However, so far I only have results for linear technology. Thus it is best to view the results in section 3 as numerical examples of the theoretical results.

2 Theory

2.1 Model framework

There is a continuum of infinitely lived agents j. Time is discrete and indexed by $t \in \{0, 1, 2, ..., \infty\}$. Each agent is endowed with working ability η and entrepreneurial ability θ. All markets are perfectly competitive. At the beginning of each period, agents decide whether to become workers or entrepreneurs. If they become workers they supply labour inelastically to firms in the corporate sector and they supply their savings to the financial intermediaries. If they become entrepreneurs, they invest in a risky investment technology that turns their initial investment into capital. They can supplement their own savings by borrowing from the financial intermediaries. If entrepreneurs have borrowed at

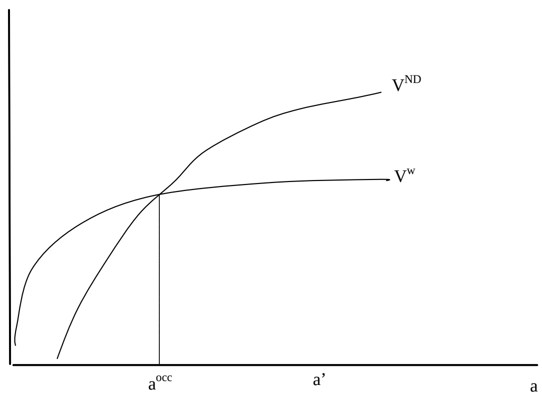

Figure 1: Value function of a worker V^W and of an entrepreneur V^{ND}.

the beginning of the period they have to repay their loans at the end of the period. However, entrepreneurs are allowed to default on their debt. The default mechanism is modeled on the US bankruptcy law. Financial intermediaries observe agents abilities and therefore they know the default probability of each agent and price the loan accordingly.

1 shows the value function of agents if they become a worker V^W or an entrepreneur V^{ND}. Given that the value functions intersect, their upper envelope is not concave. Thus, a randomization device is welfare improving. In the region $\left(Y, a^{crit}\right)$ agents would like to have such a randomization device. For example an agent with assets $a' \in \left(a^{occ}, a^{crit}\right)$ becomes entrepreneur. However, he would prefer a gamble that gets him to a^{crit} with some probability p and to Y with probability $(1-p)$.

The insight of Hopenhayn and Vereshchagina (2009) is that entrepreneurs have such a randomization device. They can choose the riskiness of their project. Thus they enlarge the technology set to include arbitrary levels of riskiness of the projects. However, in order to focus on pure risk-taking, they assume expected returns are identical. Thus choosing a riskier project does not lead to a higher expected return. They show that wlog the return distribution can be reduced to 2 points. The bad outcome yields y and the good outcome yields a_{crit}. The probability of success, which is chosen by the entrepreneur is, $p \in [0,1]$. The average/expected return is

$$(1-p)\,y + pa_{crit} = A$$

Now all entrepreneurs with assets $a \in \left(a^{occ}, a^{crit}\right)$ will choose risky projects. Moreover the level of riskiness p is falling with assets. And agents with assets above a^{crit} will invest only in the risk free project.

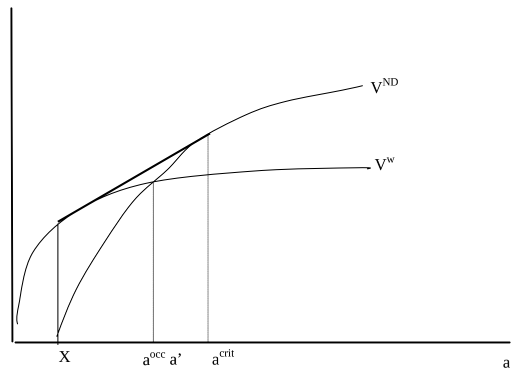

Figure 2: Randomization region

2.2 Borrowing and the possibility of bankruptcy

In Hopenhayn and Vereshchagina (2008), agents have to self-finance. I allow them to borrow and to default. Someone who has defaulted is denied credit for some time, so his value function will be below the one of a worker.

I assume that only non-contingent loans are available. Default is modeled on chapter 7 of the US bankruptcy code in which agents who default keep all assets up to an exemption level X_0. For now, I assume that the invested capital is so high that even if the project fails and agents declare bankruptcy, they have undepreciated capital that is higher than the exemption level. Thus agents who default will end up having assets . Therefore agents can not necessarily get the 'optimal' randomization region. Since upon defaulting they end up with $a = X_0$ and utility $V^D(X_0)$, the randomization region will have the point $V^D(X_0)$ as its lower bound. The upper bound is whatever line originating at $V^D(X_0)$ is tangent to the value function V^{ND}.

2.3 Making bankruptcy law harsher

Even though I didn't make it explicit, all three value functions depend on the exemption level X. Suppose X is reduced from X_0 to X_1 then $V^{ND}(X,a), V^D(X,a), V^W(X,a)$ will shift. The direction of the shift depends on the level of the original X_0.

Proposition 1 *The direction of the shift of $V^D(X,a), V^W(X,a)$ depends on the shift in $V^{ND}(X,a)$.*
Proof. *(Sketch:) If $V^{ND}(X,a)$ increases, there will be more entrepreneurs and so less workers and therefore higher wages for workers so $V^W(X,a)$ will go up. Since both, $V^{ND}(X,a)$ and $V^W(X,a)$, increase, $V^D(X,a)$ will increase as well*
■

Proposition 2 *There exists a critical X^{crit} such that*

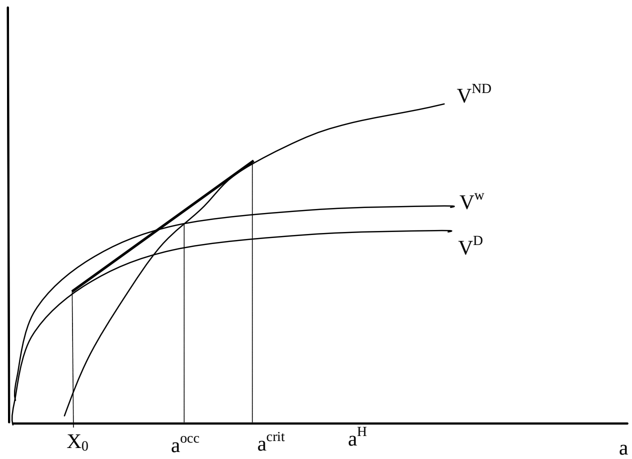

Figure 3: Randomization region with borrowing and default.

1. *if $X_0 > X^{crit}$ a reduction in X from X_0 to $X_1 \left(> X^{crit}\right)$ leads to an increase in $V^{ND}(X,a)$.*
2. *the converse*

Proof.

1. *(Sketch:) If X_0 was very high, a reduction in X (which means banks keep more in case of default) improves credit market conditions by more than it reduces the insurance effects. In this case $V^{ND}(X,a)$ increases. The idea here is that the net benefits of X follow a hump-shape. For low levels of X an increase in X provides a lot of insurance at a low cost of only slightly worse credit conditions. The more however X is increased the worse the credit conditions get and at some point this negative effects dominates.*
2. *....*

■

For the next proposition, I focus on the case where a reduction in X leads to a fall in the value functions. Note that the effect of a change in X is strongest for $V^{ND}(X,a)$ and that $V^D(X,a), V^W(X,a)$ do not change (much). I make this assumption only to avoid 2nd round effects and to make the graph readable.

The effects of lowering X from X_0 to X_1 which lowers the value of being an entrepreneur $V^{ND}(X)$ are summarized in the following propositions.

Proposition 3 *Entry into entrepreneurship requires more wealth. The critical level of wealth at which agents enter rises from a_0^{occ} to a_1^{occ}*

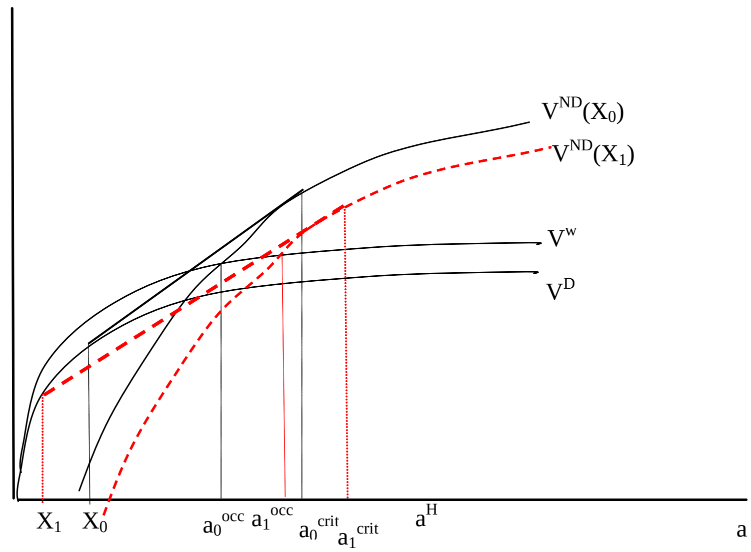

Figure 4: Effects of change in exemption level

Proof. *(Sketch:) The value function of entrepreneurs $V^{ND}(X)$ has decreased. The value function of the workers has not changed. Therefore the intersection of the value functions moves further to the right.*

Here I assumed away the fall in $V^{W}(X)$. However it is very likely that the effect on $V^{W}(X)$ is an order of magnitude smaller that the effect on $V^{ND}(X)$. I can show this numerically but, I wouldn't know how to construct a proof of this. ■

As long as the wealth distribution does not change too much, a higher critical wealth level implies less entrepreneurship. This case is found in the data. Fan and White (2003) show that in states with low exemption levels the fraction of entrepreneurs is lower than in states with high exemption levels..

Proposition 4 *The effect on the number of bankruptcies is ambiguous for two reasons.*

Proof. (Sketch:) ■

Proposition 5 1. *The randomization region might increase or decrease depending on whether the lower or the upper bound increases more. In the graph, it falls from $\overrightarrow{a_o^{occ}a_0^{crit}}$ to $\overrightarrow{a_1^{occ}a_1^{crit}}$.*

Lastly, the central proposition that shows that making bankruptcy law harsher can lead agents to take on more risk.

Proposition 6 *The amount of risk-taking increases unambiguously from* $\overrightarrow{X_0 a_0^{crit}}$ *to* $\overrightarrow{X_1 a_1^{crit}}$.

Proof. *(Sketch:) This is because the lower bound falls and the upper bound increases. The lower bound falls simply because the exemption level has decreased. The upper bound falls because* $V^{ND}(X)$ *has decreased.* ■

3 A Quantitative Model[1]

3.1 Preferences and abilities

At the beginning of each period t each agent observes his working ability η_t and entrepreneurial ability θ_t. These ability levels follow two independent stochastic processes. For notational simplicity, I summarize these 2 abilities in the vector $s_t = \{\eta_t, \theta_t\}$. The transition probability of s_t to s_{t+1} between two periods is governed by Γ_{ss}.

Agents maximize the following standard expected utility function

$$E\left[\sum_{t=0}^{\infty} \beta^t u(c_t) \, | a_0, s_0\right]$$

where u is continuous and strictly concave in consumption $c_t \geq 0$, β is the time discount factor initial assets are a_0 and $s_0 = \{\eta_0, \theta_0\}$ is the initial ability vector.

3.2 Occupational choice

At the beginning of a period, each agent has a certain level of wealth a_t. He decides whether to become a worker or whether to become an entrepreneur. If he becomes a worker he receives a known wage w. If he becomes an entrepreneur, he can borrow from the financial sector and invest in a risky project. Consumption c_t takes place in the evening. Denote by $V^E(a)$ $\left(V^W(a)\right)$ the value function of an entrepreneur (worker). The value function at the beginning of the period is

$$V(a) = \max\left[V^E(a), V^W(a)\right]$$

3.3 Bankruptcy

If an agent defaults he can keep assets up to an exemption level X. Variations in this level is the main focus of the paper. Thus, an agent with a cash on hand coh and debt b is left with $\min[coh, X]$ after defaulting.

However, for simplicity, I do not assume that agents are excluded after a default. Thus they can borrow after a default.

[1] This is not the final model. In particular technology so far is linear whereas at the end it will be a standard convave production function as e.g. in Cagetti and De Nardi (2006).

3.4 Technology

Technology is linear and the outcome is a two point distribution. If an agent invests k, with (endogenous) probability $p(\geq \bar{p})$ he fails and $y_f = 0$ (this is done for simplicity) and with probability $(1-p)$ project succeeds and he receives y^h where the expected value is constant:

$$\begin{aligned} py^f + (1-p)\, y^s &= Ak \\ (1-p)\, y^s &= Ak \\ y^s &= \frac{Ak}{(1-p)} \end{aligned}$$

[2]The choice variables of the agent are k and p. The occupational choice leads to a value function that is non-concave around the intersection of the $V^E(a)$ and $V^W(a)$. In this area the agent might prefer to randomize the outcome, that is he prefers a failure probability p that is strictly greater than the lower limit on failure $\bar{p}$

Capital depreciation is the same in both states (could be changed) so that total resources if project fails are $p\,(0 + (1-\delta)\,k)$ and if it succeeds $(1-p)\,(y^s + (1-\delta)\,k)$.

3.5 Financial Intermediation

Agents supply savings to a perfectly competitive financial sector Demand for loans comes from both sectors of the economy. Since there are no agency problems in the corporate sector, the interest rate received for deposits is pinned down by the marginal product of capital in the corporate sector.

Financial intermediaries offer one period non-contingent debt contracts to entrepreneurs. They observe agent $j's$ entrepreneurial ability θ_j, his working ability η_j and his wealth a_j. Thus, I completely abstract from informational problems. Financial intermediaries can perfectly anticipate the decisions the entrepreneur will take. In particular, they know a) the probability with which the entrepreneur will default and b) the amount they will recover in case of default. Perfect competition among intermediaries implies that they have to break even on each of the contracts. Therefore they offer each entrepreneur j a menu of contracts. Each contract consists of an amount lend $b\left(\theta_j, \eta_j, a_j, X\right)$ and a corresponding interest rate $r\left(b, \theta_j, \eta_j, a_j, X\right)$ such that the intermediary breaks even in expectation.

Denote by q, the probability that the agent defaults, then the zero profit condition is

$$q \max\left[(1-\delta)\,k - X, 0\right] + (1-q)\, r(\cdot)\, b = Rb$$

Solving for the interest rate charged

$$r(\cdot) = \frac{Rb - q \max\left[(1-\delta)\,k - X, 0\right]}{(1-q)\, b}$$

[2]Thus, so far, I have solved the model only for the linear case. I am currently working on the more realistic case of a concave production function.

Since technology is linear, I need a borrowing limit. Otherwise agents would borrow unlimited amount and choose risk-free project.

3.6 Problem of the agent

3.6.1 Worker

A worker doesn't face any uncertainty so his problem at the end of the period is

$$\begin{aligned} V^W(a) &= \max_{c,a'} \{u(c) + \beta V(a')\} \\ st &: c + a' = w + Ra \end{aligned}$$

3.6.2 Entrepreneur

At the beginning of the period the agent has to decide how much to borrow b, how much to invest k and how much risk ($p \geq \bar{p}$)to take. After uncertainty is resolved and production has taken place, the agent must decide whether to default of whether to repay his debts. At the end of the period he decides how much to consume/save.

$$\begin{aligned} V^E(a) &= \max_{b,k,p,c,a'} \mathbb{E}\{u(c) + \beta V(a')\} \\ c + a' &= y + (1-\delta)k - r(\cdot)b \quad \text{if repays} \\ c + a' &= \min[y + (1-\delta)k, X] \quad \text{if defaults} \\ k &\leq a + b \\ p &\geq \bar{p} \end{aligned}$$

He repays iff

$$(1-\delta)k - r(\cdot)b \geq X$$

3.7 Model mechanism

3.7.1 Only exogenous risk

The parameters for the following example are

$$A = 0.18, \delta = 0.08, R = 1.03, \sigma = 2, \beta = 0.92, w = 1, X = 1.8$$

The wage is normalized to 1.

To understand the intuition, I start with the case in which the agent can not influence the success probability so that

$$\begin{aligned} p &= \bar{p} \\ y^f &= 0 \\ y^s &= \frac{Ak}{(1-p)} \end{aligned}$$

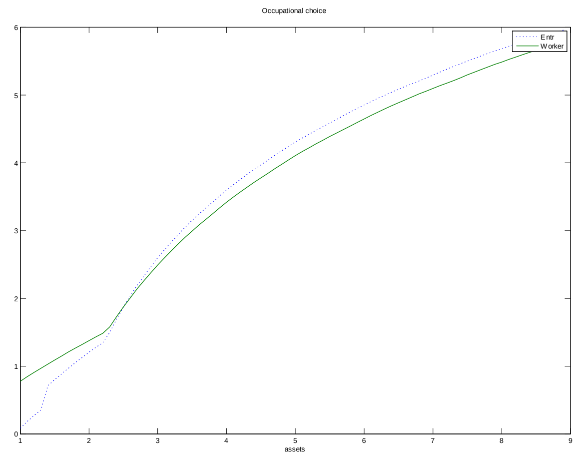

Figure 5: Occupational choice

The value functions $V^W(a)$ and $V^E(a)$ are shown in figure 5.

Taking the upper envelope of the two value functions yields $V(a)$, see figure (6). The corresponding policy functions are shown in figure (). Agents with $a < 2.4$ become workers and save. Agents with $a > 3.7$ become entrepreneurs. This rich agents do not default when they are hit by the bad shock therefore they borrow at the risk free rate. Agents with $2.4 < a < 3.7$ become entrepreneurs and they default when they are hit by the bad shock. Therefore, they have to pay a higher interest rate. Note that all the firms borrow up to the borrowing limit. The shock probability is exogenously set at $\bar{p} = 0.15$.

It is obvious from figure (6) that $V(a)$ has a non-concave region around $a = 2.4$. The insight of Vereshchagina and Hopenhayn is that this non-concavity leads an entrepreneur to more risk taking.

3.7.2 Endogenous risk-taking

Now, I allow the agent to change the success probability of his project while keeping the expected value constant. Given the assumption that output in case of failure is set to zero: $y^f = 0$, this implies that the agent can trade off a lower probability of success against a higher y^s. The exact relationship is $y^s = \frac{Ak}{(1-p)}$. Given the non-concavity the agent might engage in such risk-taking behavior.

Figure (8) depicts the resulting value function and compares it to the value function when endogenous risk taking is not feasible. Endogenous risk taking increases the welfare of the agents around the kink in the value function of the case with exogenous risk taking only. The effect on other agents is relatively small.

Figure (9) shows the corresponding policy functions. The graph confirms

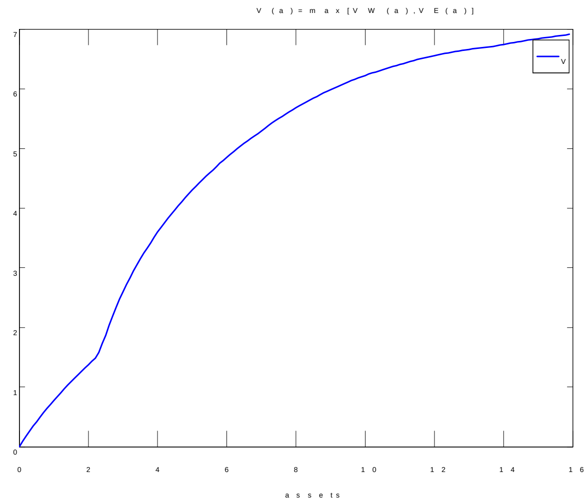

Figure 6: Value function V(a)

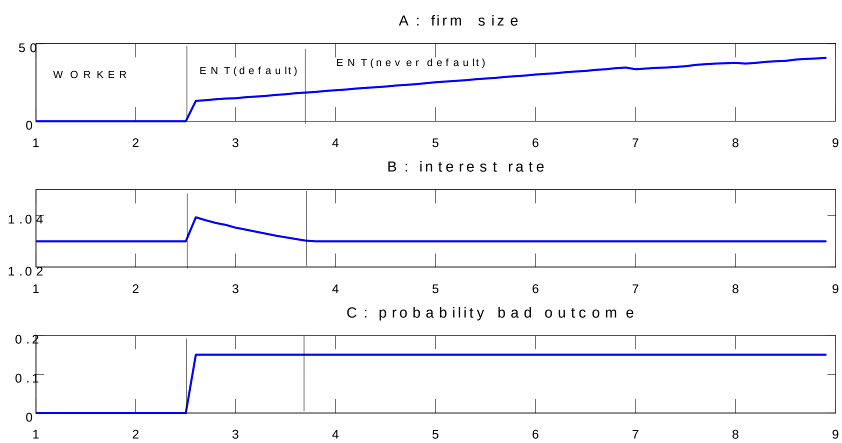

Figure 7: Firm size, interest rate and probability of failure with exogenous risk only

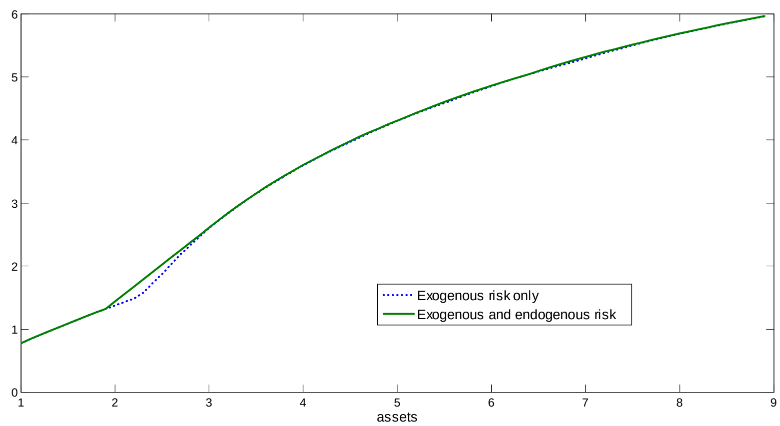

Figure 8: Value functions with and without endogenous risk taking.

once of the key results of Vereshchagina and Hopenhayn. Endogenous risk taking allows poorer agents to enter entrepreneurship. They do this by accepting high probabilities of failure, here in excess of 50%. Consequently, they have to pay high interest rates.

3.7.3 The effects of changing the exemption level

The main question of this paper is to analyze the effects of changing the exemption level on risk taking and on welfare.

Figure (10) shows the value functions for 3 different values of the exemption level. Increasing the exemption level from $X = 1$ to $X = 3.5$ leads to lower welfare because the value function for $a > 4$ is hardly affected and the positive effects of more insurance are dominated by the negative effects of worsened credit market conditions. However a further increase to $X = 4$ is beneficial since this increases the value function for $a > 4$. The reason for this result is that at $X = 4$, the agent has, also in the case of a failure, enough resources to immediately re-enter entrepreneurship. At all lower levels of X, after being hit by a bad shock the agent will become (and stay) a worker. This is summarized in the following result.

Result 1: Welfare follows a U shape.

Since there is a small area in the wealth distribution in which the value function with $X = 4$ is actually lower than that with $X = 1$, this is so far a plausible conjecture only. But, the economics behind it is interesting. Changes in the exemption level have only small (and negative) effects on welfare as long as the occupational choice after a default is not altered. However there are large welfare gains when the exemption level is so generous that agents are left with sufficient resources to immediately re-enter entrepreneurship.

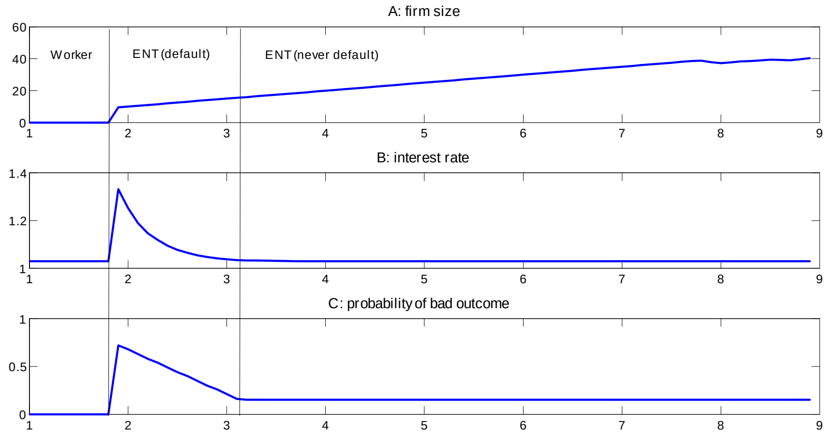

Figure 9: Firm size, interest rate and failure probability with endogenous risk taking.

Result 1b: Political economy: The rich gain most from a very generous bankruptcy law. The only losers from a very generous bankruptcy law ($X = 4$) are those agents ($a = 2.3$) whose credit market conditions worsen so much that they know longer become entrepreneurs.

The following figures show the risk taking (failure probabilities) and interest rates for different values of X. Each figure is an agent with a certain amount of wealth a.

Figure (11) shows an agent who is among the poorest entrepreneurs ($a = 2.4$). If $X = 1$ he becomes an entrepreneur but he runs a very risk project. With 42% probability he will fail, in which case the agent defaults and is left with $X = 1$. He will be a worker in the following period. With 58% probability he will succeed in that case he continues to be an entrepreneur and he will be rich enough next period to invest in a less risky project. Increasing the exemption level leads some agents to take on more risk until credit market conditions are so bad that they prefer to become workers. The reason for this result is standard. An increase in the exemption level leads to more insurance in the case of the bad outcome which in turn implies a higher loss for the bank. In order to break even the bank charges a higher interest rate. Since the amount borrowed does not change (see 11 panel B), and since the value function doesn't change much the upper boundary of the optimal randomization region has hardly changed. The only way in which the agent can reach the same y^s (after repayment) is to take on more risk. Therefore p^f increases. However when the exemption level reaches $X = 3.5$, the credit market conditions are so bad that the agent decides to become a worker.

However the policy function of a slightly richer agent ($a = 2.9$) looks differ-

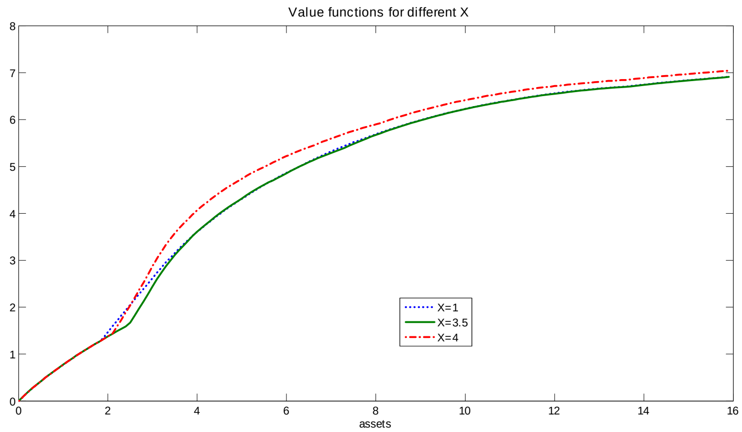

Figure 10: Value functions for different exemption levels

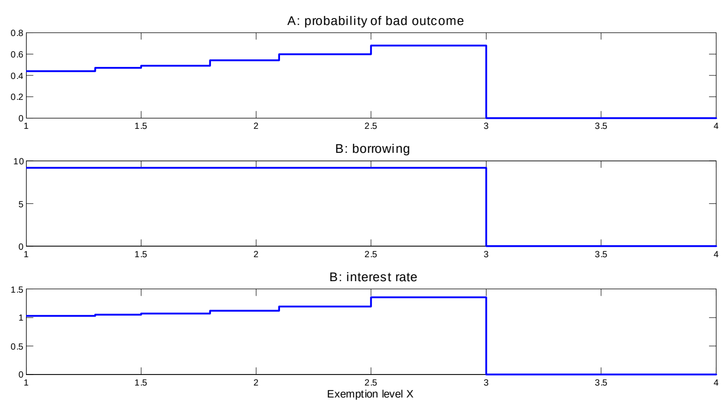

Figure 11: Policy functions across different X for agent with wealth a=2.4

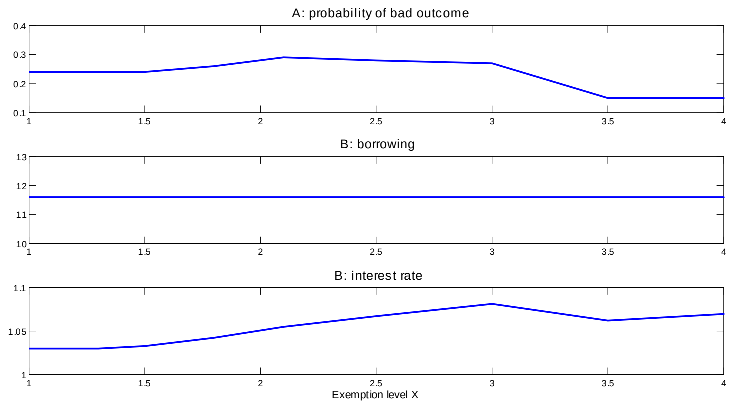

Figure 12: Policy functions across different X for agent with wealth a=2.9

ent. If the exemption level is increased from $X = 1.5$ to $X = 2.5$, the agent also takes on more risk. But as the exemption level is increased further, risk taking is reduced. The reason for this is that the upper bound of the optimal risk taking interval has shrunk. Thus at $X = 3.5$, the agent chooses $p^f = \bar{p}$ despite becoming a worker in case he fails.

Result 2: The effects of increasing the exemption level on risk taking are ambiguous. In particular if the exemption level increases to high levels, agents might take on less risk (while keeping borrowing unchanged) despite having more insurance.

This result is more or less in line with the evidence of Berkowitz and White. They show that the interest rates small firms face is non monotonic in X. At first they increases with X. In the fourth quintile however, they fall before they rise again for the highest observed exemption level. This is roughly in line with panel B in figure 12. However, they look at the median firm in each segment whereas the graph is for one particular agent. It is unclear/unlikely that this agent is the median agent. In addition they also report that the amount borrowed follows the same pattern whereas here it is constant. And the graphs here are not a proper calibration, the parameters are just chosen for convenience. In particular the borrowing limit is unrealistically high.

Result 2b: If the exemption level is so high (here $X = 4$) that all unsuccessful entrepreneurs can immediately after defaulting re-enter entrepreneurship, the failure probability is at its lower limit $p = p^f$ There is no additional risk taking.

4 Conclusion

TBW

5 Algorithm

1. The value function iteration

   (a) Compute
   $$V = \max\left[V^E, V^W\right] \tag{1}$$

   (b) Create 2 grids, one for the workers problem from $\left[a_{\min}, 1.2 * a^{int}\right]$ and one for the entrepreneurs problem from $[\bar{a}_L, a_{\max}]$.

   (c) Solve the workers problem.

   (d) Solve the entrepreneur's problem.

      i. assume savings function $S(a)$
      Solve for optimal borrowing and optimal risk-taking[3]
      $$\begin{aligned} \bar{V}^E(a,\theta,\eta) &= \max_{b,k_l,k_h}\left\{pV\left(a^G\right) + (1-p)\,V\left(a^B\right)\right\} \\ a^G &= \theta k_h^\nu + (1-\delta)\,k_h - (1+r)\,b \\ a^B &= \theta k_l^\nu + (1-\delta)\,k_l - (1+r)\,b \\ & \quad \bar{s} \text{ given} \end{aligned}$$
      solve for endogenous risk-taker, suppose b given, then pick k_l such that
      $$\theta k_l^\nu + (1-\delta)\,k_l - (1+r)\,b = \bar{a}_L$$
      and k_h such that
      $$\theta k_h^\nu + (1-\delta)\,k_h - (1+r)\,b = \bar{a}_H$$

      ii. solve for many b, pick best one, keep track of future states. Note that each b have an associated interest rates $rb()$ such that the bank breaks even.

      iii. Take $b(a, S(a))$ and future states and solve for optimal savings/consumption/investment
      $$\begin{aligned} V^E(a,\theta,\eta) &= \max_{c,i}\left\{u(c) + \beta\left(pV\left(a^G\right) + (1-p)\,V\left(a^B\right)\right)\right\} \\ a^G &= \theta\left(s+\bar{b}\right)^\nu + (1-\delta)\left(s+\bar{b}\right) - (1+r)\,\bar{b} \\ a^B &= \theta\left(f\left(s+\bar{b}\right)\right)^\nu + (1-\delta)\,f\left(s+\bar{b}\right) - (1+r)\,\bar{b} \end{aligned}$$

      iv. Update $V^E(\cdot)$

   (e) Update (**??**)

[3] Note that the algorithm is written for the case of a general, concave production function. The computations shown so far werde done for the linear case. To compare with the main text, set $\nu = 1$ and $\theta = A$.

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