Coarse Reputation and Entrepreneurial Risk Choice*

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Abstract

I analyze a model of anonymous debt markets in which investors finance entrepreneurs and only observe whether they have defaulted in the past. I show that there is a dynamic complementarity in risk choice: incentives to choose the safe project over the risky project in the current period are stronger (weaker) if other entrepreneurs ran safe (risky) projects in the past and also if they are expected to run safe (risky) projects in the future. Reputation concerns can induce entrepreneurs to be too conservative. This drives the economy to an inefficient equilibrium in which entrepreneurs choose safe projects over risky ones because if they fail they are excluded from financial markets. In this case a transition to the socially optimal risky equilibrium can be achieved by taxing entrepreneurs and subsidizing investment in a way that balances the budget and is Pareto improving.

1 Introduction

Attitude towards business failure is often cited as a determinant of entrepreneurship. For example, a higher tolerance towards failure is commonly invoked to explain the higher level and dynamism of entrepreneurial activity in the US, relative to Europe.[1] Moreover, there seems to be a strong stigma attached to failure in Europe, which makes it difficult for failed entrepreneurs to start a new project:

> "... In Europe those who go bankrupt tend to be considered as "losers". They face great difficulty to finance a new venture."
>
> European Commission (1998)

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[1] According to the European Commission (2007), 48% of Europeans agreed with the statement "You should not start a business if it might fail", compared with just 19% in the United States in 2007 (in 2004 the percentages were 51% and 33%, respectively).

This paper proposes an explanation, based on an endogenous stigma of failure, for why investors might be reluctant to finance failed entrepreneurs. I show how, for identical fundamentals, there might be two equilibria – one in which entrepreneurs run risky projects and are not heavily penalized if they fail and one in which entrepreneurs run only safe projects and are excluded from financial markets if they fail. Furthermore, I analyze how entrepreneurs' current risk choices depend on other entrepreneurs' past and future risk choices and why these equilibria are persistent.

When deciding whether to finance an entrepreneur whose previous venture went bankrupt, investors need to assess whether this failure was due to bad luck or a lack of talent. In the former case, it is wise to give the entrepreneur another chance since the bankruptcy was not due to poor entrepreneurial skills; in the latter case, it is unwise to refinance the entrepreneur.

Information about the entire history of successes and failures of this entrepreneur could help in the decision process. However, in practice complete histories are rarely available. Credit scores, when they are available, only imperfectly account for a borrower's credit history. Furthermore, private credit bureaus and public registers report mostly negative information such as defaults and arrears. In any case, it is also easier and cheaper for a creditor to only check if a borrower went bankrupt. For example, in the US, nearly all bankruptcy courts have an automated line which allows a bankruptcy search by case number, name, or social security number. Similarly, in some countries creditors can ask borrowers to provide a certificate of non-bankruptcy.

To investigate how this information structure affects risk-taking decisions of entrepreneurs I develop a model of anonymous credit markets in which investors only observe whether a borrower defaulted in the past or not. This economy has two stationary equilibria, one in which entrepreneurs run safe projects and one in which they run risky projects. The *safe* equilibrium is characterized by safe projects with low returns and a high ratio of good to bad entrepreneurs. In the *risky* equilibrium[2] returns are higher but the ratio of good to bad entrepreneurs is lower. For a range of fundamentals, the economy either converges to the safe or to the risky stationary equilibrium. I show that the safe equilibrium can prevail despite being Pareto dominated by the risky equilibrium.

[2] Returns are uncorrelated: there is no aggregate risk.

This follows because in the safe equilibrium entrepreneurs are excluded from financial markets if they fail and hence prefer safe projects in spite of their lower return. I further show how a policy of taxes and subsidies can be used to induce entrepreneurs to take on risk and reach the optimal risky equilibrium. Moreover this policy is budget-balanced and is Pareto improving for current and future generations of entrepreneurs.

Investors do not observe entrepreneurs' types (good or bad) but only observe their records. A *clean record* signals that an entrepreneur never defaulted whereas a *dirty record* signals that she defaulted at some point in the past. Since bad entrepreneurs always fail, the ratio of good to bad entrepreneurs is higher for clean records than for dirty records. This implies that entrepreneurs benefit from lower borrowing costs if they have a clean record than with a dirty record. Therefore, good entrepreneurs with clean records face a trade-off when they choose between a risky and a safe project: the risky project offers a higher expected return than the safe one but fails with positive probability; if she fails, the entrepreneur loses her clean record and incurs higher borrowing costs in the future.

When they run safe projects, good entrepreneurs are always successful and only bad entrepreneurs fail, which means that the pool of clean records improves while the pool of dirty records deteriorates. As a result borrowing costs decrease for clean records but increase for dirty records. This in turn increases the value of a clean record and gives entrepreneurs stronger incentives to choose the safe project. Similarly, if entrepreneurs run risky projects, good entrepreneurs fail with positive probability and the difference in quality between the pool of clean and dirty records is lower, which results in a smaller difference in borrowing costs. Consequently, the value of a clean record is lower and incentives to run risky projects are stronger.

Not only is there a complementarity in project choice in the current period but there is also a dynamic complementarity with past and future project choices of all entrepreneurs. If entrepreneurs ran safe project in the past, few good entrepreneurs have dirty records. This implies that borrowing costs are much lower for a clean than for a dirty record [3] and the value of a clean record is high, which makes the safe project more attractive. Analogously, if entrepreneurs are expected to run safe projects in

[3] Dirty records' projects are not even financed if the quality of their pool is too low.

the future, borrowing costs will become lower for clean records and higher for dirty records (until dirty records are not financed anymore), which increases the current and future value of a clean record and induces entrepreneurs to choose the safe project. For a range of fundamentals this complementarity in project choice pushes the economy either towards a safe or a risky stationary equilibrium. Those equilibria differ in terms of welfare, which means that entrepreneurs' decisions are not always optimal when multiple equilibria exist.

The main result of this paper is that, for some fundamentals, the economy can be trapped in a safe equilibrium although the risky equilibrium would be optimal. Entrepreneurs all choose to run safe projects because risky projects present a positive probability of losing their clean records and thus not being financed in the future. In this case, I show that a social planner endowed with the same information as investors can fix this market failure by taxing entrepreneurs' revenues and subsidizing investment in failed entrepreneurs in a way that balances the budget and is Pareto improving. By allowing failed entrepreneurs to start new projects, this policy encourages risk taking. Moreover, once good entrepreneurs also fail, failure does not signal solely a lack of entrepreneurial ability, but incorporates a component of luck as well. Therefore the stigma attached to a failure diminishes and the economy moves to the Pareto-superior risky equilibrium.

This paper is organized as follows. Following the literature review, Section 2 introduces the model. Stationary equilibria are introduced in Section 3. Section 4 discusses the dynamics of the model. Section 5 explores the welfare properties of those stationary equilibria. Section 6 discusses how the economy can be trapped in an inefficient safe equilibrium. Section 7 concludes.

1.1 Related Literature

There is a large literature on reputation in debt markets, pioneered by Diamond (1989), that shows that reputation concerns can deter excessive risk-taking. Instead of assuming that the entire history of the borrower is observed by the lender, in my model investors only observe if a borrower ever defaulted in the past or not. As a result, reputation concerns can also induce entrepreneurs to be excessively cautious[4].

The effect of asymmetric information on entrepreneurial finance is analyzed in several papers. In Gromb and Scharfstein (2002) agents become either entrepreneurs or intrapreneurs (projects are financed by the firm). Firms use information about failed intrapreneurs to redeploy them into other jobs while entrepreneurs look for jobs in an imperfectly informed labor market. This results in equilibria with high and low entrepreneurship which sometimes coexist. Schumacher, Kowalik and Gerling (2010) show that if banks cannot perfectly observe the risk of previous projects, there exists an inefficient equilibrium in which entrepreneurs might undertake only low-risk projects because they have no access to finance after a failure. The mechanism in my model is closest to Landier (2006). In his framework, failure is due either to bad luck or to lack of talent and investors do not distinguish whether an entrepreneur starts a new venture because the previous one failed or to pursue a more promising project. If the cost of capital for new project is high (low), few (many) entrepreneurs abandon projects. This implies that the pool of failed entrepreneurs contains few (many) good entrepreneurs and in turn justifies the high (low) cost of capital. I use a similar idea to build a fully dynamic model of anonymous credit markets which, in contrast to these papers, has the feature that in equilibrium entrepreneurs' project choices depend on other entrepreneurs' choices in the current period and also on their past and future project choices. This implies that a suboptimal equilibrium is not only due to agents' beliefs but is inherited from previous generations.

Similarly to Tirole (1996) who applies the idea of collective reputation to the persistence of corruption and to firm quality, an entrepreneur's project choice depends on her own past behavior -through her record- and other entrepreneurs' past behaviors -through the cost of borrowing. Finally, in the spirit of Ely and Valimaki (2003), this paper provides an example in which reputation concerns can induce agents to take the wrong action.

[4] In Diamond (1989)'s setting, excessive risk-taking has it source in a moral hazard problem between the entrepreneur and the investor. In order to focus on the main mechanism there is no moral hazard problem in my model but the result that entrepreneurs can be excessively cautious survives if moral hazard is introduced.

2 The Model

2.1 Environment

There is a continuum of good and bad entrepreneurs, with respective fractions π and $1-\pi$, who survive with probability δ to the next period. Types are private information. Every period good entrepreneurs choose between a safe project that returns $S > 1$ with certainty and a risky project that delivers R with probability p and 0 with probability $1-p$. The risky project has a higher expected return than the safe one, i.e. $pR > S$. Bad entrepreneurs mimic good entrepreneurs' project choices but always fail[5]. Both projects cost 1, which entrepreneurs need to borrow from short-lived investors who are replaced every period[6].

Investors do not observe entrepreneurs' types but have access to entrepreneurs' records, which are either clean if an entrepreneur never defaulted or dirty otherwise. Both entrepreneurs and investors are risk neutral. Investors compete with each others to finance entrepreneurs, which means that they just break even in equilibrium. For simplicity investors's outside investment opportunities have a zero return which normalizes the expected repayment to the cost of a project.

If the project is successful, the entrepreneur's period payoff consists in the return of the project net of the cost of debt and the investor gets the face value of debt net of the cost of the project. If the project fails it is liquidated and the entrepreneur's record is dirty forever. The entrepreneur gets a payoff of zero and the investor's loss equals the cost of the project, 1.

2.2 Timing

The timing in each period is as follows:

1. $1-\delta$ new entrepreneurs are born to replace those who died at the end of the previous period. $(1-\delta)\,\pi$ are good entrepreneurs and $(1-\delta)\,(1-\pi)$ are bad ones.

[5] One could think of a behavioral type or assume that bad entrepreneurs get positive utility just from running projects.

[6] It is sufficient to assume that the same entrepreneur and investor never meet again in the future.

2. Entrepreneurs are matched with new investors who only observe their record, which is c (clean) if she never defaulted and d (dirty) if she defaulted at least once in the past. New entrepreneurs start with a clean record. Each entrepreneur acquires a loan of 1 at a rate that depends on her record and on the type of project she chooses (safe or risky). The project choice is contractible.

3. Safe and risky projects run by good entrepreneurs succeed respectively with probability 1 and p. Projects run by bad entrepreneurs always fail.

4. If a project succeeds the entrepreneur repays the investor and consumes the remaining cash flow. If the project is not successful it is liquidated and the investor and entrepreneur get a payoff of respectively -1 and 0. The entrepreneur's record stays clean only if she always repaid investors.

5. Entrepreneurs die with probability $1-\delta$.

2.3 Flows Across States

The cost of debt depends on the fractions of good and bad entrepreneurs with clean and dirty records. I denote by $\mu_{jk,t}$ the proportion of agents of good and bad type $j \in \{G, B\}$ with clean and dirty records $k \in \{c, d\}$. Bad entrepreneurs only hold a clean record in the first period of their lives and then a dirty record as long as they survive. There are $1-\pi$ bad entrepreneurs who always fail. Thus only the $1-\delta$ newborns have a clean record

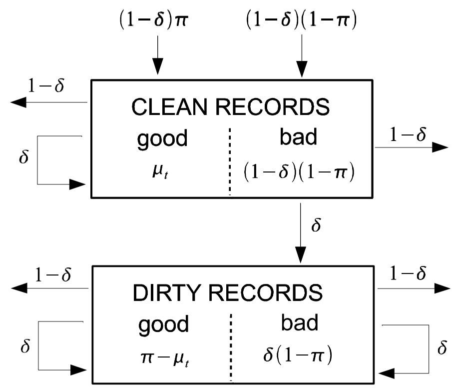
$$\mu_{Bc} = (1-\delta)(1-\pi)$$

and the remaining bad entrepreneurs have a dirty record

$$\mu_{Bd} = \delta(1-\pi)$$

Since the fractions μ_{Bc} and μ_{Bd} of bad entrepreneurs are constant, the proportion of good types with clean records $\mu_t \equiv \mu_{Gc,t}$ is a sufficient variable to keep track of the evolution of all groups. The proportion of good entrepreneurs with dirty records is $\mu_{Gd,t} = \pi - \mu_t$.

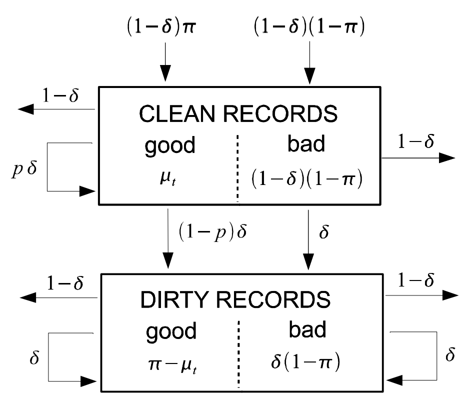
The law of motion of μ_t depends on the project choice. If good entrepreneurs choose the safe project they are always successful. Each period good entrepreneurs with a clean record survive with probability δ and there is a mass $(1-\delta)\,\pi$ of new good entrepreneurs (who start with a clean record):



If clean records choose the safe project the law of motion for the fraction of good entrepreneurs with clean records is

$$\mu_{t+1} = \delta\mu_t + (1-\delta)\,\pi \tag{1}$$

If good entrepreneurs with clean records choose the risky project they succeed with probability p and survive with probability δ, in which case they keep their clean records. Otherwise, with probability $1-p$ the project fails and their record is dirty for the rest of their lives.



The law of motion becomes

$$\mu_{t+1} = p\delta\mu_t + (1-\delta)\,\pi \tag{2}$$

2.4 Investor's Problem

Every period there is a new continuum of investors competing to finance entrepreneurs. If the latter choose the safe project, investors charge $C(\mu_t, k)$ to entrepreneurs with record k and are paid back only if the project is successful. For investors to break even, the borrowing cost is equal to the cost of the project and the cost of financing μ_{Bc} bad entrepreneurs with clean records divided by μ_t good entrepreneurs:

$$C(\mu_t, c) = 1 + \frac{(1-\delta)(1-\pi)}{\mu_t}$$

Similarly, the borrowing cost for dirty records is the cost of the project and the cost of financing μ_{Bd} bad entrepreneurs with dirty records divided by $\pi - \mu_t$ good entrepreneurs with dirty records. However, if the expected cost of financing a dirty record is higher than the expected return investors are not willing to finance dirty records. For tractability, the expected cost of debt for a dirty record is

$$C(\mu_t, d) = \min\left\{1 + \frac{\delta(1-\pi)}{\pi - \mu_t}, pR\right\}$$

This implies that if $C(\mu_t, d) = pR$ both the investor and the entrepreneur get a payoff of zero, which corresponds to the situation in which no loan is made. The pool of clean records always contains a smaller proportion of bad entrepreneurs than the pool of dirty records. Consequently, borrowing costs are lower for clean records.

If entrepreneurs choose the risky projects, investors need to charge $\frac{C(\mu_t,k)}{p}$ to break even since the project only succeeds with probability p. Thus the face value of debt is $D(\mu_t, k) = C(\mu_t, k)$ if the entrepreneur chooses the safe project and $D(\mu_t, k) = \frac{C(\mu_t,k)}{p}$ if she chooses the risky project. Good entrepreneurs pay back $C(\mu_t, k)$ in the former and $\frac{C(\mu_t,k)}{p}$ with probability p in the latter case. This implies that the expected cost of financing a project for an entrepreneur with record k, $C(\mu_t, k)$, does not depend on the project choice.

2.5 Entrepreneur's Problem

The expected lifetime utility of a good entrepreneur with a clean record is

$$V(\mu_t, c) = \max\left\{\begin{array}{c} S - C(\mu_t, c) + \delta V(\mu_{t+1}, c), \\ pR - C(\mu_t, c) + p\delta V(\mu_{t+1}, c) + (1-p)\delta V(\mu_{t+1}, d) \end{array}\right\} \quad (3)$$

If she plays safe, she gets $S - C(\mu_t, c)$ and enters the following period with a clean record. If she chooses the risky project, she is successful with probability p, in which case she repays $\frac{C(\mu_t,c)}{p}$, keeps $R - \frac{C(\mu_t,c)}{p}$ for herself and enters the next period with a clean record. With probability $1-p$, she defaults, gets nothing and enters the next period with a dirty record. Individually, entrepreneurs have no effect on the law of motion for the fraction of good entrepreneurs with clean records and hence take μ_{t+1} as given.

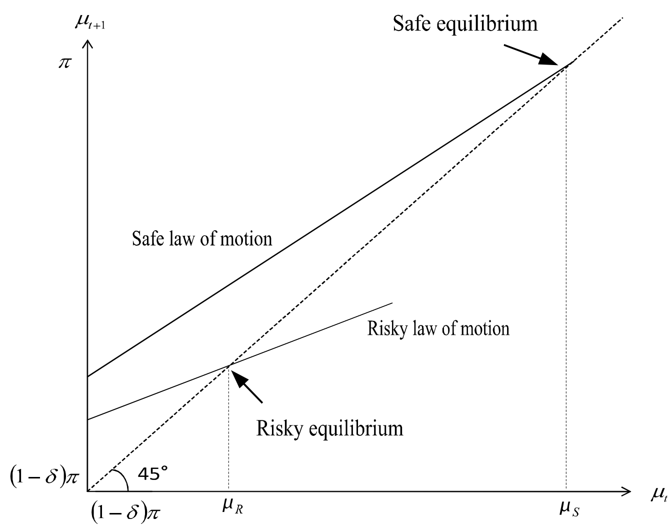
Since dirty records have no reputation motives, they always choose the project with the highest expected return, which is the risky one. The expected lifetime utility of a good entrepreneur with a dirty record is

$$V(\mu_t, d) = pR - C(\mu_t, d) + \delta V\left(\mu_{t+1}, d\right) \tag{4}$$

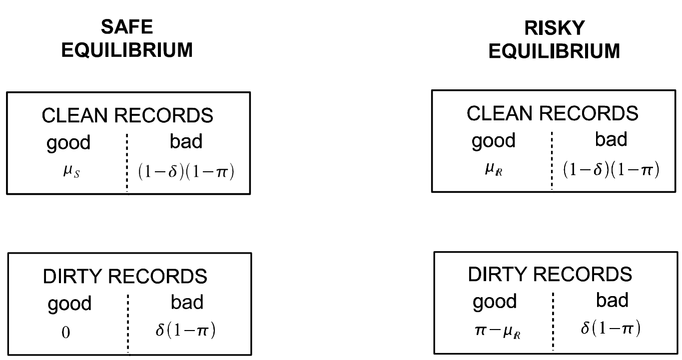
When the expected cost of a project is higher or equal to pR, no loan is made and the period payoff is zero since $C(\mu_t, d) = pR$.

3 Stationary Equilibria

This model has two types of stationary equilibria that correspond to the fixed points of the safe and risky laws of motion (1) and (2), respectively $\mu_S = \pi$ and $\mu_R \equiv \frac{(1-\delta)\pi}{1-p\delta} < \mu_S$.



In the *safe* equilibrium, since safe projects run by good entrepreneurs never fail, only bad entrepreneurs have a dirty record and are not financed. In the *risky* equilibrium, good entrepreneurs' projects fail with probability p, which means that some good entrepreneurs also have a dirty record.



For the remainder of the paper I assume that fundamentals are such that dirty records create a positive surplus in the risky equilibrium:

$$(\pi - \mu_R)(pR - 1) - \delta(1 - \pi) > 0 \tag{A1}$$

This assumption guarantees that dirty records are financed in the risky equilibrium ($C(\mu_R, d) < pR$), which is the case of interest and is also a necessary condition for the main result of the paper.

3.1 Safe Equilibrium

In this equilibrium good entrepreneurs run safe projects and never fail. Their expected lifetime utility is

$$V(\mu_S, c) = S - C(\mu_S, c) + \delta V(\mu_S, c)$$

Only bad entrepreneurs default, which implies that a dirty record unambiguously signals a bad type and failed entrepreneurs are thus not financed ($C(\mu_S, d) = pR$).

A safe equilibrium exists if there is no profitable deviation for investors and entrepreneurs. Investors cannot charge less since they just break even by charging $C(\mu_S, c)$ and would not finance any entrepreneur if they charged more than $C(\mu_S, c)$[7]. A one-shot deviation by an entrepreneur would give her a higher expected period payoff $pR - C(\mu_S, c)$ (instead of $S - C(\mu_S, c)$) but she would fail with probability $1 - p$ and not be refinanced in this case. Thus, for a safe equilibrium to exist

$$pR - S \leq (1 - p)\,\delta \Delta V(\mu_S) \tag{5}$$

This condition means that the expected gain from running the risky instead of the safe project is not greater than the discounted expected loss from choosing the risky project. The latter corresponds to the discounted value of a clean record in the safe equilibrium multiplied by the probability of failing the risky project and losing the clean record. The value of a clean record in the safe equilibrium is

$$\Delta V(\mu_S) \equiv V(\mu_S, c) - V(\mu_S, d) = V(\mu_S, c) = \frac{S - C(\mu_S, c)}{1 - \delta}$$

since dirty records are not financed.

[7] I assumed throughout the paper that the continuum of investors is bigger than the continuum of entrepreneurs.

3.2 Risky Equilibrium

Given assumption A1, all entrepreneurs are financed in the risky equilibrium. Good entrepreneurs with dirty records run risky projects every period and have expected lifetime utility

$$V\left(\mu_R, d\right) = \frac{pR - C\left(\mu_R, d\right)}{1-\delta}$$

When running a risky project, clean records are successful with probability p, get $R - \frac{C(\mu_R, c)}{p}$ in the current period and keep their clean record. Otherwise they get zero in the current period and have a dirty record for the rest of their lives

$$V\left(\mu_R, c\right) = pR - C\left(\mu_R, c\right) + p\delta V\left(\mu_R, c\right) + (1-p)\,\delta V\left(\mu_R, d\right)$$

The existence of a risky equilibrium requires that entrepreneurs do not want to run the safe project in the current period and keep their clean record with certainty. That means, the return differential between the risky and the safe project is at least as large as the discounted value of a clean record multiplied by the probability of a failure for the risky project.

$$pR - S \geq (1-p)\,\delta\Delta V\left(\mu_R\right) \tag{6}$$

The value of the clean record in the risky equilibrium is

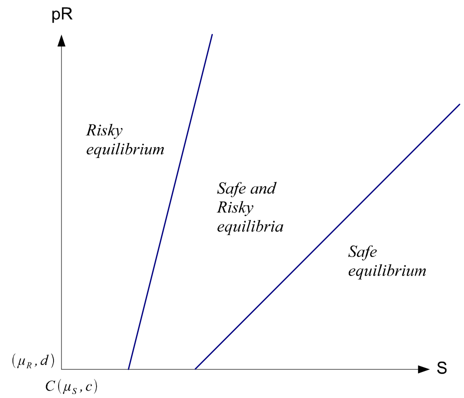
$$\Delta V\left(\mu_R\right) \equiv V\left(\mu_R, c\right) - V\left(\mu_R, d\right) = \frac{C\left(\mu_R, d\right) - C\left(\mu_R, c\right)}{1-p\delta}$$

It corresponds to the difference in borrowing costs between a dirty and a clean record discounted by the probability of success p and the probability of survival δ.

3.3 Multiplicity of Equilibria

Using the necessary conditions for existence of a safe (5) and risky (6) equilibrium, the plane (pR, S) can be divided in different zones. If the difference in expected return between the risky and the safe project $pR - S$ is high only risky equilibria exist while only safe equilibria exist for a small difference in expected returns. Otherwise, depending on initial beliefs and the initial fraction of good entrepreneurs with clean records μ_0 there can be a safe or a risky equilibrium for the same fundamentals.

Proposition 1 *There exists fundamentals such that the safe and the risky equilibrium coexist*



Proof. Since $C(\cdot,\cdot)$ does not depend on S and R (and is finite), one can pick S and R such that

$$\frac{C(\mu_R, d) - C(\mu_R, c)}{1 - p\delta} \leq \frac{pR - S}{(1-p)\,\delta} \leq \frac{S - C(\mu_S, c)}{1 - \delta}$$

Then both (5) and (6) are satisfied. ∎

The trade-off between the safe and the risky project is the following: The risky project offers a higher expected return in the current period than the safe one but also has a higher probability of failing, which is sanctioned by a dirty record. Dirty records are either excluded from financial markets or incur higher borrowing costs than clean records, which means that an entrepreneur who loses her clean record lowers her future payoffs.

The multiplicity of equilibria result from the value of a clean record being higher in the safe than in the risky equilibrium. If entrepreneurs run the safe project the pool of clean records contains a high fraction of good entrepreneurs, which translates into low borrowing costs for clean records. The pool of dirty records, on the other hand, contains only bad entrepreneurs and thus dirty records are not financed. The value of a clean record is then high and choosing the safe project guarantees a clean record in the future. If entrepreneurs run the risky project the pool of clean records is of lesser quality but the pool of dirty records contains enough good entrepreneurs for them to be financed. Thus the difference in borrowing cost between a clean and a dirty record is small. The value of a clean record is then lower and the trade-off between the current period and future payoffs is in favor of the current payoff.

The next section analyzes equilibria out of the steady state and discusses the conditions under which the economy converges to each of the stationary equilibria.

4 Dynamics

The focus of this paper is on symmetric threshold equilibria in which good entrepreneurs choose the risky project as long as $\mu_t < \mu^*$ and the safe project for $\mu_t \geq \mu^*$[8]. The equilibrium law of motion for μ_t is

$$\mu_{t+1}(\mu_t) = \begin{cases} p\delta\mu_t + (1-\delta)\pi & \text{if} \quad \mu_t < \mu^* \\ \delta\mu_t + (1-\delta)\pi & \text{if} \quad \mu_t \geq \mu^* \end{cases} \tag{7}$$

In this section, I first discuss how borrowing costs depend on the evolution of the fraction of good entrepreneurs with clean records. Then I analyze how the project choice depends on the value of a clean record, itself determined by future borrowing costs. Finally I characterize the sets of threshold equilibria.

4.1 Cost of Debt

As the fraction of good entrepreneurs with clean records μ_t increases, the pool of entrepreneurs with clean records improves in the sense that the ratio of bad over good entrepreneurs $\frac{(1-\delta)(1-\pi)}{\mu_t}$ decreases. As a result, the probability of drawing a good entrepreneur from the pool of entrepreneurs with clean records increases in the proportion μ_t of good entrepreneurs with clean records, which means that borrowing costs for clean records $C(\mu_t, c)$ decrease in μ_t. Similarly, when μ_t increases the ratio of bad over good entrepreneurs with dirty records $\frac{\delta(1-\pi)}{\pi-\mu_t}$ increases and the probability of drawing a good entrepreneur from the pool of entrepreneur with dirty records decreases. Thus the expected cost of debt for dirty records $C(\mu_t, d)$ increases in the fraction of good entrepreneurs with a clean record until it reaches pR. Finally, the cost differential between a dirty and a clean record, $\Delta C(\mu_t) \equiv C(\mu_t, d) - C(\mu_t, c)$, is increasing in the proportion of good entrepreneurs with clean records.

[8] At μ^* entrepreneurs are indifferent between the risky and safe project. The type of project they choose has no influence on the results since μ^* has measure zero on the real line $[(1-\delta)\pi, \pi]$.

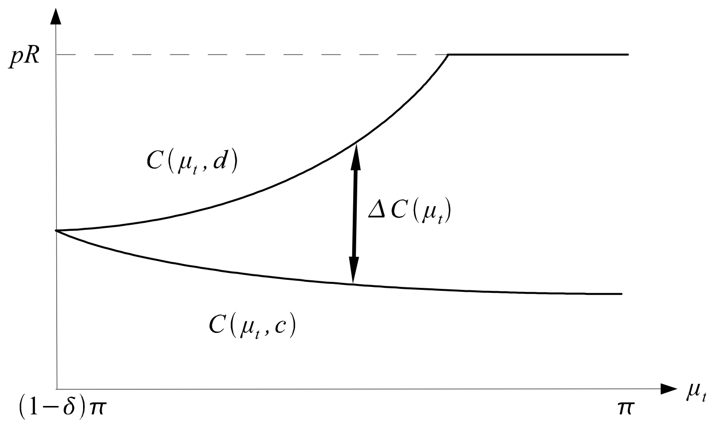


Figure 1

4.2 Project Choice

From the entrepreneur's problem (3), the differential gain from choosing the safe rather than the risky project in the current period is

$$\Lambda(\mu_t) \equiv \underbrace{S - pR}_{Return\ Differential} + (1-p)\,\delta \underbrace{\Delta V\left(\mu_{t+1}\right)}_{Value\ of\ a\ Clean\ Record} \tag{8}$$

Return Differential accounts for the differences in expected return. The second element, *Value of a Clean Record*, is discounted by the probability of survival and by the difference in probability of success between a safe and a risky project. The *Value of a Clean Record* at μ_t is equal to the expected discounted difference in value between a clean and a dirty record,

$$\Delta V(\mu_t) \equiv V(\mu_t, c) - V(\mu_t, d)$$

It depends on the current fraction of entrepreneurs with a clean record μ_t and on the threshold μ^* they use. The *Value of a Clean Record* is always positive since a clean record incurs lower borrowing costs than a dirty record (or the latter are not even financed). *Return Differential* is negative, which implies the following trade-off for an entrepreneur with a clean record: the risky project has a higher expected return than the safe one but also a positive probability to fail, in which case the clean record is lost.

4.3 Value of a Clean Record

The value of a clean record is a function of the sequence of future borrowing costs for clean records $C(\mu_t, c)$ and dirty records $C(\mu_t, d)$, which both depend on the evolution of μ_t. Next period's fraction of good entrepreneurs with clean records increases in the current period's fraction of good entrepreneurs with clean records. Since surviving entrepreneurs only keep their clean record with probability p when they choose the risky project, the fraction of good entrepreneurs with clean records increases faster when they choose the safe project. Thus, an economy that starts with a higher fraction of good entrepreneurs with clean records will always have a higher fraction of good entrepreneurs:

Lemma 2 *For a given μ^*, if $\mu_t > \mu'_t$, $\mu_{t+j} > \mu'_{t+j}$ for all $j \geq 0$.*

Proof. Suppose $\mu_t > \mu'_t$. Using (7)

$$\mu_{t+1} - \mu'_{t+1} = \begin{cases} \delta\left(\mu_t - \mu'_t\right) & \text{if} \quad \mu_t > \mu'_t \geq \mu \\ \delta\left(\mu_t - p\mu'_t\right) & \text{if} \quad \mu_t \geq \mu > \mu'_t \\ \delta p\left(\mu_t - \mu'_t\right) & \text{if} \quad \mu > \mu_t > \mu'_t \end{cases} > 0$$

■

This implies that the sequence of cost differentials $\Delta C\left(\mu_{t+j}\right)$, $j \geq 0$, is strictly higher when the economy starts with a higher fraction of good entrepreneurs with clean records (see figure 1). Consequently the value of a clean record also increases in the current fraction of good entrepreneurs with clean records.

Lemma 3 *$\Delta V(\mu_t)$ strictly increases in μ_t*

Proof. If project choices are the same at all t for two sequences $\left\{\mu_{t+j}\right\}_{j=0}^{\infty}$ and $\left\{\mu'_{t+j}\right\}_{j=0}^{\infty}$ with $\mu_t > \mu'_t$, the value of a clean record will be higher with $\left\{\mu_{t+j}\right\}_{j=0}^{\infty}$ than $\left\{\mu'_{t+j}\right\}_{j=0}^{\infty}$ since the expected revenues are the same and the cost differential $\Delta C\left(\mu_{t+j}\right)$ is higher for $\left\{\mu_{t+j}\right\}_{j=0}^{\infty}$ by Lemma 3. If the optimal project choice is not identical for all j, define $\tilde{V}(\mu_t, c)$ as the expected lifetime utility that would be obtained by picking the sequence of projects that is optimal with $\left\{\mu'_{t+j}\right\}_{j=0}^{\infty}$. Then,

$$\begin{aligned} \Delta V(\mu_t) &= V(\mu_t, c) - V(\mu_t, d) \geq \tilde{V}(\mu_t, c) - V(\mu_t, d) \\ &> V(\mu'_t, c) - V(\mu'_t, d) = \Delta V(\mu'_t) \end{aligned}$$

The weak inequality follows from $V(\mu_c, c) \geq \tilde{V}(\mu_t, c)$ since the sequence of project chosen is not necessarily optimal under $\left\{\mu_{t+j}\right\}_{j=0}^{\infty}$. The strict inequality results from the cost differential being strictly higher with $\{\mu_t\}_{t=0}^{\infty}$ than with $\{\mu_t'\}_{t=0}^{\infty}$. ■

Since the value of a clean record increases in the fraction of good entrepreneurs with clean records, the differential gain $\Lambda(\mu_t)$ also increases in the fraction of good entrepreneurs with clean records μ_t.

4.4 Complementarity in Risk Choice

For a given threshold μ^* the value of a clean record increases in the proportion of good entrepreneurs with clean records μ_t. Since the return differential is constant the net expected benefit of playing safe increases monotonically in the proportion of entrepreneurs with clean records (see equation (8)). This is the first source of complementarity: if clean records ran safe (risky) projects in the past the current fraction of good entrepreneurs with clean records is high (low) and the value of a clean record is high (low).

The second source of complementarity comes from current and future risk choices made by other entrepreneurs with clean records. If they run safe projects, all surviving good entrepreneurs keep their clean records whereas only a fraction p of those entrepreneurs keep their clean records if they run risky projects. Since the cost differential increases in the fraction of good entrepreneurs with clean records, the value of a clean record is higher when clean records pick the safe rather than the risky project. As a result, the net benefit of choosing the safe project is then also higher when clean records choose the safe project.

4.5 Threshold Equilibria

In general, a strategy for an entrepreneur with a clean record is a project choice for any value of μ_t. However, given that other entrepreneurs with clean records use a threshold strategy (risky project below μ^* and safe project above μ^*) it is also optimal for any entrepreneur to use a threshold strategy.

Definition 4 (Threshold Equilibrium) *A threshold equilibrium is defined by a thresh-*

old μ^* such that:

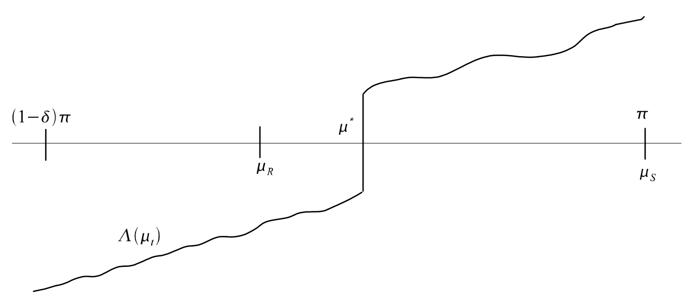
1. Given the expected borrowing costs $C(\mu_t, c)$ and $C(\mu_t, d)$ and the law of motion $\mu_{t+1}(\mu_t)$, good entrepreneurs maximize $V(\mu_t, c)$ by choosing the risky project for all $\mu_t < \mu^*$ and the safe one for $\mu_t \geq \mu^*$

2. Investors break even by charging $C(\mu_t, c)$ and $\frac{C(\mu_t,c)}{p}$ to clean records if they play respectively safe and risky and $\frac{C(\mu_t,d)}{p}$ to dirty records[9]

For the remainder of the paper I impose that the fundamentals (S, R, p, δ, π) are such that the safe and risky stationary equilibria exist (conditions (5) and (6)) for some initial condition and belief. That means, nobody unilaterally deviates from choosing the safe project at μ_S and from the risky project at μ_R:

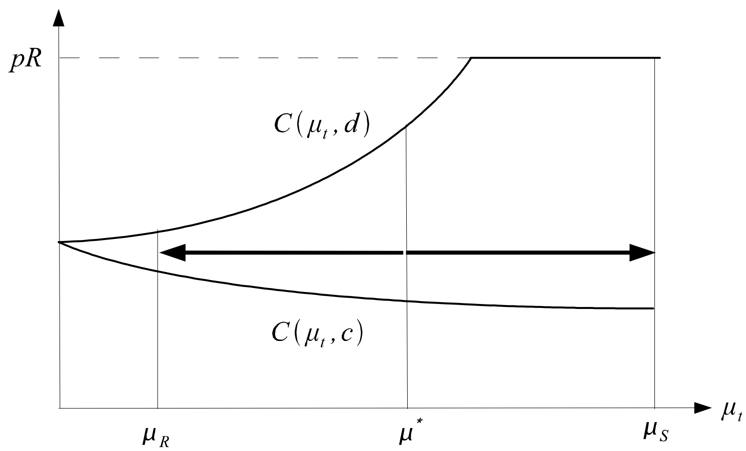
$$(1-p)\,\delta\Delta V(\mu_R) \leq pR - S \leq (1-p)\,\delta\Delta V(\mu_S) \tag{A2}$$

This guarantees that there exists a threshold equilibrium $\mu^* \in [\mu_R, \mu_S]$ such that the differential gain from choosing the safe rather than the risky project is negative below the threshold, $\Lambda(\mu_t) < 0$ for $\mu_t < \mu^*$, and positive above the threshold, $\Lambda(\mu_t) > 0$ for $\mu_t > \mu^*$:



Below μ^* the fraction of good entrepreneurs with clean records decreases and converges to μ_R, which implies that the cost differential also decreases over time. Above μ^* the fraction of good entrepreneurs with clean records increases and converges to μ_S and the cost differential increases over time.

[9] Dirty records always play risky in equilibrium since $pR > S$.



Thus the sequence of cost differential faced when clean records choose the safe project is strictly higher than if they choose the risky one, which results in a jump in the value of a clean record at the threshold μ^* and hence a discontinuity in the differential gain Λ at μ^*.

The jump in the differential gain between the safe and risky project at μ^* implies that there exists a continuum of equilibria. To understand why, consider a potential equilibrium threshold $\mu^{**} = \mu^* + \varepsilon$ (ε positive and small). The sequences of cost differentials starting from μ^{**} converging to μ_R and μ_S are slightly higher than those starting from μ^*, which implies that the value of a clean record is higher when everyone chooses respectively the risky and the safe project. Given that the differential gain at μ^* is strictly positive (negative) when everyone chooses the safe (risky) project, this remains true at μ^{**} for a small ε.

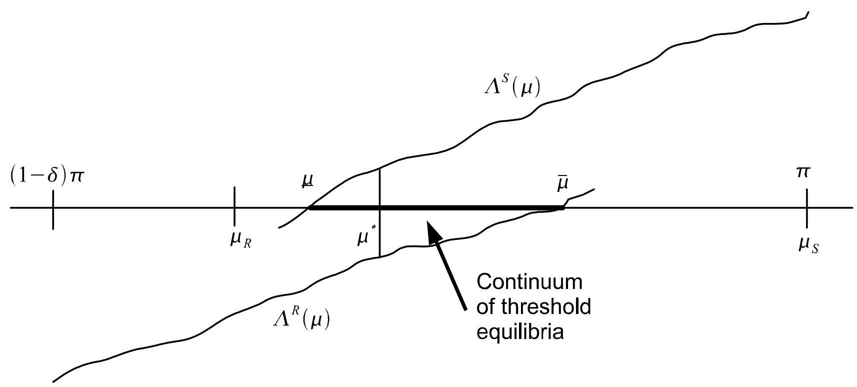
In order to define this continuum of equilibria I define $\Delta V^S(\mu)$ and $\Delta V^R(\mu)$ as the values of a clean record when clean records chooses respectively the safe and the risky project forever at μ. When all clean records choose the safe project, the safe law of motion (1) can be rewritten $\mu_t = \delta^t \mu + \left(1 - \delta^t\right) \mu_S$, where μ is the starting point. $\Delta V^S(\mu)$ is the discounted sum of the difference in payoffs between a good entrepreneur with a clean record who always run the safe project and an entrepreneur with a dirty record (who always run the risky project).

$$\Delta V^S(\mu) = \sum_{t=0}^{\infty} \delta^t \left(S - pR + \Delta C\left(\delta^t \mu + \left(1-\delta^t\right)\mu_S\right)\right)$$

Similarly, when all clean records choose the risky project, the risky law of motion (2) becomes $\mu_t = (p\delta)^t \mu + \left(1 - (p\delta)^t\right)\mu_S$. The sum of the difference in payoffs between a good entrepreneur with a clean record who always run the risky project and an entrepreneur with a dirty record is discounted by the probability of survival δ and the the probability of success p.

$$\Delta V^R(\mu) = \sum_{t=0}^{\infty} (p\delta)^t \left(\Delta C\left((p\delta)^t \mu + \left(1-(p\delta)^t\right)\mu_R\right)\right)$$

A2 guarantees that there always exist a continuum of equilibria $\mu^* \in \left[\underline{\mu}, \overline{\mu}\right] \subset [\mu_R, \mu_S]$:



I define

$$\Lambda^R(\mu) \equiv S - pR + (1-p)\,\delta\Delta V^R(p\delta\mu + (1-\delta)\pi)$$

as the differential gain from choosing the safe over the risky project in this case. If $\Lambda^R(\mu_S) \leq 0$, the upper bound is $\overline{\mu} = \mu_S$. Otherwise, from A2, $\Lambda^R(\mu_R) \leq 0$, and the fact that ΔV^R is continuous and increasing imply that there exists an upper bound $\overline{\mu} \in [\mu_R, \mu_S)$ defined by $\Lambda^R(\overline{\mu}) = 0$.

Similarly, I define

$$\Lambda^S(\mu) \equiv S - pR + (1-p)\,\delta\Delta V^S(\delta\mu + (1-\delta)\pi)$$

as the differential gain when all other clean records choose the safe project in the current period and forever after. If $\Lambda^S(\mu_R) \geq 0$, the lower bound is $\underline{\mu} = \mu_R$. Otherwise, from A2, $\Lambda^S(\mu_S) \geq 0$, and the fact that ΔV^S is continuous and increasing imply that there exists a lower bound $\underline{\mu} \in (\mu_R, \mu_S]$ defined by $\Lambda^S(\underline{\mu}) = 0$.

Proposition 5 *Given A2, there exists a continuum of threshold equilibria* $\mu^* \in [\underline{\mu}, \overline{\mu}] \subset [\mu_R, \mu_S]$*, where* $\underline{\mu}$ *and* $\overline{\mu}$ *are defined by*

$$\Lambda^R(\overline{\mu})(\overline{\mu} - \mu_S) = 0$$

and

$$\Lambda^S(\underline{\mu})(\underline{\mu} - \mu_R) = 0$$

Proof. To show that all $\mu^* \in [\underline{\mu}, \overline{\mu}]$ are threshold equilibria, I demonstrate that given that all other clean records choose the risky project below μ^* and the safe project above μ^*, it is optimal for any clean record to also do so.

For any $\mu_t < \mu^*$,

$$\begin{aligned} \Lambda(\mu_t) &= S - pR + (1-p)\delta\Delta V(p\delta\mu_t + (1-\delta)\pi) \\ &= \Lambda^R(\mu_t) < \Lambda^R(\mu^*) \leq \Lambda^R(\overline{\mu}) \leq 0 \end{aligned}$$

The inequalities follow from Λ^R increasing and non-positive at $\overline{\mu}$. Incentives to choose the risky project decrease over time since $\mu_t \to \mu_R$ and the value of a clean record ΔV is decreasing. Thus, if the risky project is chosen at some point, it is also chosen forever after when everyone runs the risky project forever, which implies that $\Lambda(\mu_t) = \Lambda^R(\mu_t)$.

Similarly, for any $\mu_t > \mu^*$,

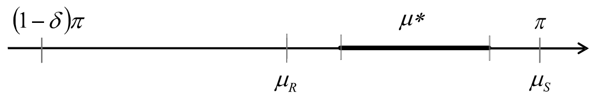
$$\begin{aligned} \Lambda(\mu_t) &= S - pR + (1-p)\delta\Delta V(\delta\mu_t + (1-\delta)\pi) \\ &= \Lambda^S(\mu_t) > \Lambda^S(\mu^*) \geq \Lambda^S(\underline{\mu}) \geq 0 \end{aligned}$$

The inequalities follow from Λ^S increasing and non-negative at $\underline{\mu}$. Incentives to choose the safe project increase over time since $\mu_t \to \mu_S$ and the value of a clean record ΔV is increasing. Thus, if the safe project is chosen at some point, it is also chosen forever after when everyone runs the safe project forever, which implies that $\Lambda(\mu_t) = \Lambda^S(\mu_t)$.

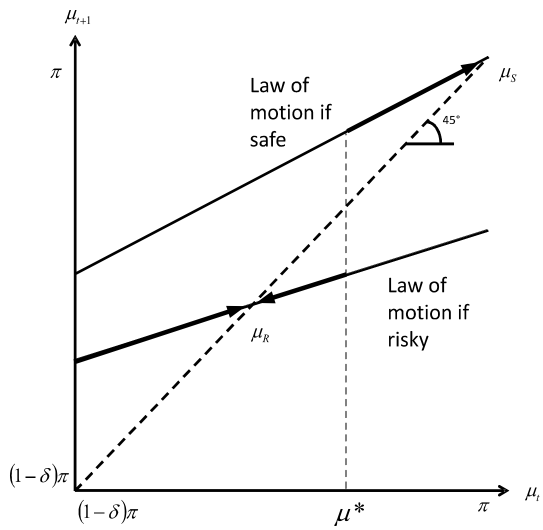
■

4.6 Sets of Equilibria

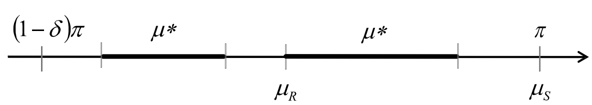
By Proposition 5 there exists a continuum of equilibria μ^* above μ_R:



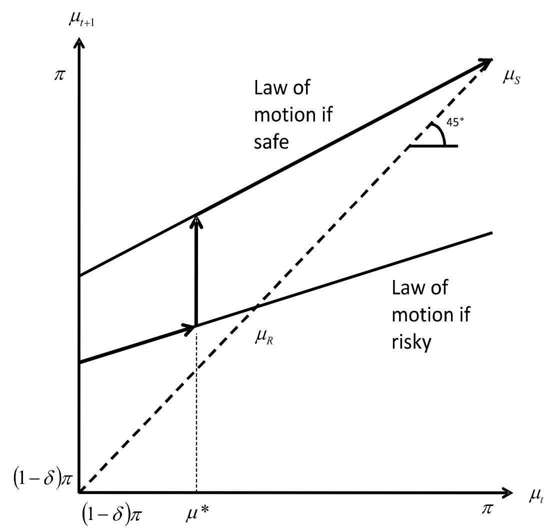
In those equilibria the economy converges to the safe stationary equilibrium if the initial fraction of good entrepreneurs with clean records is higher than the equilibrium threshold and to the risky stationary equilibrium otherwise:



In addition, when $\underline{\mu} = \mu_R$ there also exist threshold equilibria below μ_R for some fundamentals (see Proposition 8 in the Appendix):



If $\mu^* < \mu_R$ only the safe stationary equilibrium is reached when the threshold μ^* is below μ_R. In this case entrepreneurs choose the risky project for any $\mu_t < \mu^*$ and converge to the risky stationary equilibrium μ_R. However, in finite time they reach $\mu_t > \mu^*$, at which point the value of a clean record becomes too high to take the risk of losing it. At this point good entrepreneurs run the safe project every period and the economy converge to the safe stationary equilibrium μ_S.



5 Welfare

5.1 The Planner's Problem

In a world of perfect information only good entrepreneurs would be financed and the risky project would always be preferred to the safe. With imperfect information good and bad entrepreneurs are sorted using their record. The safe project allows to sort good entrepreneurs from bad ones more efficiently than the risky one since good entrepreneurs are always successful when they run the safe project, which is not the case with the risky project. However, there is also a loss since the risky project is more productive than the safe one.

Keeping the same information structure as in the decentralized problem, a social planner has two choices to make. First, she decides if entrepreneurs with clean records run safe or risky projects. If they run the safe project, the static return is the number of good entrepreneurs clean records μ_t multiplied by the return of the project S. If they run the risky project, the period return is $\mu_t pR$. In both cases, among clean records, μ_t good entrepreneurs and μ_{Bc} bad entrepreneurs that are financed. If entrepreneurs play safe, all good entrepreneurs are successful whereas only a fraction p of today's entrepreneurs are successful with the risky project. Thus starting from the same pool of clean records, the quality of next period's pool of clean records is higher if entrepreneurs run the safe rather than the risky project. Second, the social planner needs to decide if dirty records should be financed or not. Since they keep their dirty record no matter what they play, there is no informational benefit in having them run the safe project and the higher return of the risky project is hence preferred.

The period surplus of the safe stationary equilibrium is equal to the surplus $S-1$ created by $\mu_S = \pi$ good entrepreneurs net of the cost of financing $(1-\delta)(1-\pi)$ projects run by new bad entrepreneurs.

$$\begin{aligned} Y_S &= \mu_S (S-1) - (1-\delta)(1-\pi) \\ &= \mu_S (S - C(\mu_S, c)) \end{aligned} \tag{9}$$

All entrepreneurs with a clean record are financed. Among them μ_S good entrepreneurs are financed, produce S and pay back $C(\mu_S, 0)$. The extra cost of financing

$\mu_{Bc} = (1-\delta)(1-\pi)$ new bad entrepreneurs is born by μ_S good entrepreneurs:

$$C(\mu_S, c) = 1 + \frac{(1-\delta)(1-\pi)}{\mu_S}$$

The social surplus created in the risky equilibrium is

$$\begin{aligned} Y_R &= \mu_R(pR-1) - (1-\delta)(1-\pi) + (\pi-\mu_R)(pR-1) - \delta(1-\pi) \quad (10) \\ &= \mu_R(pR - C(\mu_R, c)) + (\pi-\mu_R)(pR - C(\mu_R, d)) \end{aligned}$$

and corresponds to the social surplus produced respectively by clean and dirty records. A1 guarantees that the net surplus created by $\pi - \mu_R$ good entrepreneurs with dirty records is larger than the cost of financing $\mu_{Bd} = \delta(1-\pi)$ bad entrepreneurs with clean records. Clean and dirty records pay different borrowing costs that reflect the quality of their pools. Among clean records, only $\mu_R < \pi$ good entrepreneurs but the same number μ_{Bc} of bad entrepreneurs are financed. This is reflected in higher borrowing costs for clean records than in the safe equilibrium

$$C(\mu_R, c) = 1 + \frac{(1-\delta)(1-\pi)}{\mu_R} > C(\mu_S, c)$$

The cost of financing bad entrepreneurs is fully internalized by the market since borrowing costs reflect the quality of the pools of clean and dirty records and dirty records are only financed when it is efficient to do so. This implies that investors' decisions are optimal.

However, entrepreneurs' choices are not always welfare maximizing. Individually, entrepreneurs have no effect on the quality of the pools of clean and dirty records and hence clean records do not take into account that their project choices influence future borrowing costs. By running safe projects they improve the pool of clean records and deteriorate the pool of dirty records, which translates into a decrease in borrowing costs for clean records and an increase in cost for dirty records.

5.2 Welfare Comparisons across Equilibria

In general, welfare comparisons between stationary equilibria are ambiguous if the transition is taken into account. Specifically, if the economy is in the risky equilibrium but the total period surplus is higher in the safe equilibrium, it does not follow that a transition to this safe equilibrium is desirable. If all entrepreneurs with clean records run the safe project there is a benefit in terms of sorting but a cost in term of current production. The benefit is that the pool of clean records is improved, which ultimately implies that the period surplus becomes higher since

$$Y_S = \pi (S-1) - (1-\delta)(1-\pi) > \pi (pR-1) - (1-\pi) = Y_R$$

However, for a given fraction of good entrepreneurs with clean records, the total surplus decreases for any $\mu \in [\mu_R, \mu_S]$ when entrepreneurs with clean records run safe projects

$$\begin{aligned} Y_S(\mu) &= \mu (S-1) - (1-\delta)(1-\pi) + \max\{(\pi-\mu)(pR-1) - \delta(1-\pi), 0\} \\ &< \mu (pR-1) - (1-\delta)(1-\pi) + \max\{(\pi-\mu)(pR-1) - \delta(1-\pi), 0\} = Y_R(\mu) \end{aligned}$$

since the safe project is less productive than the risky one. Thus the cost is incurred immediately but benefits only arise in the future. Hence, welfare depends on the weights given to future generations by the social planner. If the weights of future generations are high enough the transition is worthwhile, otherwise the decrease in utility of current generations is not compensated by future generations' increase in utility.

Fortunately, a clear welfare statement can be made when entrepreneurs with clean records play safe but the total period surplus would be higher in the risky equilibrium:

$$Y_S = \pi (S-1) - (1-\delta)(1-\pi) < \pi (pR-1) - (1-\pi) = Y_R$$

This arises when the benefit of sorting, namely not financing $\delta(1-\pi)$ bad entrepreneurs with dirty records, is smaller than the cost of running the safe instead of the risky project:

$$\delta (1-\pi) < \pi (pR - S) \tag{11}$$

The latter implies that there is no value in sorting entrepreneurs. Good entrepreneurs with clean records should run risky projects and, as soon as the pool of dirty records contains enough good entrepreneurs, dirty records should be financed as well. No information about entrepreneurs' records is necessary to achieve the period surplus of the risky equilibrium. Thus, the surplus is also higher during the transition to the risky equilibrium than in the safe equilibrium:

$$\begin{aligned} Y_R(\mu) &= \mu(pR-1) - (1-\delta)(1-\pi) + \max\{(\pi-\mu)(pR-1) - \delta(1-\pi), 0\} \\ &\geq Y_R > Y_S \end{aligned}$$

As a result, when (11) is satisfied, the safe equilibrium is dynamically inefficient. That means, not only does the risky equilibrium Pareto dominate the safe equilibrium but a transition from the safe to the risky equilibrium is Pareto-improving.

6 Inefficient Safe Equilibrium

If the surplus produced by dirty records is large enough entrepreneurs can be too cautious. They do not internalize that by failing they deteriorate the pool of clean records but also improve the pool of dirty records. If the second effect dominates the first, entrepreneurs can be trapped in the safe equilibrium although the risky one would produce a higher social surplus.

When fundamentals are such that the period surplus is higher in the risky than in the safe equilibrium, good entrepreneurs are also better off in the risky equilibrium. The expected lifetime utility of a good entrepreneur with a clean record in the safe equilibrium is

$$V\left(\mu_S, c\right) = \frac{1}{1-\delta}\frac{Y_S}{\pi}$$

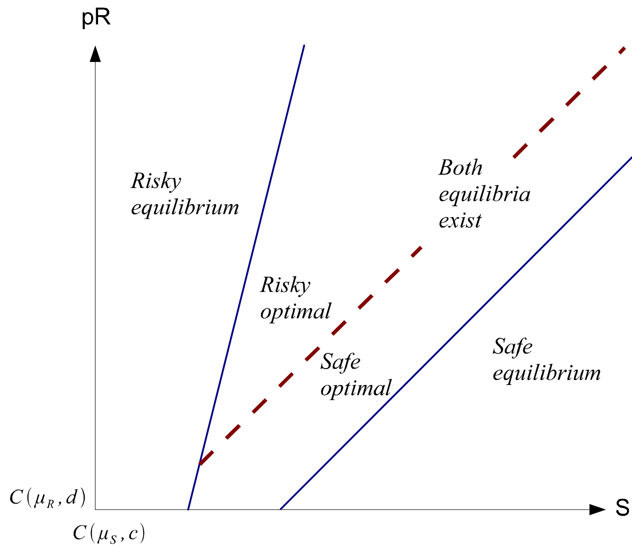
Every period the surplus Y_S is shared between π good entrepreneurs who live on average $\frac{1}{1-\delta}$ periods. Similarly, in the risky equilibrium,

$$V\left(\mu_R, c\right) = \frac{1}{1-\delta}\frac{Y_R}{\pi}$$

The surplus Y_R is shared between π good entrepreneurs who live on average $\frac{1}{1-\delta}$ periods. As long as a good entrepreneur keeps her clean record, she gets a higher share of the period surplus than if she has a dirty record since the cost of borrowing is lower. However, over the entrepreneur's lifetime her expected average period payoff is $\frac{Y_R}{\pi}$.

Thus, if the surplus created in the risky equilibrium is higher than in the safe one, the risky equilibrium also Pareto-dominates the safe one since the lifetime utility of a good entrepreneur with a clean record is higher: $V\left(\mu_S, c\right) > V\left(\mu_R, c\right)$. The following proposition establishes that the economy can be in a safe equilibrium that is dynamically inefficient:

Proposition 6 *There are fundamentals for which there exists a safe equilibrium that is dynamically inefficient*



Proof. Since $C(\mu_S, 0)$ does not depend on S and R (and is finite), one can pick S and R such that

$$\frac{\delta(1-\pi)}{\pi} < pR - S \leq (1-p)\,\delta\frac{S - C(\mu_S, c)}{1-\delta}$$

The condition for existence of a safe equilibrium (5) is satisfied and the strict inequality implies that $Y_R > Y_S$. If all entrepreneurs run risky projects and share the surplus between successful entrepreneurs, all good entrepreneurs are strictly better off since their expected lifetime utility is

$$\frac{p\frac{Y_R(\mu)}{p\pi}}{1-\delta} \geq \frac{p\frac{Y_R}{p\pi}}{1-\delta} > \frac{\frac{Y_S}{\pi}}{1-\delta} = V(\mu_S, c)$$

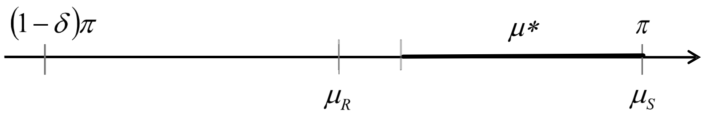
and bad entrepreneurs are also better off since they were not financed in the safe equilibrium. ■

6.1 Coordination versus Initial Condition

The necessary condition for existence of a safe equilibrium (5) states that at μ_S no clean record unilaterally chooses the risky projects when everyone else picks the safe one. In some cases, this inefficient safe equilibrium is due to a coordination problem. That means that if all good entrepreneurs with clean records decided to run the risky project forever no entrepreneur would want to continue running safe projects and the economy would converge to the risky project. This happens when the net benefit of playing safe in the current period is non-positive when everyone else runs risky projects forever:

$$S - pR + (1-p)\,\delta\Delta V^R(\mu_S) \leq 0$$

Stated differently, the upper bound on the set of threshold equilibria is $\overline{\mu} = \mu_S$

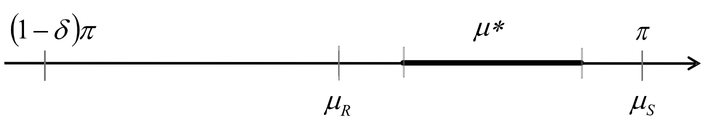


which means that if entrepreneurs can coordinate on $\mu^* = \mu_S$ the economy will converge to the risky equilibrium.

However, it can also be the case that solving the coordination problem is not enough to convince entrepreneurs to choose risky projects. In other words, the net benefit of choosing the safe project over the risky project in the current period is positive even if everyone else runs risky projects forever:

$$S - pR + (1-p)\,\delta\Delta V^R(\mu_S) > 0$$

This corresponds to



In this case there is no threshold equilibrium $\mu^* = \mu_S$. Thus, at $\mu_t = \mu_S$, even if all entrepreneurs could coordinate on running risky projects forever, they would be better off deviating unilaterally and choosing the safe project instead. All entrepreneurs would be better if the economy transitions to μ_R but the high initial value of a clean record results in a free-riding problem: despite the fact that everyone would be better off running risky projects, nobody wants to incurs the risk of losing their clean records. This situation occurs in the numerical example in Section 6.4.

6.2 Bad Reputation

From the planner's perspective, records become useless when the surplus in the risky equilibrium is higher than in the safe one. Indeed, the planner could redistribute the surplus of the risky equilibrium so that clean and dirty records are better off. In the safe equilibrium, clean records get

$$S - C(\mu_S, 0) = \frac{Y_S}{\pi}$$

every period and dirty records are not financed.

If there were no records investors could finance all entrepreneurs at expected rate $C^P = 1 + \frac{1-\pi}{\pi}$ and break even since π good entrepreneurs run risky projects and are successful with probability p:

$$\pi p C^P = 1$$

All good entrepreneurs would be better off since their expected lifetime utilities would be

$$\frac{pR - C^P}{1-\delta} = \frac{\frac{Y_R}{\pi}}{1-\delta} > \frac{\frac{Y_S}{\pi}}{1-\delta} = \frac{S - C(\mu_S, 0)}{1-\delta}$$

Since only bad entrepreneurs fail in the safe equilibrium, a dirty record is a perfect signal that the entrepreneur is bad. Thus investors only finance clean records and failed entrepreneurs are excluded from financial markets. In this case, reputation is bad: if investors could not observe entrepreneurs' records, this inefficient safe equilibrium would not arise. Instead, there would be a pooled equilibrium in which all entrepreneurs borrow at expected cost $C^P = 1+\frac{1-\pi}{\pi}$ so that the fraction $1-\pi$ of bad entrepreneurs are financed by the fraction π of good ones. Since a clean record does not lower borrowing costs, entrepreneurs would all choose the risky project. The policy of taxes and subsidies I describe in the next section is based on this idea of reducing the value of a clean record to zero to eliminate reputation concerns and induce entrepreneurs to take on risk.

6.3 Government Intervention

If the economy is stuck in an inefficient safe equilibrium the government can tax returns and subsidize investment in dirty records to bring the economy to the risky equilibrium.

This intervention is budget balanced, maximizes the social surplus and is a Pareto improvement, including during the transition from the safe to the risky steady state.

The social surplus being larger when entrepreneurs choose the risky project, resources are redistributed such that the borrowing cost is the same for dirty and clean records. Since the value of a reputation comes from the difference in borrowing costs between a clean and a dirty record, entrepreneurs now choose the project solely according to the period return. Dirty records are obviously better off with this policy. Although clean records subsidize dirty records they also take advantage of this policy since every period they lose their clean records with probability $1-p$ and start benefiting from the subsidy.

From the first period onwards successful entrepreneurs pay a tax

$$T(\mu_t) = \frac{\pi - \mu_{t+1}}{\pi} \frac{\Delta C\left(\mu_{t+1}\right)}{p}$$

where $\mu_{t+1} = p\delta\mu_t + (1-\delta)\pi$, $\mu_0 = \mu_S$. From the second period onwards the proceeds from the tax pay for the subsidy

$$F(\mu_t) = \frac{\pi - \mu_t}{\pi - \mu_t + \delta(1-\pi)} \Delta C(\mu_t)$$

The subsidy is such that investors finance entrepreneurs with dirty records at the same expected cost $C(\mu_t, c)$ as clean records. Since a clean record loses all value, this system of taxes and subsidies induces clean records to take on risk, such that the economy moves towards μ_R. Good entrepreneurs are better off and investors and bad entrepreneurs are not worse off. Moreover, this policy is self financed.

Proposition 7 *If the economy is in an inefficient safe equilibrium, there exists a Pareto improving and budget balanced policy such that the economy transitions to the risky equilibrium*

Proof. With the system of taxes and subsidies described above investor break even when they lend to dirty records at rate $C(\mu_t, c)$:

$$\Pr(G|\, k = d)\, p \frac{C(\mu_t, c)}{p} + F(\mu_t) - 1 = 0$$

In period t, π good entrepreneurs succeed with probability p and pay a tax $T(\mu_t)$ which finances the subsidy to all dirty records, $\pi - \mu_{t+1}$ good entrepreneurs and $\mu_{Gd} = \delta(1-\pi)$

bad entrepreneurs, in period $t+1$,:

$$\pi p T(\mu_t) = \left(\pi - \mu_{t+1} + \delta(1-\pi)\right) F\left(\mu_{t+1}\right)$$

Finally, the expected lifetime utility for a good entrepreneur is

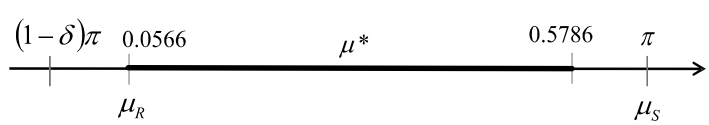
$$\begin{aligned}\sum_{t=0}^{\infty} \delta^t \left(p\left(R - T(\mu_t)\right) - C(\mu_t, c)\right) &= \frac{pR - \frac{1}{\pi} + \frac{(1-\delta)(1-\pi)\left(\mu_t - \mu_{t+1}\right)}{\mu_{t+1}\mu_t}}{1-\delta} > \frac{pR - \frac{1}{\pi}}{1-\delta} \\ &= \frac{\frac{Y_R}{\pi}}{1-\delta} > \frac{\frac{Y_S}{\pi}}{1-\delta} = V(\mu_S, c)\end{aligned}$$

which implies that entrepreneurs with clean records are also better off during the transition. Investors and bad entrepreneurs still get a payoff of zero and are are hence not worse off. ■

6.4 Numerical Example

This example illustrates how the economy can be stuck in a safe equilibrium that is inefficient (Proposition 5) and describes a government intervention to bring the economy to the risky equilibrium that is both budget-balanced and Pareto-improving.

For $p = 0.6, R = 5, S = 2, \pi = 0.6, \delta = 0.96$, dirty records are financed in the risky equilibrium (Assumption A1) and the safe and the risky stationary equilibria exist (Assumption A2) and . The social surplus is higher in the risky steady state, $Y_R = 0.8$, than in the safe one, $Y_S = 0.584$. The set of threshold equilibria is



Which steady state is reached is determined by beliefs and by the initial mass of good entrepreneurs with clean records μ_0. If the economy starts at $\mu_0 < \mu^*$ it converges to the risky equilibrium $\mu_R = 0.0566$ in which the lifetime utilities of good entrepreneurs with dirty and clean records are respectively $V(\mu_R, d) = 32.33$ and $V(\mu_R, c) = 33.33$. If $\mu_0 > \mu^*$ the economy converges to the safe steady state $\mu_S = 0.6$ in which the lifetime utility of good entrepreneurs is only $V(\mu_S, c) = 24.33$ and dirty records are not financed.

The highest equilibrium threshold is lower than μ_S. This means that it is not a simple coordination problem that needs to be solved to reach the risky equilibrium. If the planner implements the system of taxes and subsidies described in Subsection 6.3, the expected lifetime utility of a good entrepreneur is

$$\sum_{t=0}^{\infty} \delta^t \left(p\left(R - T\left(\mu_t\right)\right) - C\left(\mu_t, c\right)\right) = 33.55 > V\left(\mu_S, c\right)$$

where $\mu_{t+1} = p\delta\mu_t + (1-\delta)\pi$, $\mu_0 = .6$. The steady state tax is $T(\mu_R) = 0.64$ and the expected lifetime utility is

$$\frac{p\left(R - T\left(\mu_R\right)\right) - C\left(\mu_R, c\right)}{1-\delta} = 33.33$$

in the new steady state for both clean and dirty records.

7 Conclusion

Instead of assuming that investors know the entire history of debt repayment of a borrower, as is standard in the reputation literature, this paper analyzes how credit markets with asymmetric information work when reputations are either good (clean record) or bad (dirty record) and develops new insights on the role of reputation in risk-taking. More specifically I show how current project choices are affected not only by what other entrepreneurs have done in the current period but also by their past and future project choices.

The main result is that, for some fundamentals, the economy can be trapped in an inefficient equilibrium in which entrepreneurs run safe projects because a failure results in exclusion from financial markets. I describe a budget-balanced policy that consists in taxing successful projects to subsidize investment in failed entrepreneurs, which leads to a Pareto improvement. By allowing failed entrepreneurs to start new projects, this policy removes hurdles that discourage risk-taking.

This model also sheds light on why a transition from a traditional (safe) to an innovative (risky) industry can be difficult even if technical knowledge and good institutions are present. Moreover, it explains why economic policies that seek to improve entrepreneurs' probability of success by mitigating their fear of failure might be counterproductive; to remove the stigma of failure and provide incentives to take on risk, good entrepreneurs must sometimes fail.

More work is needed to understand the effects of coarse reputation in markets with adverse selection. A promising avenue for further research is to study how financial markets work when investors' information is somewhere between the two extremes that are clean/dirty records and the entire history of debt repayment.

8 Appendix

Proposition 8 *If*

$$\begin{aligned}\Lambda^S(\mu_R) &\equiv S - pR + (1-p)\,\delta\Delta V^S(\delta\mu_R + (1-\delta)\,\pi) > 0 \\ &> S - pR + (1-p)\,\delta\Delta V^S(p\delta(1-\delta)\,\pi + (1-\delta)\,\pi)\end{aligned}$$

the set of equilibria is $\mu^* \in [\max\{(1-\delta)\,\pi, p\widetilde{\mu}\}, \widetilde{\mu}] \cup [\mu_R, \overline{\mu}]$ *where* $\widetilde{\mu} \in ((1-\delta)\,\pi, \mu_R)$ *such that*

$$S - pR + (1-p)\,\delta\Delta V^S(p\delta\widetilde{\mu} + (1-\delta)\,\pi) = 0$$

and $\overline{\mu}$ *is defined as in Proposition 5*

Proof. I only prove that $\mu^* \in [\max\{(1-\delta)\,\pi, p\widetilde{\mu}\}, \widetilde{\mu}]$ are threshold equilibria. (For $\mu^* \in [\mu_R, \overline{\mu}]$ see proof of Proposition 5)

For $\mu_t < \mu^*$

$$\begin{aligned}\Lambda(\mu_t) &\equiv S - pR + (1-p)\,\delta\Delta V(p\delta\mu_t + (1-\delta)\,\pi) \\ &< S - pR + (1-p)\,\delta\Delta V(p\delta\mu^* + (1-\delta)\,\pi) \\ &= S - pR + (1-p)\,\delta\Delta V^S(p\delta\mu^* + (1-\delta)\,\pi) \\ &\leq S - pR + (1-p)\,\delta\Delta V^S(p\delta\widetilde{\mu} + (1-\delta)\,\pi) = 0\end{aligned}$$

The inequalities follows from Lemma 3 and the equality from $\Delta V(p\delta\mu^* + (1-\delta)\,\pi) = \Delta V^S(p\delta\mu^* + (1-\delta)\,\pi)$ since $p\delta\mu^* + (1-\delta)\,\pi > \mu^*$ for $\mu^* < \mu_R$.

For $\mu_t > \mu^*$

$$\begin{aligned}\Lambda(\mu_t) &\equiv S - pR + (1-p)\,\delta\Delta V(\delta\mu_t + (1-\delta)\,\pi) \\ &= \Lambda^S(\mu_t) > \Lambda^S(\mu^*) \\ &\geq S - pR + (1-p)\,\delta\Delta V^S(\delta\max\{(1-\delta)\,\pi, p\widetilde{\mu}\} + (1-\delta)\,\pi) \geq 0\end{aligned}$$

The first and second inequalities follow from Λ^S increasing and the last inequality follows from the definition of $\widetilde{\mu}$. ■

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