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The role of credit constraints on the cleansing effect of recessions

VERY PRELIMINARY

Sophie Osotimehin
CREST and Paris School of Economics

Francesco Pappadà
Paris School of Economics

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Abstract

We provide a measure of the cleansing effect of recessions in a model where heterogeneous firms face financial constraints and endogenously exit the market. Firms that survive recessions are either the most productive or those with the highest net worth. We show that credit constraints mitigate the cleansing effect of recessions as they induce productive firms with low net worth to exit. However, despite this selection distortion, the average productivity rises more during a recession the more stringent are credit frictions. Credit constraints amplify the aggregate output loss during a recession as they lead to excessive destruction of firms.

Keywords: cleansing, business cycles, firm dynamics, credit frictions
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1 Introduction

In a Schumpeterian view, recessions are considered as periods of cleansing. As their profitability becomes insufficient, the least productive firms are forced to exit, thus improving the efficiency in the allocation of resources. This view of recessions is emphasized in Caballero and Hammour (1994) and in Mortensen and Pissarides (1994). Empirical studies provide extensive evidence for the increase in job and firm destruction during recessions (Haltiwanger (1990)). However, there is little evidence on the reallocation of resources between firms during recessions. Baily, Bartelsman and Haltiwanger (2001) show that the labor share of less productive plants falls during recessions, whereas Schuh and Triest (1998) find no relationship between the amount of reallocation during a recession in a given industry and the subsequent growth in that industry. Baden-Fuller (1989) analyzes the steel castings industry, and shows that some less profitable plants survived the 1980 recession. These mixed findings suggest that the cleansing effect of recessions could be different across sectors. We believe that this heterogeneity could be explained by sector specific access to credit. In particular, recessions would fail to select the most productive firms in sectors where firms rely heavily on external finance or in which assets are intangible and cannot serve as collateral.

This paper investigates how credit constraints shape the distribution of firms' productivity after a recession. Our intuition is that credit constraints mitigate the cleansing effect of recessions, as recessions do not drive out only the least productive firms but also the financially fragile firms. We provide two measures of the cleansing effect of recessions which indicate the quality of the selection mechanism at the exit margin. The first indicator is the gap between the productivity of exiting and surviving firm. The second one is the probability to find a surviving firm which productivity is lower than the most productive exiting firm. The higher the gap or the lower this probability, the higher the cleansing effect of recessions. We find that credit constraints reduce the intensity of the cleansing effect as they induce productive but creditworthless firms to exit during the recession.
Despite this imperfect cleansing, the average productivity rises further during a recession the more binding credit constraints are. On the one hand, credit frictions distort the selection mechanism, destroying some high productivity firms and sparing some less efficient firms. On the other hand, credit frictions reinforce the role of productivity at the exit margin. As credit frictions increase, firms with low net worth need to be more and more productive to survive the recession. The second effect dominates and leads recession to

increase the average productivity further than in the frictionless economy.
These results have important consequences on the extent of recessions. We show that credit market frictions amplify the aggregate output loss during recessions as they blur the selection mechanism and lead to an excessive destruction of firms: they induce the exit of high productivity firms that would have survived the recession absent credit frictions. This amplification mechanism is enhanced by the imperfect selection of exiting firms. Since firms that exit are not the least productive, this reduces the aggregate production further and increases the cost of the recession. Though also based on credit market imperfections, this amplification mechanism is therefore clearly distinct from the financial accelerator (Bernanke, Gertler and Gilchrist, 1999). While Bernanke et al.(1999) focus on the procyclicality of net worth, we emphasize the role of the extensive margin.

We explore these mechanisms in a model of industry dynamics with financial constraints. This model extends the framework of Cooley and Quadrini (2001) by introducing an endogenous exit decision and aggregate productivity shocks. Firms produce goods using capital, are heterogeneous in their permanent level of productivity, and receive a transitory idiosyncratic i.i.d. productivity shocks. These shocks can be costly verified by the financial intermediary after their realization. As in Calstrom and Fuerst (1997) and Bernanke and Gertler (1999), credit constraints endogenously arise from asymmetry of information and costly state verification. The financial contract is a one-period debt contract in which the firm defaults when the shock is too negative, and the financial intermediary monitors the firm's income only when the firm defaults. The financial contract determines the amount the firm can borrow and the interest rate as a function of the firm's level of net worth and its permanent component of productivity. At the end of the period, firms have to reimburse the debt to the financial intermediary. When firms are hit by a bad transitory shock, they may be unable to repay their debt, they therefore default and enter next period with net worth equal to zero. Default does not necessarily imply exit as high productivity firms are likely to have a high continuation value despite a zero net worth. The firms decision to exit is more complex in the presence of credit constraints. As in the frictionless economy, firms that are not productive enough exit the market. But firms could also exit because their level of net worth is not high enough for their participation constraint or that of the financial intermediary to be satisfied. As a consequence, firms that survive recessions are firms with either a high productivity or a high net worth.

This paper is related to Barlevy (2003) who shows that the presence of credit constraints can reverse the cleansing effect. In his model, firms that need more borrowing yield endogenously more surplus. As the firms exit decision depends only on their access to credit, the most efficient firms are then also the most likely to exit the market. In contrast with Barlevy (2003), our paper embeds a positive link between the firms' productivity and their access to credit in a dynamic framework. As high productivity firms are likely to have a higher net worth and therefore to be less credit constrained, this interaction dampens the effects emphasized by Barlevy. We also differ from Barlevy (2003) by exploring the aggregate consequences of this imperfect cleansing on average productivity and production. We show that the imperfect cleansing increases average productivity and amplifies the impact of the recession on aggregate production.

This paper is organized as follows. In section 2, we describe the model of firm dynamics and financial constraints. We analyze how the exit decision in that framework differs from the exit decision in the frictionless economy. Section 3 presents the calibration of the model, which is solved numerically, and the properties of the steady state economy. Section 4 describes two measures of the cleansing effect of recessions and shows the consequences of credit market frictions. Section 5 investigates the implication of the imperfect cleansing on the extent of the recession and present the amplification mechanism based on the extensive margin. Section 6 concludes.

2 A model of firm dynamics and financial constraints

In this section, we describe our model of firm dynamics with credit market imperfections. As in Cooley and Quadrini (2001), financial constraints are embedded in dynamic framework. We extend their framework by introducing an endogenous exit decision and aggregate productivity shocks[1]. Before presenting the specificities of the model with financial constraints, we first describe the motive for exit in the frictionless economy.

In both economies, risk-neutral firms have access to a production technology using capital as the only input and with decreasing returns to scale: k^α where $0 < \alpha < 1$. Capital depreciates at rate δ. Firms are heterogeneous with respect to their permanent level of

[1] We also differ from their framework by not considering equity issuance. Furthermore, there is no debt renegotiation in case of default. Including this mechanism would not change our argument, since the default does not imply exit. The decision to exit takes place when the participation constraint of the firm or the financial intermediator is not satisfied.

productivity θ. A fraction $\nu(\theta)$ of firms produce with a level of productivity $\theta \in \{\theta_1 ..., \theta_N\}$. Each period, firms are hit by an aggregate productivity shock Z and by an idiosyncratic i.i.d productivity shock ϵ, with distribution $\Phi(\epsilon)$ and mean zero. Firms incur a fixed operational cost of production c_F per period. This fixed cost will induce some firms to exit the market.

Exit in the frictionless economy

In the frictionless economy, firms borrow capital at the risk-free interest rate r. The period profit of a firm with productivity θ is therefore: $\pi(Z;\theta) = (\theta + \epsilon)Zk^{\alpha} - (\delta + r)k - c_F$. At the beginning of the period, firms choose their level of capital after observing the value of the aggregate shock Z, but before knowing the idiosyncratic shock ϵ. At the end of the period each firm has to decide whether to exit or stay in the market. The value of a firm θ before choosing its level of capital is therefore:

$$\widehat{V}(Z;\theta) = \max_k \left\{ \int \pi(Z;\theta) d\Phi(\epsilon) + \beta \max \left[E_Z \widehat{V}(Z';\theta), 0 \right] \right\}$$

where E_Z denotes expectations conditional on the current value Z. When credit markets are perfect, firms exit when they are not productive enough: they exit if $\theta < \underline{\theta}_{FL}(Z)$, where $\underline{\theta}_{FL}(Z)$ is defined by $E_Z \widehat{V}(Z';\underline{\theta}_{FL}) = 0$.

The economy with financial frictions

Following Bernanke and Gertler (1989) and Carlstrom and Fuerst (1997), credit constraints arise from an asymmetry of information. The idiosyncratic shock ϵ is privately observed by the firm, whereas the financial intermediary can observe ϵ only at a cost μk^{α}. In this type of environment[2], Williamson (1987) has shown that the optimal one-period contract is a debt contract in which the firm defaults when the shock is too low, and the competitive financial intermediary monitors the firm's income only when the firm defaults. The terms of the financial contract will depend on the value of the firm's net worth e and its permanent level of productivity θ, both observable by the competitive financial intermediary and the entrepreneur at zero costs.

Assumption 1. The risk free interest rate is such that: $\beta < \frac{1}{1+r}$

This assumption, which implies that the risk free rate is lower in the frictional economy than in the frictionless economy, guarantees that firms will not always choose to reinvest

[2]We also assume that the financial intermediary cannot use a mixed strategy, we therefore do not allow for stochastic monitoring.

all their profits and thus gives an upper bound to their net worth. This condition can be interpreted as a general equilibrium property of economies with financial constraints. As it goes beyond the scope of this paper to analyze the impact of credit frictions on the risk free rate, note that we choose to leave aside this effect on the risk free rate when comparing the results in the credit constraints economy with the frictionless case. We therefore compare the credit constraints economy with the same economy without credit frictions $\mu = 0$ but with the same risk free rate.

At the beginning of the period, after observing the value of the aggregate shock Z but before the idiosyncratic shock ϵ, each firm chooses its level of capital k. The capital is financed by the firm equity e, and if $k > e$, the firm may borrow $(k - e)$ at rate $\widetilde{r}$ from the financial intermediary. At the end of the period, solvent firms decide which fraction of their profits to distribute as dividends d. When a firm is not able to reimburse its debt, it defaults. In this case, the financial intermediary pays a cost to verify the firm's income and confiscates all the firm's income. The default threshold $\bar{\epsilon}$ is given by:

$$(\theta + \bar{\epsilon})Zk^{\alpha} + (1 - \delta)k - c_F = (1 + \widetilde{r})(k - e)$$

Note that default leads to a zero net worth but does not necessarily lead to the exit of the firm. Depending on its permanent productivity component θ, the firm could find profitable to stay in the market with zero net worth.

The financial intermediary lends $k - e$ to the firm only if its expected income from the loan is equal to the opportunity cost of the funds. This break even condition reads:

$$(1 + \widetilde{r})(k - e)[1 - \Phi(\bar{\epsilon})] + \int_{-\infty}^{\bar{\epsilon}} [(\theta + \epsilon)Zk^{\alpha} + (1 - \delta)k - c_F - \mu k^{\alpha}]\, d\Phi(\epsilon) = (1 + r)(k - e)$$

The expected income of the financial intermediary is equal to the repayment of the loan if the firm does not default ($\epsilon > \bar{\epsilon}$) and to the firm's income net of monitoring costs when the firm defaults. Using the default condition, we can rewrite the participation constraint of the financial intermediary as:

$$[\theta + G(\bar{\epsilon})]Zk^{\alpha} - \Phi(\bar{\epsilon})\mu k^{\alpha} + (1 - \delta)k - c_F = (1 + r)(k - e)$$

with $G(\bar{\epsilon}) = [1 - \Phi(\bar{\epsilon})]\bar{\epsilon} + \int_{-\infty}^{\bar{\epsilon}} \epsilon d\Phi(\epsilon)$

Assumption 2. The hazard rate $\frac{d\Phi(\bar{\epsilon})}{1-\Phi(\bar{\epsilon})}$ is increasing in $\bar{\epsilon}$.

Under Assumption 2, the financial intermediary demands a higher interest rate (and therefore a higher default threshold $\bar{\epsilon}$) when the amount borrowed increases[3]. In this case, the expected income of the financial intermediary is increasing in $\bar{\epsilon}$ for $\bar{\epsilon} \leq \bar{\epsilon}_b$ where $\bar{\epsilon}_b$ maximizes the expected income of the financial intermediary. The financial intermediary therefore demands a higher $\bar{\epsilon}$ to compensate for the income loss induced by the increase in the amount borrowed $k - e$.

The firm's problem

Denote $V(e, Z; \theta)$ the value of the firm at the beginning of the period before choosing its level of capital. The firm's problem[4] can be written:

$$V(e, Z; \theta) = \max_k \left\{ \int \max_d \left[d + \beta E_Z V(e', Z'; \theta) \right] \Phi(\epsilon) \right\} \tag{1}$$

subject to:

$$e' = \begin{cases} (\epsilon - \bar{\epsilon}) Z k^\alpha - d & \text{if } \epsilon \geq \bar{\epsilon} \\ 0 & \text{if } \epsilon < \bar{\epsilon} \end{cases} \tag{2}$$

$$(\theta + G(\bar{\epsilon})) Z k^\alpha - \Phi(\bar{\epsilon}) \mu k^\alpha + (1 - \delta) k - c_F = (1 + r)(k - e) \tag{3}$$

$$d \geq 0 \tag{4}$$

The firm faces a trade off when deciding its level of capital: on the one hand, if the firm is solvent, a higher level of capital increases its next period level of production. On the other hand it increases its probability to default as the interest rate charged by the financial intermediary increases with the amount borrowed, according to the participation constraint of the financial intermediary (Equation (3)).

Equation (4) imposes that the firm cannot issue new shares. The firm can increase its net worth only by reinvesting its profits. The evolution of the firm's net worth is defined by

[3] Note that the positive relation between $k - e$ and $\bar{\epsilon}$ holds for any k if $(1 + r)e > c_F$ and otherwise for k not too small ($k > \frac{\alpha}{1-\alpha} \frac{c_F - (1+r)e}{\delta + r}$). We ensure in the simulations that these conditions are satisfied.

[4] It can be verified that there is a unique fixed point of the mapping defined by the firm's problem as the mapping satisfies Blackwell sufficient conditions for contraction.

Equation (2). When the firm does not default on its debt, it has to decide which fraction of the profits to reinvest in the firm, and which fraction to distribute as dividends. Because the discount rate is higher than the market rate, the firm will not always choose to reinvest all its profits. It will distribute dividends if $e > \bar{e}(Z;\theta)$ with $\bar{e}(Z;\theta)$ defined as $\beta\frac{\partial V(\bar{e},Z;\theta)}{\partial e} = 1$.

In contrast with the frictionless economy, the exit decision does not appear explicitly in the program of the firm. In this setup, the decision to exit is embedded in the dividend decision. When firms decide to exit, they distribute their whole income as dividends and thereby leave no net worth to finance the next period's investment.

Exit conditions

As in the frictionless economy, firms that are not productive enough exit the market (1.). Moreover, in the presence of credit constraints, two additional motives for exit arise for firms with a level of productivity above the threshold (2.). Firms could exit because their level of net worth is not high enough for the participation constraint of the firm (a), or for the participation constraint of the financial intermediary (b) to be satisfied.

1. Firms exit if $\theta < \underline{\theta}$

where $\underline{\theta}$ is the level of productivity below which the firm is not willing to stay in the market, whatever its level of net worth. $\underline{\theta}$ is defined as:

$$\bar{e}(Z;\underline{\theta}) = V(\bar{e}(Z;\underline{\theta}), Z;\underline{\theta})$$

$\underline{\theta}$ depends on the riskless interest rate r. The comparison with the frictionless economy therefore depends on the impact of financial constraints on the interest rate (Assumption 1).

2. Firms with $\theta > \underline{\theta}$ exit if:

(a) $e < \underline{e}_f(Z;\theta)$ with $\underline{e}_f(Z;\theta)$ is the level of net worth below which the entrepreneur is not willing to invest in the firm. $\underline{e}_f(Z;\theta)$ is defined as:

$$\underline{e}_f = V(\underline{e}_f, Z;\theta)$$

When investing its net worth in the firm, the entrepreneur forgoes the safe asset return of (1+r). However its opportunity cost is e and not $(1+r)e$: as the discount rate is higher than the safe asset return, the entrepreneur always prefer distributing its net worth as dividends rather than investing it in the safe asset.

(b) $e < \underline{e}_b(Z;\theta)$ where $\underline{e}_b(Z;\theta)$ is the level of net worth below which the financial intermediary will not accept to loan any funds. $\underline{e}_b(Z;\theta)$ is defined as:

$$(G(\bar{\epsilon}_b)+\theta)Zk_b^\alpha - \Phi(\bar{\epsilon})\mu k_b^\alpha + (1-\delta)k_b - c_F = (1+r)(k - \underline{e}_b)$$

where $(\bar{\epsilon}_b, k_b)$ maximize the expected income of the financial intermediary.

In contrast with the frictionless economy, some firms exit even in the absence of aggregate shocks. A bad idiosyncratic shock may lower the firm's net worth below the threshold (a) or (b), and may therefore lead to the exit of the firm. However, high productive firms never exit because of idiosyncratic shocks. The possibility to default implies that the net worth cannot go below zero. Then, firms for which $\max\{\underline{e}_b, \underline{e}_f\} < 0$ never exit because of idiosyncratic shocks.
For all firms with $\theta \geq \underline{\theta}$, the exit, default and dividend distribution conditions restrict the space state for net worth to a compact set $[\underline{e}(Z;\theta), \bar{e}(Z;\theta)]$ with $\underline{e}(Z;\theta) = \max\{0, \underline{e}_b(Z;\theta), \underline{e}_f(Z;\theta)\}$

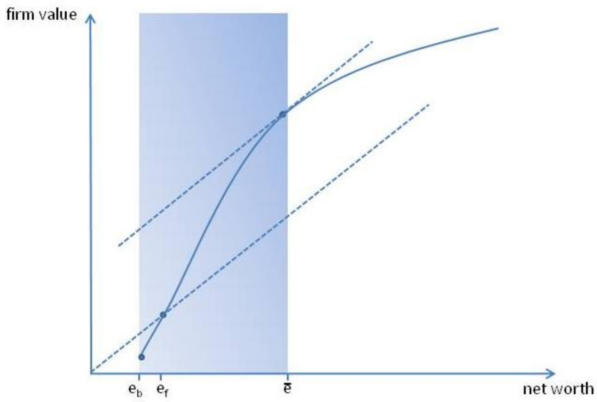

Figure 1: The exit thresholds $\underline{e}_f$ and $\underline{e}_b$ and the dividend threshold $\bar{e}$

The idiosyncratic shocks generate an endogenous distribution of net worth. More precisely, the economy is characterized by N probability measures $\{\lambda_i, i = 1, ..., N\}$ over the sets $\{[\underline{e}(Z;\theta_i), \bar{e}(Z;\theta_i)], i = 1, ..., N\}$. The distribution λ over net worth results from the interaction between the decision rules of the firm ($k(e, Z;\theta)$, $\bar{e}(Z;\theta)$ and $\underline{e}(Z;\theta)$) and the distribution of idiosyncratic shocks ϵ. As firms may exit the industry, the distribution λ

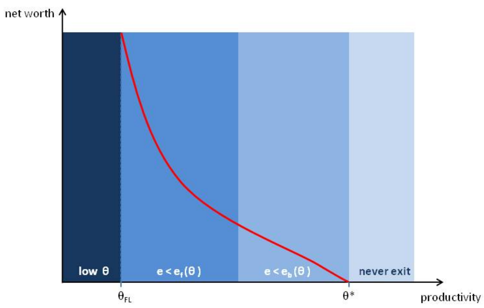

Figure 2: The three motives for exit

is not fully characterized until we specify how firms enter the industry. We assume that potential entrants have enough net worth to pay the fixed entry cost and enter with the minimum level of net worth required $\underline{e}(Z;\theta)$. These conditions give rise to a mapping Ω that indicates next period distribution of net worth given the current distribution, that is $\lambda' = \Omega(\lambda)$. In the following, we will focus essentially on the stationary distribution[5] $\lambda^* = \Omega(\lambda^*)$.

The aggregate production reads[6]:

$$\begin{aligned} Y(Z,\lambda) &= Z \sum_{\theta > \underline{\theta}} \nu(\theta) \int_{\underline{e}(Z;\theta)}^{\bar{e}(Z;\theta)} \theta \left[k(e,Z;\theta) \right]^{\alpha} d\lambda(\theta) \\ Y(Z,\lambda) &= ZF(\underline{e},\bar{e},k,\lambda) \end{aligned}$$

where $\nu(\theta)$ is the initial fraction of firms with productivity θ and $\lambda(\theta)$ is the probability measure for firms with productivity θ.

[5]The stationary probability measure exists and is unique as the associated transition function is monotone, has the Feller property and satisfies a mixing condition. The proof is similar to Cooley and Quadrini (2001).

[6]We assume that the fraction of output required for the monitoring process is not destroyed.

3 Steady state results

3.1 Calibration

We calibrate the model on the steady state of the economy and normalize the aggregate shock to $Z = 1$. The model period is one year and the risk free rate is set to 4 percent and the depreciation rate to 7 percent. The ratio θ_N/θ_1 is chosen so that the most productive firm is about twice as productive as the least productive firm consistently with the estimates reported in Barltelsman and Doms (2000). The distribution $\nu(\theta)$ is skewed toward small firms[7]. The return to scale parameter of the production function is set at 0.7 consistently with the estimates of Henessy and Whited (2006). The discount rate β is set at 95.7. The remaining parameters μ, c_F and σ are chosen to match the following targets: the average probability of exit, which is estimated in Evans (1987) to be 4.5 percent, a 10% bankruptcy cost as estimated by Henessy and Whited (2006), a 1% default rate as in Cooley and Quadrini (2001).
Our preliminary results are based on the following calibration:

θ	$\{0.396, 0.41, 0.55, 0.80\}$
$\nu(\theta)$	$\{0.04, 0.71, 0.20, 0.05\}$
σ	0.4
r	0.04
β	$1/(1 + r + 0.002)$
δ	0.07
c_F	1
α	0.7
μ	0.3

Table 1: Parameters value

3.2 Capital decisions and exit behaviors

In figure 3, we show how financial constraints link the firms capital choice to their level of net worth. A higher level of net worth relaxes the financial intermediary's participation constraint and allows the firm to expand its production scale. Firms with high enough level of net worth face no credit constraints as they can invest as much as in the frictionless

[7] To avoid unrealistic exit rates when considering aggregate shocks, the proportion of low productivity firms that exit during the recession has to be small.

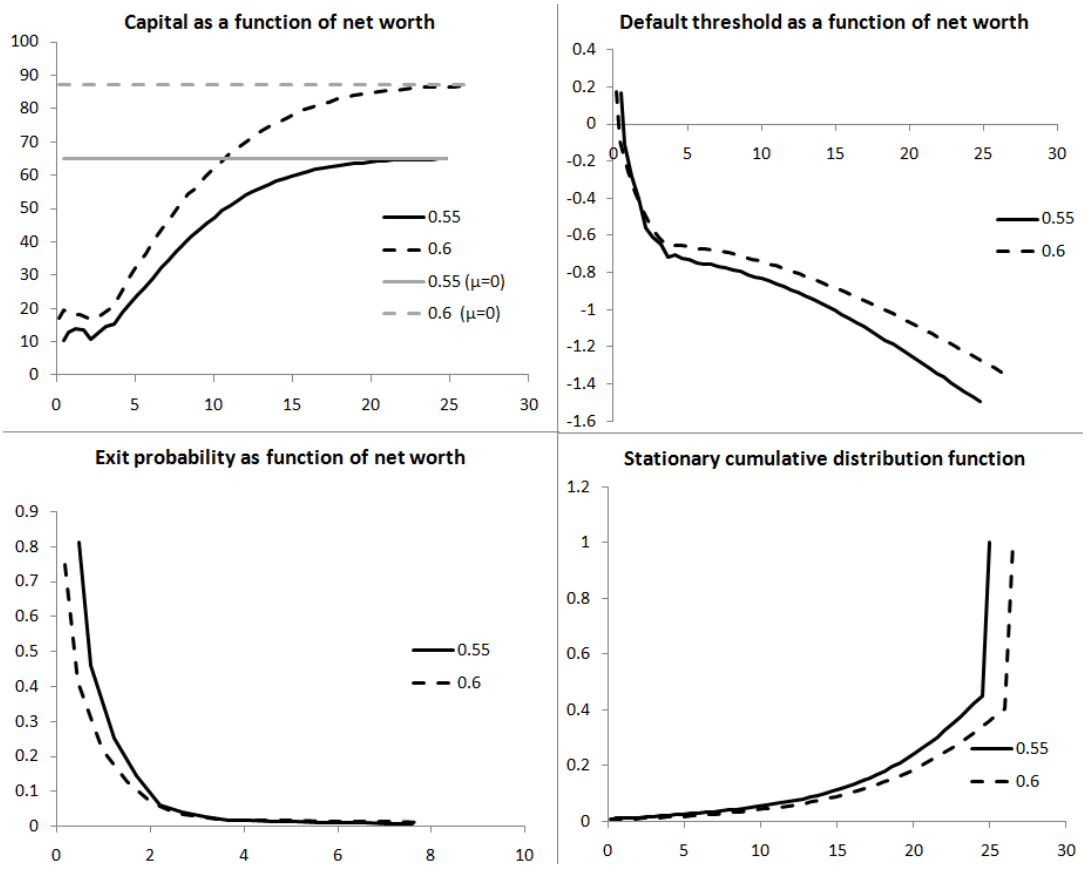

Figure 3: The role of permanent productivity

case ($\mu = 0$). A higher net worth also reduces the firms probability to default on their debt and the probability to exit the market as well. We then illustrate the impact of the permanent productivity θ. For any level of net worth, a higher productivity enables the firm to invest more capital. Nonetheless, both the probability of default and the probability of exit differ according to the level of net worth. The probability to default increases with productivity for high level of net worth, whereas the probability to exit decreases with productivity, in particular for low net worth firms. As expected, net worth and productivity are highly correlated: an increase in the permanent level of productivity θ shifts the cumulative distribution of net worth to the right and raises the average net worth. We then investigate whether the degree of financial frictions affects the exit probability of firms during the recession. As illustrated in figure 4, a higher μ decreases the level of capital, increases default probability, and raises exit probability only for firms with very low levels of net worth. Does the increase in exit probability of low net worth firms have

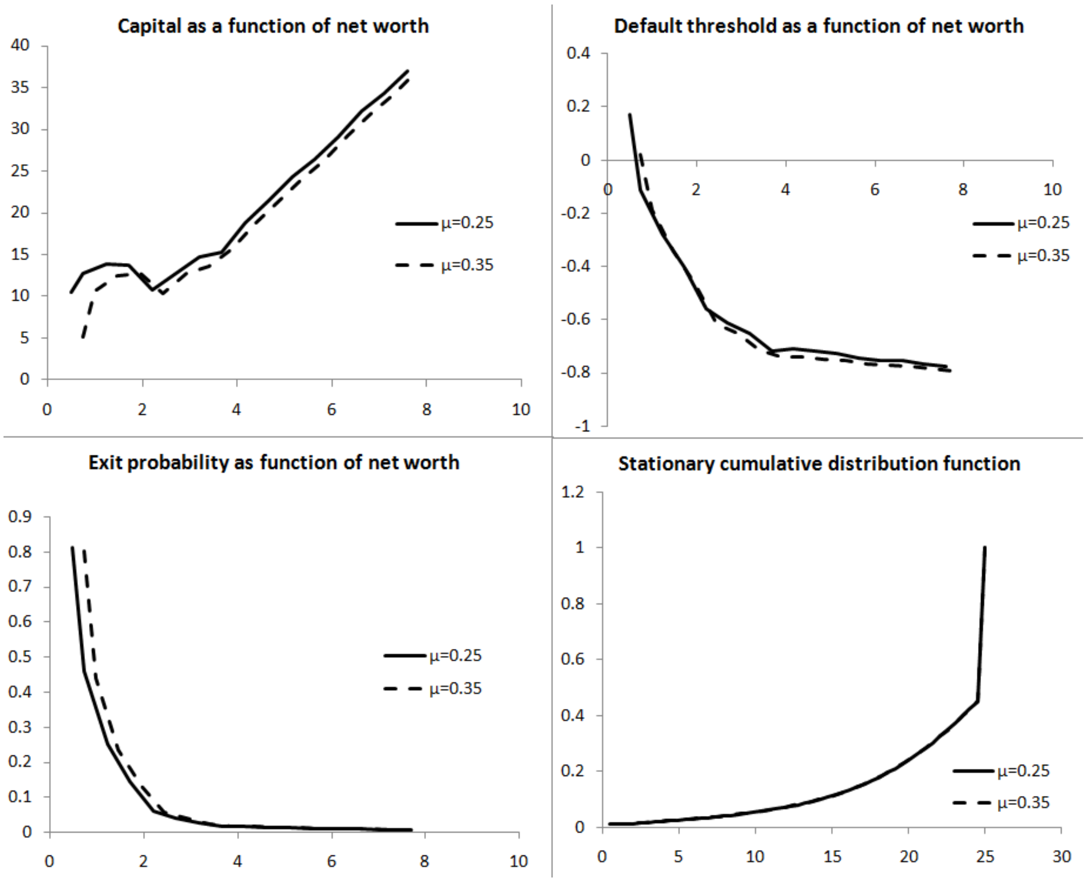

Figure 4: The role of financial constraints

a big impact on the stationary distribution of firms? The answer is no. Since the fraction of firms with low net worth is small, the stationary distribution of firms is barely affected by the degree of financial frictions.

4 Measuring the cleansing effect of recessions

Recessions are times of cleansing if they eliminate the least productive firms. In this section we propose two measures of the cleansing effect of recessions. We then simulate the model for different values of the credit frictions parameter (μ) to show how credit market frictions reduce the intensity of the cleansing.

4.1 Two indicators

The cleansing effect of recessions is a selection effect: the intensity of the cleansing effect depends on the "ability" of recessions to select the most efficient firms. The stronger the cleansing effect, the higher the difference in productivity between the firms that exit and those that survive the recession. Our first indicator IC_1 is built on that intuition. IC_1 is equal to the relative gap between the average productivity of exiting firm and that of surviving firm. As IC_1 increases, the intensity of the cleansing effect increases.

$$IC_1 = 1 - \frac{\text{Average productivity of exiting firms}}{\text{Average productivity of surviving firms}} \tag{5}$$

The second indicator IC_2 is based on the probability to find a firm that survived the recession with a productivity lower than the highest productive of exiting firms. Denote θ^* as the productivity of the marginal exiting firm, that is the exiting firm with the highest level of permanent productivity θ.

$$\begin{aligned} IC_2 &= 1 - \frac{P(\theta < \theta^* | \text{survive})}{P(\theta < \theta^*)} \\ &= 1 - \frac{P(\text{survive} | \theta < \theta^*)}{P(\text{survive})} \end{aligned}$$

IC_2 is also equal to the probability to survive a recession for a firm with productivity lower than the highest productive of exiting firms. As this indicator is a probability, it has the advantage of being bounded. In the frictionless case, the conditional probability to survive for a firm with productivity $\theta \leq \theta^*_{FL}$ is equal to zero, and the cleansing indicator is equal to 1. The productivity explains completely the probability of exit, and the cleansing is perfect: all firms with θ lower than the productivity of the marginal exiting firm are shut down.

On the other hand, if the probability of survival for firms with $\theta \leq \theta^*$ equals the unconditional probability of survival, the cleansing indicator turns out to be equal to 0. In such a case, the probability of survival is orthogonal to the level of productivity θ. The cleansing indicator could eventually turn negative if the conditional probability of survival is greater than the unconditional probability of survival. A negative value of the cleansing indicator would mean a reversal of the cleansing effect, with the low productivity firms more likely to survive with respect to the high productivity firms as in Barlevy (2003).

However, under the realistic assumption that the unconditional probability of survival is greater than the conditional probability of survival, $IC_2 \in [0, 1]$.

4.2 Simulation results

In this section, we study the impact response of the economy to a permanent aggregate shock Z. We consider a 2% decrease in aggregate productivity (from $Z = 1$ to $Z = 0.98$) and analyze how this shock modifies the exit behavior of firms depending on the degree of financial constraints.

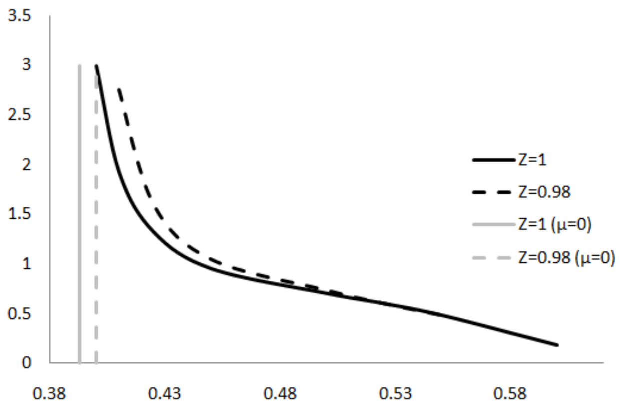

Figure 5: Decrease in the aggregate productivity Z and the exit threshold

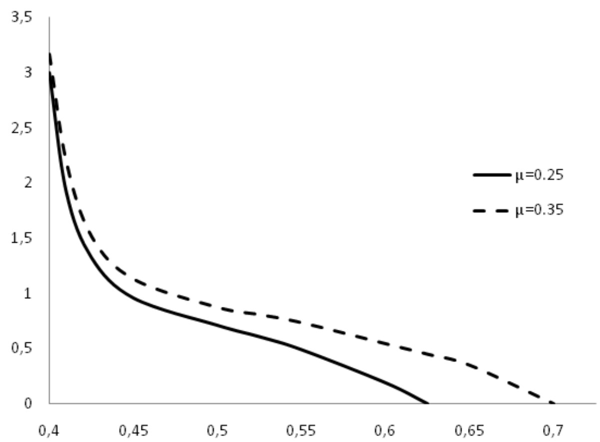

Figure 6: The exit threshold and the degree of credit constraints

Figure 5 shows how the decrease in aggregate productivity raises the exit threshold $\underline{e}$ for a given level of financial constraints. On impact, the aggregate productivity shock leads to the exit of all the firms between the solid and the dashed line. Comparing this exit threshold with the vertical line which indicates the productivity threshold in the frictionless

Table 2: Preliminary results

	$\mu = 0$	$\mu = .30$	$\mu = 0.45$
Productivity gap (IC_1)	0.2	0.092	0
Survival probability gap (IC_2)	1	0.006	0
Average productivity	0.457	0.462	0.8

Note: the average productivity refers to the average of the permanent productivity component θ.

economy ($\mu = 0$) illustrates the imperfect selection mechanism. In the frictionless economy, all exiting firms are less productive than firms that survive the recession. In the credit constraints economy, since exit also depends on the firms' net worth, the recession could induce high productivity firms to exit while allowing lower productive firms to survive. This may increase the inefficiency in the allocation of resources as it may make resources flow from high to less efficient firms. This imperfect selection at the exit margin seem to increase with the degree of financial constraints. As suggested by figure 6, an increase in financial frictions lead to the exit of more and more productive firms. The productivity of the most productive exiting firm θ^* increases when credit constraints become more stringent. However, an increase in θ^* is only suggestive of an imperfect selection as θ^* could also be affected by the type and the magnitude of the shock. To assess the impact of credit constraints on the cleansing effect of recessions, we therefore use the two indicators IC_1 and IC_2 and measure to which extent the selection mechanism differs from the frictionless economy.

Table 2 shows how the two indicators vary when the credit constraints become more stringent. The first indicator of cleansing refers to the relative average productivity of exiting firms with respect to the surviving firms. As long as credit frictions increase, the average productivity of exiting firms is much closer to the average productivity of surviving firms and the indicator decreases. For very high level of financial frictions ($\mu \to \infty$), the exit decision is orthogonal to the firm's productivity. The second indicator of cleansing takes the value 1 when the cleansing is perfect and 0 when there is no sorting on productivity. This indicator show that the probability to find a firm that survived the recession with a productivity lower than exiting firms increases when credit constraints becomes tighter. Credit constraints distort the selection at the exit margin as they reinforce the role of net worth in the exit decisions. In contrast with the frictionless economy, exit is not only based on the productivity of the firms. As a result, some high productivity firms exit while low productivity (but creditworthy) firms survive the recession.

The cleansing effect is usually associated with an increase in average productivity. By eliminating the least efficient firms, recessions would reallocate resources towards more productive firms, thereby increasing average productivity. Though credit market imperfections lead to an imperfect selection at the exit margin, Table 2 also shows that this imperfect cleansing does not dampen the increase in average productivity. On the contrary, an increase in the degree of financial frictions increases average productivity. On the one hand, credit frictions distort the selection mechanism, destroying some high productivity firms and sparing some less efficient ones. On the other hand, credit frictions reinforce the role of productivity at the exit margin. As credit frictions increase, firms need to be more and more productive to survive the recession. The second effect dominates and leads recession to increase average productivity further than in the frictionless economy.

5 A new amplification channel

Since Bernanke and Gertler (1989), and Bernanke Gertler and Gilchrist(1999), it is well known that credit market frictions may amplify and propagate aggregate shocks to the economy. The financial accelerator stems from the negative link between the cost of external finance and the firms' net worth. The procyclicality of the firms' net worth then imply that the cost of external finance increase when the activity is slack, thereby amplifying the fall in investment. As we focus on the impact of the aggregate shock on the exit margin, we do not capture the effects of the financial accelerator[8]. However, our results indicate that credit market frictions may amplify aggregate shocks through a different channel. The amplification mechanism that we highlight in this section is based on the extensive margin effect of recessions: credit frictions amplify recessions because they generate an excessive destruction of firms: they induce the exit of firms that would have survived the recession absent credit frictions.

Figure 5 illustrate this excessive destruction. In the frictionless economy, only firms with productivity below $\underline{\theta}_{FL}(Z)$ exit the market. When the economy is credit constrained, some more productive firms also exit the market when their level of net worth is insufficiently high. As documented in Table 3, the recession exit rate in the credit constrained economy is about twice that of the frictionless economy.

[8] We do not look at the impact of the aggregate shock on the distribution of net worth.

Table 3: A decomposition of the output loss

	Aggregate production	Direct effect	Intensive margin	Extensive margin	Exit probability
Frictionless	8,42%	2.0%	4.60%	2.04%	4%
Credit frictions	14.48%	2.0%	3.56%	4.40%	10.6%

Note: does not add up exactly because of approximation errors.

To assess the magnitude of this excessive destruction mechanism, we decompose the impact of a negative aggregate shock $\Delta Z < 0$ on production as follows:

$$\Delta Y(Z,\lambda^*) \approx \underbrace{\mathbf{\Delta Z}F(\underline{e},\bar{e},k,\lambda^*)}_{\text{Direct effect}} + \underbrace{Z\left[F(\underline{e},\bar{e},\mathbf{k}+\mathbf{\Delta k},\lambda^*) - F(\underline{e},\bar{e},\mathbf{k},\lambda^*)\right]}_{\text{Intensive margin}} - \underbrace{ZF(\underline{\mathbf{e}},\underline{\mathbf{e}}+\mathbf{\Delta}\underline{\mathbf{e}},k,\lambda^*)}_{\text{Extensive margin}}$$

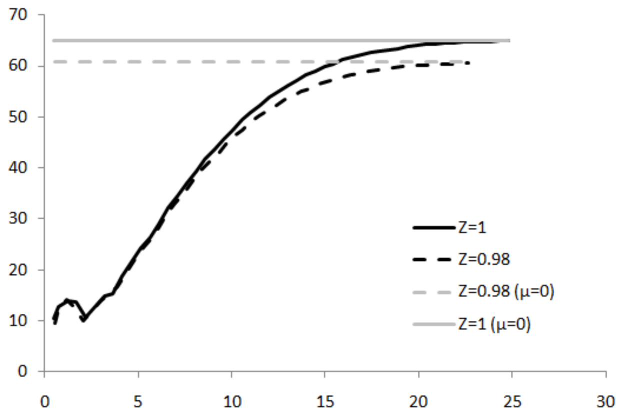

Figure 7: Dampening effect along the intensive margin

When an expected negative aggregate shock hits the economy, the productivity of every firm decreases ($\Delta Z < 0$). This shock modifies the behavior of firms along the intensive and the extensive margin. All firms decrease their investment ($\Delta k < 0$) and more firms are forced to exit the market ($\Delta \underline{e} > 0$).

Table 3 reports the decomposition of the output loss due to the direct effect, the intensive and the extensive margin. The overall output loss following a 2% negative shock on aggregate productivity is larger in the economy with credit frictions than in the frictionless economy. For a given distribution of net worth, credit market frictions dampen the impact of the negative productivity shock on the capital stock. The financial intermediary becomes more reluctant to lend its funds but, on the other hand, firms wish to invest and borrow less. Figure 7 shows that the second effect dominates: the negative productivity shock reduces capital further in the frictionless economy than in the credit constraints economy. Despite this dampening effect, credit market frictions magnify the consequence of the negative shock on the aggregate production. The extensive margin brings about a new amplification mechanism. As credit frictions make firms more vulnerable to the recession, more firms exit the market ($\Delta \underline{e} > 0$) and the aggregate production decreases further. The output loss at the extensive margin is higher in the world with economy with frictions. In the frictionless economy, some firms exit because they are not productive enough ($\theta < \underline{\theta}_{FL}(Z)$). In the economy with credit frictions, high productivity firms may also exit. The observed negative shock on aggregate productivity pushes up the exit threshold on net worth. To compensate the decrease in aggregate productivity, firms need a higher net worth as it allows them to expand their production scale and cover their fixed cost of production. As shown in the previous section, credit frictions lead to the exit of some high productivity firms which would have been spared by the recession in the frictionless economy. The distortion at the selection margin and the excessive destruction effect amplify aggregate shocks in the credit constraints economy.

6 Conclusion

This paper investigates the consequences of credit market imperfections on the cleansing effect and on the aggregate impact of recessions. Credit constraints mitigate the cleansing effect of recessions as they induce high productivity firms to exit during the recession. We show the implications of this imperfect cleansing on the extent of recessions. Credit market frictions amplify the aggregate output loss during the recession as they blur the selection mechanism and lead to an excessive destruction of firms. These results suggest that the selection mechanism at the exit margin is crucial for measuring the cost of recessions. From an empirical standpoint, we plan to investigate the testable prediction of the model: industries in which credit constraints are more severe should also be the industries in which recessions fail to select the most efficient firms.

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