Financial Constraints, Precautionary Saving

and Firm Dynamics

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utionary Saving and Firm

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Abstract

roposes a structural model that analyses the way ...nancing constraints afconsumption and saving decisions of the entrepreneur of a small/medium reneur may face ...nancing constraints because he cannot precommit to rethe debt is secured by collateral. In addition he cannot retain all earnings, n of returns is non tradable and can only be consumed. These assumpprecautionary saving exect: the proportion of wealth allocated between d safe assets depends on future expected ...nancing problems. The model all ... ms are on average more ... nancially constrained, despite all ... ms are I regarding their ability to access external ...nance. Model's simulations consistent with the empirical evidence about ...nancing constraints and at the micro level, ...r.m investment depends on cash ‡ow variations not s in expected pro. tability. At the aggregate level, small ... rms experience variation in sales, investment and short term debt than larger ..r.ms do. ing result is that credit availability is more exective than interest rate in etary policy for ...nancially constrained (small) ..r.ms, while interest rate for unconstrained (large) ..r.ms.

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1 Introduction

rkets a ..r.m can always raise external funds to ..nance all the projects net present value. This is not possible if some imperfections are present . Under asymmetric information or contract incompleteness (imperfect al hazard problem limits the availability of debt (Stiglitz and Weiss, kor, 1986; Milde and Riley, 1988; Hart and Moore, 1998). In addition ses equity ..nancing costs so that they overcome expected pro..ts of ects (Myers and Majluf, 1984).

ct that ..nancing constraints should in‡uence real activity both at inlevel. At the individual level, if external ..nance is limited, retained in source of funds, and ..rm investment is a function of internal ..nance of expected productivity of capital. At the aggregate level ..nancing and propagate the e¤ects of initial real and monetary shocks, through nancial accelerator e¤ect: constrained ..rms can only invest if internal ce at the beginning of a downturn the reduction in cash ‡ow depresses ertler and Gilchrist, 1996); ii) the asset price e¤ect: when the borrowing ds on the collateral value of its assets, at the beginning of a downturn reduces borrowing and investment (Kiyotaki and Moore, 1997; Ortalo e, Gertler and Gilchrist, 1998); iii) the ‡ight to quality e¤ect: during ase collateral requirements, thereby reducing loans to borrowers facing II three e¤ects have opposite direction during an upturn.

rk produced a considerable evidence supporting this view. At the agas a proxy for access to credit markets, it has found that small manuce more procyclical variation in sales, inventories, and short term debt ernanke, Gertler and Gilchrist, 1996). At the microeconomic level, mainly on panel data estimation technique. It shows that investment o internal ...nance: cash ‡ow in‡uences investment more than its infor-..rm's fundamentals would predict, according to the neoclassical model ent costs (Among many others see Whited (1992); Hubbard, Kashayap amillo, Schiantarelli and Weiss (1996) and Gilchrist and Himmelberg

rature is the absence of a theoretical framework able to explain both egate evidence. On the one hand empirical work on the aggregate exects is based on generic considerations on which ...r.ms are more likely to be re the likely exects of constraints. The assumption that dimension is a

traints is imposed rather than founded on a theory of ..r.m behaviour at ther hand microeconomic analysis is based on reduced form estimation, solve the dynamic investment problem of a constrained ..r.m to derive s.

Il this gap in the literature, with a model that analyses the way ...nancing oice between consumption, investment and precautionary saving for all/medium ..r.m. The model is solved using a numerical method, and vestment and saving path of the ..r.m is shown to be consistent with I evidence.

e model explains why expected ...nancing constraints can a ect current rough a precautionary saving e ect, and why this e ect is stronger for ...r.ms.

of the model is used to simulate an arti..cial economy, with many ..r.ms of size and pro..tability. The responses of such economy to unexpected ks are consistent to all main macroeconomic stylised facts.

e paper is organised as follows: chapter 2 discusses macroeconomic f ...nancing constraints, chapter 3 illustrates the model, and chapter 4

2 Evidence of the effects of financing constraints.

ating the presence of ...nancing constraints at the macroeconomic level

rms that are more likely to be constrained in the access of external f the behaviour of constrained vs unconstrained ..r.ms across di¤erent ycle regarding sales, debt and inventories.

ilcox (1993), Gertler and Gilchrist (1993,1994) and Oliner and Rudehe behaviour of small versus large manufacturing ..r.ms after Romer isodes of tight monetary policy that led to a recession. Dimension is cing problems.

d Gilchrist (1996) conduct a similar study. They inspect quarterly data vel, and are able to control for industry exects and to use bank depencriterion to identify ..nancially constrained ..r.ms. They observe that tightening short term debt increases for large ..r.ms, which increase the pers, while it decreases for small ..r.ms. Moreover during the downturn tary action sales drop earlier for small ..r.ms, which also substantially ile large ... rms maintain inventories at an higher level. As a result sales, ories and the inventory/ sales ratio are more procyclical for small than

served also during business cycle ‡uctuations not directly related to anke Gertler and Gilchrist's (1996) computations show that one third s can be accounted for by the di¤erence between small and large ..r.ms. mpare this evidence with a similar analysis on a panel data of Italian ufacturing ..r.ms (Caggese, 1998). On the one hand Italian data are eful in capturing business cycle e¤ects, on the other hand they provide formation¹, enabling to directly identify ..nancially constrained ..r.ms. r of Italian ..r.ms is consistent with the US evidence: i) the di¤erence in ver total assets between constrained and unconstrained ..r.ms increases 1988-1989) and decreases in the long 1990-93 recession (see ..gure 1A); ibit higher growth rates of total sales during booms, and lower during ity is more pronounced for the subset of pro..table ..r.ms that declare to ing long term ..nancing and to have not enough collateral. These seem s and downturns (see ..gures 2A and 3A).

3 A model of investment with private income and collateral constraint.

ion is to build a simple dynamic model of consumption and investment ng constraints.

entrepreneur (henceforth E) of a small-medium ..r.m. E is the maxnamic problem, and can be interpreted as the owner/manager of the

d maximises the expected discounted sum of future consumption. He n a concave technology with capital as the only factor of production. ds on the unobservable value of a parameter θ , that follows a stationary

ilability for E is limited. Equity ...nancing is not available, and debt he fact that ..r.m's output is non veri..able (Hart and Moore, 1998). E

n a survey, the problems they faced in ...nancing investments in 1989-1991.

it will be mentioned later, the model is such that E could be reinterpreted as a manager areholders' and his own private interest.

arnings to repay the debt, he can only commit to use next period decial markets are otherwise perfect, and the banking sector is composed mpetitive banks. Therefore E can borrow and lend one period debt at , and the upper bound to its borrowing capacity is the collateral value

delled in the following way: a share of ..r.m's output is non tradable stored and has to be consumed in the period. The tradable (..nancial) ither saved or consumed. One possible justi..cation for this assumption non monetary return from running the ..r.m³. This modelling choice is fact that the share of a small/medium ..r.m's pro..ts consumed by its served dividends. It is known that small ..r.ms almost never distribute e for E must come partly from wage costs and partly from tax evasion. not a good way to represent his consumption choices. In this model e to consume a share of public output in addition to the private one, pirical evidence we will show that in the model the optimal dividend

therefore the following:

k

p

$$y_t^T = p_t \theta_t k_t^{\alpha} \tag{1}$$

$$y_t^{NT} = \eta y_t^T \tag{2}$$

$$0 < \alpha < 1; \eta > 0$$

tput price. y^T is tradable and y^{NT} nontradable output. η determines ublic and private output

eginning of each period E faces an exogenous probability to retire.

- γ e continues activity, observes the realisation of θ and decides the level be productive the next period.
- $1-\gamma$ he retires, liquidates the assets of the ...m and consumes a_t , the total

stify this assumption is to interpret E as a manager that receives private bene.ts (Jensen, ..r.m's output. His objective is to maximise his intertemporal utility, and he receives from ge proportional to tradable pro.ts. Linearity in preferences implies that his objective is ed average of tradable and non tradable output.

to say that, after retiring, E perceives a perpetual rent of ra_t

$$a_t = (1+\eta)y_t^T + p_t^i(1-\delta)k_t - b_t$$
(3)

$$w_t = a_t - y_t^{NT} \tag{4}$$

 $0<\delta<1$

 a_t

 w_t δ ively *total* and *financial* net worth of the ..r.m. p^i is the price of capital ciation rate. Prices are assumed to be deterministic. b_t is face value of e repaid at time t.

n of the dynamic problem is the following:

$$V_t(w_t, k_t, \theta_t) = \underset{k_{t+1}, b_{t+1}}{MAX} \gamma E_t \left\{ x_t + \frac{1}{R} E_t \left[V_{t+1}(w_{t+1}, k_{t+1}, \theta_{t+1}) \right] \right\} + (1 - \gamma) a_t$$
(5)

$$x_t + k_{t+1} = a_t + \frac{b_{t+1}}{R}$$
(6)

$$x_t \ge y_t^{NT} \tag{7}$$

$$b_{t+1} \le \tau p_{t+1}^I k_{t+1}$$
 (8)

$$0<\tau\leq 1-\delta; 0<\gamma<1$$

dget constraint, and shows that total net worth plus borrowing must d next period capital⁵. Equations 7 and 8 are the constraints on cong respectively. x_t is consumption at time t. k_{t+1} and b_{t+1} , the next repayment, are the control variables⁶. R = 1 + r, where r is the market constant. τ is the fraction of capital that can be used as collateral. that w_t , not a_t , is the state variable of the problem. By substituting e function can be expressed as a dynamic lagrangean (Chow, 1997):

$$V_{0}(w_{0},k_{0},\theta_{0}) = \underset{\{k_{t+1}\}_{t=0}^{\infty},\{b_{t+1}\}_{t=0}^{\infty}}{MAX} E_{t} \left\{ \sum_{t=0}^{\infty} \left(\frac{\gamma}{R}\right)^{t} \left\{ \gamma x_{t} + (1-\gamma)a_{t} + \mu_{t} \left(x_{t} - y_{t}^{NT}\right) + \lambda_{t} \left[\tau p_{t+1}^{I}k_{t+1} - b_{t+1}\right] \right\}$$

$$(9)$$

e t is: $i_t = k_{t+1} - (1 - \delta) k_t$. Hence capital takes one period to become productive. o adjustment costs it is equivalent, in term of notation simplicity, to use i_t or k_{t+1} as the standard Khun-Tucker conditions on lagrange multipliers μ_t and (9) by x_t , the ... st order condition at a generic time t with respect to

 b_{t+1}

 λ_t

$$\mu_t = R\lambda_t + \gamma E_t \left(\mu_{t+1} \right) \tag{10}$$

ecursively obtaining:

$$\frac{\mu_t}{R} = E_t \left(\sum_{j=0}^{\infty} \gamma^j \lambda_{t+j} \right)$$
(11)

hat the value of the multiplier associated to the consumption constraint value of the discounted sum of the multipliers associated to all future

non negative, and $\mu_t > 0$ if and only if $E_t\left(\sum_{j=0}^{\infty} \gamma^j \lambda_{t+j}\right) > 0$. Su¢ cient $E_t\left(\sum_{j=0}^{\infty} \gamma^j \lambda_{t+j}\right) > 0$ is that there is a positive probability of realising in future ..ts⁷. In this case, no matter how pro.table is on average the ..r.m and umulated, there is always some chance to loose it after a long enough This result implies that the constraint on consumption always binds. at, as long as there is some positive probability to be constrained in to save rather than to consume, since postponing consumption reduces ancing constraints.

roblem. The consumption constraint (7) holds with equality, and can d (6). Moreover $x_t = y_t^{NT}$ implies that the consumption at time *t* is t-1. Therefore we can consider the value function for E conditional on ro and *after* consuming y_0^{NT} , before deciding k_1 and b_1 . This implies nly relevant state variables:

 w_0

 θ_0

$$V_{0}(w_{0},\theta_{0}) = \underset{\{k_{t+1}\}_{t=0}^{\infty},\{b_{t+1}\}_{t=0}^{\infty}}{MAX} E_{0}\left\{\sum_{t=0}^{\infty} \left(\frac{\gamma}{R}\right)^{t} \left\{\frac{1}{R}\left[\gamma y_{t+1}^{T} + (1-\gamma)a_{t+1}\right] + \lambda_{t}\left[\tau p_{t+1}^{I}k_{t+1} - b_{t+1}\right]\right\}\right\}$$
(12)

$$p_t^i k_{t+1} = w_t + \frac{b_{t+1}}{R} \quad \forall t \ge 0$$
 (13)

udget constraint, and it means that net public wealth plus additional e next period capital.

in general unless the stochastic process θ_t has very low variance.

3.1 The precautionary saving effect.

f this simple model is that in equilibrium E's investment and saving y future expected ..nancing constraints. This is because E chooses a imises *total* pro..ts rather than *tradable* pro..ts. The concave technology too high with respect to the level that maximises tradable pro..ts. The ent problem. E cares about private bene..ts and expands the scale level e¢ cient in tradable terms. In this situation expected ..nancing importance of tradable versus non tradable output. E prefers to invest adable pro..ts and reduce the likelihood to be constrained in future. ehaviour can be illustrated using the ..r.st order conditions. Equation ngean of the maximisation problem. Adding to it the budget constraint multiplier ϕ_t , and taking the derivatives with respect to b_{t+1} and k_{t+1} , order conditions:

$$\phi_t = RE_t \left[\sum_{j=0}^{\infty} \gamma^j \lambda_{t+j} \right] + 1$$
(14)

$$\lambda_t \tau p_{t+1}^i - \phi_t p_t^i + \frac{1}{R} \left(1 + \eta - \gamma \right) E_t \left(M P K_{t+1} \right) + \frac{1}{R} \left(1 - \gamma \right) \left(1 - \delta \right) p_{t+1}^i +$$
(15)

$$+\frac{\gamma}{R}E_{t}\left(\phi_{t+1}\right)\left[E_{t}\left(MPK_{t+1}\right) + (1-\delta)p_{t+1}^{i}\right] + \Psi_{t+1} = 0$$

 $E_t(MPK_{t+1}) = \alpha p_{t+1}E_t(\theta_{t+1}) k_{t+1}^{\alpha-1}$ is the expected *tradable* marginal productivity of capthat the shadow cost of a binding budget constraint is equal to 1 plus xpected future shadow costs of a binding collateral constraint. That is, ure collateral constraints increases the required expected rate of return (14) into (15), and rearranging, we get equation (16), that together etermines the optimal value of k_{t+1} :

$$\frac{(1+\eta)}{R}E_t (MPK_{t+1}) = \frac{U_t}{R} + \left[Rp_t^i - \tau p_{t+1}^i\right]\lambda_t + \gamma \left[U_t - E_t (MPK_{t+1})\right]E_t \left(\sum_{j=0}^{\infty} \gamma^j \lambda_{t+1+j}\right) - \Psi_{t+1}$$
(16)

$$S_t \ge k_{t+1} \tag{17}$$

$$\lambda_t \ge 0 \tag{18}$$

$$\left[S_t - k_{t+1}\right]\lambda_t = 0\tag{19}$$

$$\begin{split} U_t &= Rp_t^i - p_{t+1}^i \left(1 - \delta\right) \text{ is the user cost of capital. } S_t &= w_t / [p_t^i - \frac{\tau}{R} p_{t+1}^i] \text{ is the borrowing} \\ \Psi_{t+1} \text{ is the following covariance factor}^8: \quad \Psi_{t+1} &= \frac{\alpha \gamma}{R} p_{t+1} k_{t+1}^{\alpha - 1} cov \left(\phi_{t+1}, \theta_{t+1}\right) \text{ .} \\ &\quad \text{o obtain a close form solution for } k_{t+1} \text{, we will } \dots \text{st describe its qualions} \text{ obtain a numerical solution in the next chapter.} \end{split}$$

ning the solution with perfect markets. This is equivalent to say that $\lambda_t = 0 \ \forall t \ge 0.$ as the F.O.C. for the optimal level of capital (equation 16) becomes

$$(1+\eta) E_t (MPK_{t+1}) = U_t$$
 (20)

 $(1 + \eta) E_t (MPK_{t+1})$ is the expected *total* marginal productivity of capital. I call $k_{t+1}^{PM}(\theta_t)$ satis. es equation 20. k_{t+1}^{PM} is the optimal level of capital when markets ver constrained, today or in future.

$$k_{t+1}^{PM} = \left[\frac{(1+\eta)\,\alpha p_{t+1} E_t\,(\theta_{t+1})}{U_t}\right]^{\frac{1}{1-\alpha}}$$
(21)

Proposition 1 Conditional on continuation, a level of investment of k_{t+1}^{PM} generates negative expected marginal tradable profits.

tforward. Since $\eta > 0$ it follows that $E_t (MPK_{t+1}) < U_t$, the marthe expected tradable marginal productivity of capital. I call $k_{t+1}^*(\theta_t)$ that maximises tradable pro..ts, which satis..es the standard condition

$$E_t\left(MPK_{t+1}\right) = U_t$$

 $E_t\left(\sum_{j=0}^{\infty}\gamma^j\lambda_{t+1+j}\right) > 0.$

$$k_{t+1}^{*} = \left[\frac{\alpha p_{t+1} E_t\left(\theta_{t+1}\right)}{U_t}\right]^{\frac{1}{1-\alpha}}$$
(22)

 $k_{t+1}^{PM} > k_{t+1}^*$ of the overinvestment problem. $k_{t+1}^{PM} - k_{t+1}^*$ increases in η , as private ight. Therefore $U_t - E_t (MPK_{t+1}) > 0$, evaluated at k_{t+1}^{PM} , measures lic pro.ts.

e solution with imperfect markets. When the collateral constraint is it will bind in future with a positive probability, then $\lambda_t = 0$, but quation (16) in this case becomes:

$$\frac{(1+\eta)}{R}E_t (MPK_{t+1}) = \frac{U_t}{R} + \gamma \left[U_t - E_t (MPK_{t+1})\right] E_t \left(\sum_{j=0}^{\infty} \gamma^j \lambda_{t+1+j}\right) - \Psi_{t+1}$$
(23)

actor is positive, unless w_t is very low.

 $\begin{array}{ll} k_{t+1}^{PM} & \mbox{23} \mbox{ is not satis.ed. The marginal productivity (left hand side) is inal cost (right hand side), because of the additional positive term$ $<math display="block">\gamma \left[U_t - E_t \left(MPK_{t+1} \right) \right] E_t \left(\sum\limits_{j=0}^{\infty} \gamma^j \lambda_{t+1+j} \right). \mbox{ This term represents the overall cost of overinvest-reted in the following way: the marginal loss in public pro.ts } (U_t - E_t \left(MPK_{t+1} \right) > 0 \mbox{ is that less ..nancial wealth is accumulated for future needs. The cost directly proportional to the expected probability of being constrained inuation } \left(E_t \left(\sum\limits_{j=0}^{\infty} \gamma^j \lambda_{t+1+j} \right) \right). \end{array}$

$$k_{t+1}^{o}(w_t, \theta_t)$$
 helevel of capital that satis. es equation (23). $k_{t+1}^{o}(w_t, \theta_t)$ is the optimal constraint is not currently binding⁹. It depends on w_t , because the level ther with θ_t , determines the probability of having a binding constraint

¹⁰ that $k_{t+1}^* < k_{t+1}^o < k_{t+1}^{PM}$. Intuitively the bigger is $E_t \left[\sum_{j=0}^{\infty} \gamma^j \lambda_{t+1+j} \right]$, ncing problems, the bigger is the cost of overinvestment, and k_{t+1}^o is his is like a precautionary saving exect. When E has bad news about to have ...nancing problems, he will save more now to increase his n if he is not actually constrained. Reducing capital towards k_{t+1}^* is ction (i.e. reducing employment, postponing nonessential investment, ranches, etc.).

 $\tilde{k}_{t+1}(w_t, \theta_t)$ the level of capital that solves the problem, satisfying equations

$$\widetilde{k}_{t+1}^{o}(w_{t},\theta_{t}) = \begin{cases} k_{t+1}^{o}(w_{t},\theta_{t}) & \text{if } k_{t+1}^{o}(w_{t},\theta_{t}) < S_{t}(w_{t},\theta_{t}) \\ S_{t}(w_{t},\theta_{t}) & \text{otherwise} \end{cases}$$
(24)

 k_{t+1}^{o} om k_{t+1}^{PM} . In fact perfect markets imply ...nancial constraints are never binding, while k_{t+1}^{o} f capital when the constraint is not binding today but will bind in future with a positive

 w_t s, the likelyhood of being ...nancially constrained decreases. That is, $E_t \left\{ \sum_{j=0}^{\infty} \lambda_{t+j+1} \right\} \rightarrow \Psi_{t+1} \rightarrow 0$, and from (25) follows that $\lim_{E_t \left\{ \sum_{j=0}^{\infty} \lambda_{t+1+j} \right\} \rightarrow 0} k_{t+1}^o = k_{t+1}^{PM}$. Moreover when

 $E_t \left\{ \sum_{j=0}^{\infty} \lambda_{t+1+j} \right\} \to \infty \text{ equation (25) is satis.ed only if } E_t (L_{t+1}) = 0. \text{ This implies that } \lim_{E_t \left\{ \sum_{j=1}^{\infty} \lambda_{t+j} \right\} \to \infty} \widetilde{k}_{t+1} = k_{t+1}^*.$

0

4 Numerical solution and simulation.

olved analytically, therefore here I provide a numerical solution obalue function and iterating the Bellman equation until convergence is

 θ a two state symmetric markow process: $\theta_t \in {\theta_L, \theta_H}$, with $\theta_H > \theta_L$. are:

$$\begin{aligned} \theta_{t+1} &= \theta_L \quad \theta_{t+1} = \theta_H \\ \theta_t &= \theta_L \quad \rho & 1 - \rho \\ \theta_t &= \theta_H \quad 1 - \rho & \rho \end{aligned}$$

 $.5 < \rho < 1$ r simplicity prices are assumed constant and normalised to 1. Chosen

$$\begin{split} \gamma &= 0.95 \quad \alpha = 0.6 \quad R = 1.01 \quad p_t = p_t^i = p_{t+1}^i = 1 \\ \delta &= 0.7 \quad \tau = 0.3 \quad \rho = 0.7 \quad \eta = 0.81 \\ \theta_L &= 1.7 \quad \theta_H = 2.3 \end{split}$$

value of δ is motivated by the fact that capital, being costlessly adr to nondurable working capital than to durable .xed capital. η indioutput is 81% of the tradable output. The higher is η , the larger is $k_{t+1}^{PM} - k_{t+1}^*$ r are expected tradable pro.ts at k_{t+1}^{PM} . 0.81 is the value that generates k_{t+1}^{PM} conditional on $\theta_{t+1} = \theta_H$. Since $k_{t+1}^o < k_{t+1}^{PM}$, such value means will obtain positive pro.ts conditional on 'good news' ($\theta_{t+1} = \theta_H$), and nal on bad news ($\theta_{t+1} = \theta_L$).

wo policy functions $\tilde{k}_{t+1} (w_t \mid \theta_t = \theta_H)$ and $\tilde{k}_{t+1} (w_t \mid \theta_t = \theta_L)$. For low w_t int is binding at time t, and $\tilde{k}_{t+1} = S_t$. This corresponds to the sectionat is a diagonal line, with slope $1/(p_t^i - \frac{\tau}{R}p_{t+1}^i)$. The denominator ofdownpayment for a unit of purchased capital when the constraint isg part of the policy function $\tilde{k}_{t+1} = k_{t+1}^o < k_{t+1}^{PM}$. The distance between k_{t+1}^{PM} the intensity of the precautionary saving exect.

, when θ_t increases, the binding constraint region expands and the gion shrinks. This feature is generated by the persistency of θ . Higher lues in future, and E expects to increase ...nancial pro..ts and ...nancial g future probability of being constrained.

4.1 Simulation: single firm.

 k_{t+1}

 θ_t

path of \vec{k}_t for 50 periods, with a sequence of expansion and contraction cratic shock is θ_H for 15 periods, then θ_L for 20 periods, and then the appendix B

ed in the appendix B.

periods. I simulate two ..r.ms with di¤erent initial endowment w_0 , but ..r.m with high w_0 has an almost zero probability to be constrained in s like an unconstrained ..r.m, and $\tilde{k}_t(w_t, \theta_t) \simeq k_t^{PM}(\theta_t) \forall t$. The ..r.m ng collateral constraint only in periods 1-4 (start-up phase) and 35-36 sequence of bad outcomes). In the other periods precautionary saving ent volatility with respect to the 'unconstrained' ..r.m.

utionary saving on the relation between investment, pro.tability and r in ..gure 3, that shows the time paths of capital and of net tradable ositive correlation with expected pro.tability, but also with changes in h ‡ow) not related to changes in expected pro.tability. This is due to g exect. In the ..r.st 15 periods E accumulates wealth. As he becomes e future, he increases the amount of wealth invested in the risky asset g precautionary saving. The situation is reversed in the next 20 periods utionary saving is responsible for much of the contraction of investment

ows an investment excess sensitivity to internal ...nance, con..r.ming on panel data reduced form investment estimations, even thought here rical and nonlinear, and it depends on the level of wealth as well.

4.2 Simulation: aggregate.

the solution of the model to simulate an arti..cial economy with many is is a very simple 'partial equilibrium' economy, because both interest genous. The purpose of this exercise is to verify that the simulated ed facts about the business cycle mentioned earlier. I will show that o unexpected shocks because of ...nancial problems, despite all ..r.ms are bject to the same constraints.

ple: I simulate an economy with 10000 ..r.ms, for 200 periods. Each es accordingly to the value of θ_{it} , that is independent across ..r.ms and time. Firms exit when their E retire, and new ..r.ms enter, but the constant. Each period aggregate statistics for small and large ..r.ms e the exects of an unexpected macroeconomic shock that hits after 100

ion is then to analyse ...r.m dynamics in a simple economy with heterory important to note that in general such dynamics are very sensitive ns. From this respect one limitation of the model presented in chapter

12

 w_0

 θ_H

cratic shock is stationary, and ..r.m's technology is concave. Therefore up to the expected steady state size of the ..r.m, that depends on the on $E(\theta_{t+1}) = (\theta_H + \theta_L)/2 = \overline{\theta}$. This corresponds to a situation where reasing, or are constant/increasing but E's 'know-how' is essential for

s limitation is that there exists a straightforward way to generate higher It is suc cient to impose the same $\overline{\theta}$ to all ..r.ms, and to assume that with a very small endowment. Given that there is an ongoing entry ..r.ms will include younger ..r.ms that are constrained because are in the ge ..r.ms will include older ..r.ms that are less constrained because they the steady state.

o generalise the analysis, I consider another dimension of ... rms heteroalue of $\overline{\theta}$. To keep things simple, I simulate 10000 ... rms that belong to

Type1:
$$\overline{\theta}^1 = 2$$
 $\theta_L^1 = 1.7$ $\theta_H^1 = 2.3$ $k^{PM_1}(\theta_L^1) = 14$ $k^{PM_1}(\theta_H^1) = 18.9$

Type 2: $\overline{\theta}^2 = 2.25 \quad \theta_L^2 = 1.9125 \quad \theta_H^2 = 2.5875 \quad k^{PM_2} \left(\theta_L^2\right) = 18.8 \quad k^{PM_1} \left(\theta_H^2\right) = 25.4$

smaller $\overline{\theta}$, but are otherwise equal, also in terms of risk, as:

$$\frac{\left(\theta_{H}^{1}-\theta_{L}^{1}\right)}{\overline{\theta}^{1}}=\frac{\left(\theta_{H}^{2}-\theta_{L}^{2}\right)}{\overline{\theta}^{2}}$$

and 2 among the 10000 ..r.ms is such that the two types on average gate level of output. The ..r.ms are then selected into small and large tradable wealth¹³.

sional heterogeneity of ..r.ms, we expect each group to include a mix of successful type 1 ..r.ms will be in the large group, while some young or ill be in the small group. A type one small ..r.m is a ..r.m that is happy 2 small ..r.m is either a young growing ..r.m, or a ..r.m that shrank after negative pro..ts.

rs are the same used in previous numerical solution. Moreover each substituted by new ..r.ms of the same type.

created ..r.m, initial endowment is the following:

nology can be interpreted as a constant/increasing return to scale technology where the I .xed amount of labour. That is, $\theta_t = \hat{\theta}_t \overline{L}^\beta$, where $\hat{\theta}_t$ is the stochastic component, \overline{L} is upply and $\alpha + \beta \ge 1$.

e obtained using di¤erent selection criteria, like capital level or output.

$$w_{0} = \frac{k^{^{PM}z}\left(\theta_{H}^{z}\right)}{\left(p_{t}^{i} - \frac{\tau}{R}p_{t+1}^{i}\right)}$$

 $z \in \{1,2\}$'s type. This ensures that new ..r.ms have enough resources to ..nance ital level, and the constraint is not binding in the ..r.st period of life. lue of w_0 does not change the qualitative results of the analysis, it nitude. Therefore this assumption has the purpose of emphasising the rms dynamics and of the precautionary saving exect versus the exect in the start-up phase.

he *cumulative rate of growth of capital* for small and large ...ms, before macroeconomic shocks. Figures 9 and 10 show the *cumulative rate*

of growth of the capital/sales ratio. Following the empirical literature (Gertler and Gilchrist,

nanke, Gertler and Gilchrist, 1996), I select ..r.ms according to a ..xed ative size distribution function. Each period the ..r.ms below the 50% the small ..r.ms group.

temporary reduction in output of 10%. Since the model does not have ty, the observed variability in the aggregate growth rates before the n the entry/exit dynamics.

tive impact on investment after the shock is around 5% for small ..r.ms The reason for the di¤erence is that lower output reduces pro..ts and ..r.ms reduce investment because the wealth shock pushes them in while other ..r.ms reduce investments because of precautionary saving stronger for small ..r.ms, that are relatively less wealthy. After the ..r.st lowly return to the previous steady state. The reduction in cumulative een 15 and 20 periods to disappear. Such persistency depends on the ect. As long as ..r.ms are on average less wealthy, with respect to the hey have higher expected probability to be constrained in future, and y reach the before-shock average wealth level.

symmetric positive shock. Both small and large ..r.ms increase invests, in absolute value, than after the negative shock. The reason of the rms experience an "actually binding" constraint before the shock (see itive shock's impact is caused almost exclusively by the precautionary egative shock's impact is caused by a mix of precautionary saving and

sider a monetary policy tightening. Figure 6 considers a permanent to 0.2. This shock is like a credit crunch, as it reduces the borrowing

au

o in this case small ... rms are more a ected, with an immediate reduction n of 3% for large ... rms. Once again this result depends both on binding nary saving. In addition we can observe that after the permanent shock the previous steady state. In fact the reduction in τ means that there trained in future, and small ... rms become permanently more "prudent"

exect of a permanent increase in interest rate. This shock has three

of capital k_{t+1}^o decreases, because the user cost of capital U_t increases. unconstrained ..r.m.

apacity S_t decreases, because the downpayment $p_t^i - \frac{\tau}{R} p_{t+1}^i$ increases. \tilde{k}_{t+1} onstrained ..r.m.

 \tilde{k}_{t+1}

ween k_{t+1}^{PM} and k_{t+1}^* decreases. Production is more e¢ cient, in the pitai ti...t e

r small ..r.ms. Capital in this model does not have adjustment costs,

- , and this result is therefore consistent with the fourth stylised fact
- t the procyclicality of inventory investment/sales ratio.

5 Conclusions

investment with collateral constraint and private income, that analyses onsumption and investment for the entrepreneur of a small medium production above the pro..t maximising level, to bene..t of the private situation future expected ..nancing constraints a¤ect his choices today, e scale of activity to generate more ..nancial earnings and improve his

why small ..r.ms are on average more ..nancially constrained, despite all cal regarding their ability to access external ..nance. It generates ..r.m ined (small) ..r.ms are shown to be more volatile in the business cycle. d, the constraint is binding, and a positive productive shock generates a ent because of the ..nancial accelerator exect. On the contrary, after an ative shock reduces investment mainly through a precautionary saving fore explains the great importance of consumers and businesses con... that, while binding constraints matter in upturns, expected ..nancial important depressing exect on investment in downturns.

ith empirical evidence about ..r.m dynamics. Other interesting results y is more exective than interest rate in propagating monetary policy ed (small) ..r.ms, while interest rate is more exective for unconstrained odel suggests an explanation to the procyclicality of inventories/ sales

References

, nonmonetary exects of the Financial Crisis in Propagation of the merican Economic Review 73, 257-76.

Ier, M. and S. Gilchrist, 1996, The Financial Accelerator and the Flight view of Economics and Statistics 78, 1-15.

Ier, M. and S. Gilchrist, 1998, Credit Market Frictions and Cyclical hcoming in Handbook of Macroeconomics, North-Holland, Amsterdam.

.V. Thakor, 1987, Collateral and Rationing: Sorting Equilibria in Mopetitive Credit Markets, International Economic Review, 28, 671-89.

"An Empirical Investigation on Financial Constraints, Firms Heteross Cycle", Mimeo, London School of Economics.

Dynamics Economics, Oxford University Press.

Gilchrist, 1993, The Role of Credit Market Imperfections in the Mon-Mechanism: Arguments and Evidence, Scandinavian Journal of Eco-

Gilchrist, 1994, Monetary Policy, Business Cycle, and the Behaviour of g Firms, Quarterly Journal of Economics 109, 309-340.

Himmel

.S. Majluf, 1984, Corporate Financing Decisions When Firms Have In-on That Investment Do Not, Journal of Financial Econom i- ae aaa o.Sn o



















Cumulative growth rates of capital/output ratio







