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Animal spirits, asymmetric information and accumulation

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1 INTRODUCTION

In a world where only firms can accumulate for productive purposes growth depends crucially on the overall behaviour of firms. In a standard textbook model of growth the representative firm invests all the available savings, with the result that growth is hindered only by technical reasons: factor returns and technical progress. In the special circumstances where no technical progress occurs, growth, due to decreasing marginal returns, is thinned down to the extent of vanishing. But other assumptions may hold: when the classical assumption of saving-investment equality no longer holds and not all savings are turned into investment, growth may be hindered by additional reasons. In a standard Keynesian model growth may be hindered by effective demand: if saving is not turned automatically into investment, income is depressed, accumulation slows down and the economy settles down at an equilibrium where the growth potential may never be realized.

In the model presented in this paper a Keynesian feature is adopted. Not all available saving is turned into investment: a monopolistic bank accumulates resources which are not channeled into production. Furthermore due to asymmetric information the bank does not know which kind of firm it is going to finance, whether good or bad. It follows from this that the only firm which is in a position to accumulate is the risky kind of firm, called bad firm, while the good firm will see its surplus entirely extracted by the bank. It is assumed in the model that the bad firm will invest all its expected savings. However its overall expected savings increase at a decreasing rate: it follows that its ability to accumulate is reduced through time. The impact on growth then will be correspondingly lower and lower, as if diminishing returns were in operation.

In this model therefore growth depends on the existence of a class of firms, namely the bad firms, with a disposition to undertake risky projects. If no such firms existed no growth would occur in the economic system. Hence, it is the nature of the environment which is conducive to growth. The environment includes bad and good firms: the former are prepared to fail while the latter do not contemplate such a possibility. Both at worst lose nothing from taking action; but bad firms may get a rent with given probability. Therefore bad and good firms must be different in their preference structure; if they were similar no firm would 'choose' to be a good firm. The two classes of firms, therefore, have different animal spirits. Good firms must possess a much weaker urge to action if despite the prospect of a rent they are not prepared to face the possibility of failing. Here we have another Keynesian feature in the story: animal spirits are crucial for accumulation and hence for growth. It is precisely the existence of a class of firms with a strong urge to action which is the source of growth.

A number of interesting implications can be drawn from the model: a) even if classical diminishing returns are ruled out growth declines to zero notwithstanding; b) risky firms prove to be beneficial

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to accumulation and growth; c) any attempt to make banks more capable of discriminating between bad and good firms will resolve itself into a restrain to growth.

2 THE MODEL SETUP

Consider a risk-neutral village economy with a measure one of potential firms-entrepreneurs that live for one period and are replaced by an identical offspring. At the beginning of each period, these agents have access, ex ante, to one of two possible projects, *Good* or *Bad*, to produce a capital good. The good project, the *safe* one, always succeeds[1] and yields $Gf(L)$ units of capital. The bad project, the *risky* one, succeeds with (a constant over time) probability p and yields $Bf(L)$ with $B > G$, whereas with probability $1-p$ it fails and gives nothing. Such a distribution describes the environment of the system, which turns out to be made up, with given probabilities, of firms which adopt the bad project and firms which adopt the good one. The function $f(\cdot)$ is increasing and concave in *L*, the endogenous amount of resources invested, and satisfies the Inada conditions. Firms' quality is considered uncorrelated through time. Assume that the good project has always a positive net value, while the other a negative one, that is[2]

$$pBf(L) < L < Gf(L) \quad \text{for each } L, \tag{1}$$

where we consider the worst scenario for bad types as they produce less than the resources exploited.

The first generation has no initial wealth and therefore needs outside financing. Creditors are assumed to form a monopolistic bank external to the village. The bank replaced every period by an identical institution[3]. The banks will design the financial contracts in order to extract all possible surplus from their prospective borrowers. As regards the informational structure, firms know their own quality. The banks instead only know that, statistically, the proportion of good types (the quality of the environment) is constant and equal to $\lambda \in (0,1)$. The amount of capital produced is instead observable.

At the end of each period, firms produce a final good according to a non-stochastic, constant returns to scale technology denoted by[4]

$$y_t = \lambda y_t^G + (1-\lambda) y_t^B = \lambda k_t^G + (1-\lambda) k_t^B = k_t, \tag{2}$$

where k_t is the (per-capita and aggregate for the normalization on population size) part of the total amount of capital that firms retain from the financial contract.
The bank keeps the remaining capital,

$$\lambda Gf(L) + (1-\lambda) pBf(L) - k_t, \tag{3}$$

[1] If we considered a positive probability of failure for good firms, the interest-rate repayment sum would progressively be lower over time. Good types would offer their collateral only in exchange for more favorable contract terms.
[2] The second inequality of (1) must be strict in order to guarantee the existence of pooling equilibria.
[3] We use this assumption to model a myopic behaviour in the maximization program of each bank. This also implies a sort of no cross-subsidization condition through periods (banks cannot offer contracts that lose money in expectation).
[4] The theoretical results remain unchanged if the coefficient of this *AK* production function is different from 1.

as rent extracted from the trade. The capital extracted as rent from the bank is not invested in the local economy. For simplicity, assume that capital never depreciates and that y_t is not exploitable to produce capital (itself) but can be used to reproduce itself.[5]

Had we full information, the optimal contracts would be, each period, $R_t = Gf(L_t)$ for the good type with L chosen by the bank is order to maximize its first-best profit $\lambda(G(L_t) - L_t)$, and no contract for the bad type. In this case, there would be no accumulation for the village. All the rent would accrue to the foreign banks which are not supposed to invest in that economy.

The timing of each-period events is as follows: at the beginning of the period potential entrepreneurs know their own quality. They ask for loans and offer their endowments, if any, as collateral. The bank then proposes a pooling or a separating financial contract (loan quantity, repayment sum and collateral). Production of capital takes place and firms pay back their debts. At the end of the period, firms use the capital they retained from the financial contract to produce the final good and bequeaths all they can to the future generation (there is not a consumption-savings choice). All payoffs are measured in expected terms.

3 EQUILIBRIUM

Initial period

As firms have no possibility to offer collateral in the initial period, the bank can propose a pooling contract that specifies just the loan advanced L_0 and a repayment sum (interest plus principal) R_0. The capital that firms retain from the contract is

$$k_0^G = Gf(L_0) - R_0 \qquad \text{for a good type and}$$
$$k_0^B = p[Bf(L_0) - R_0] \qquad \text{for a bad type.}$$

As no alternative productive activities for the local are considered, the participation constraints simply are

$$k_0^i \geq 0, \qquad i = \text{G, B.} \qquad (\text{PC}_0^{\text{i}})$$

If $R_0 > Gf(L_0)$ only bad firms apply. For (1), this is not feasible for the bank and, consequently, its best choice is setting $R_0 = Gf(L_0)$ and proposing a pooling contract, $POOL_0$, that satisfy the program

[5] If the final good (or capital) could also be used as an input to produce capital, it would be possible to derive an equilibrium loan increasing over time with the collateral offered. If for instance we consider a production function $f(L,k)$ not separable in L and k, the loan size results dependent on the capital, and so on the collateral accumulated. This can be considered realistic if we think of this model as an approximation of what happens in underdeveloped regions after the revolution brought by the *Grameen*-type Banks. In these regions, firms receive a loan for the start up even if collateral is not available. The loan then increases over time if the entrepreneurs reveal the ability to save. The savings are deposited in a banking account and can be seized in case of bankruptcy (this account is not always called collateral by the advocates of this type of banks).

$$\max_{L} \pi_0^{POOL} = p_\lambda G f(L_0) - L_0 \quad\quad (4)$$
$$s.t.\ \ (\mathrm{PC}_0^{\mathrm{G}}),$$

with $p_\lambda = \lambda + (1-\lambda)p$ and where we can clearly neglect the participation constraint for the bad project. We denote the solution of the program by L_0^{POOL}. If the maximum in (4) is below 0, credit rationing occurs.

If the firm financed is good, it gets no rent. So, it cannot invest capital in the final-good process. Its offspring will be born with an endowment equal again to $y_0^G = 0$. If the borrower is bad it receives, invests and leaves $y_0^B = k_0^B = pf(L_0^{POOL})(B-G)$. As a result, the final production in the village is

$$y_0 = (1-\lambda)k_0^B. \quad\quad (5)$$

The bank instead receives and invests elsewhere $\lambda G f(L_0^{POOL}) + (1-\lambda)pBf(L_0^{POOL}) - (1-\lambda)k_0^B$ units of capital.

With a pooling we have $\pi_0^{POOL} = \lambda G f(L_0) + (1-\lambda)Gf(L_0) - L_0 < \lambda G f(L_0) + (1-\lambda)Bf(L_0) - L_0$. This means that it is better to have all firms financed rather than none, as by the end of the period the economic system accumulates resources for production.

Subsequent periods: pooling or separating contracts

At the beginning of period 1, the newborn prospective entrepreneurs will have a per-capita[6] endowment equal to y_0. This is equal to the final production of the village and to the bequests of the bad firms as the good firms retain nothing from trading with the bank and hence invest and leave nothing. The firms born from the good firms can be treated as making up an economy again in its initial period. This is why attention is paid only to the firms born from the bad ones. Since for these firms there is now the possibility to offer the asset accumulated as collateral, the new bank will choose a pooling or a separating contract on the basis of its profitability.

The bank can offer a pooling contract $POOL_1$ that specifies the loan advanced, L_1^{POOL}, and a couple $(R_1^{POOL}, (1-\lambda)k_0^B)$ where R_1^{POOL} is the sum the new firm has to repay if the final product is positive and $(1-\lambda)k_0^B$ the given collateral[7] transferred in case of bankruptcy. Firms' capital results from the new production, the repayment of the loan and the capital inherited from the previous period. For each kind of firms it is the following:

$$k_1^G = (1-\lambda)k_0^B + Gf(L_1) - R_1 \quad\quad \text{for a good type and}$$
$$k_1^B = (1-\lambda)k_0^B + p[Bf(L_1) - R_1] - (1-p)(1-\lambda)k_0^B \quad\quad \text{for a bad type.}$$

where the collateral is paid in case of failure only by bad firms.

The participation constraints now are

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[6] To ease the exposition, from this period on the contracts will be based on the average amount of collateral inherited.

[7] The bank can require all the endowment as collateral for the assumptions of monopoly, asset verifiability and for the fact that good firms never fail.

$$k_1^i \geq (1-\lambda)k_0^B, \qquad i = \mathrm{G, B}. \tag{PC_1^i}$$

The program of the new bank is

$$\max_L \pi_1^{POOL} = p_\lambda G f(L_1) + (1-p_\lambda)(1-\lambda)k_0^B - L_1 \quad s.t.\ (\mathrm{PC}_1^{\mathrm{G}}), \tag{6}$$

with $(1-p_\lambda) = (1-\lambda)(1-p)$.

That is, the bank takes the available endowment as given and maximizes its profit. Again, the best choices are $R_1^{POOL} = R_0 = Gf(L_0^{POOL})$ and $L_1^{POOL} = L_0^{POOL}$, but the profit is larger as there is now a new positive term in the equation.

If the firm being financed is good, again it receives no rent. So, it can just invest, and subsequently leave, no more than the capital inherited $y_1^G = (1-\lambda)k_0^B$. A bad firm, on the other hand, receives from trading with the bank and from re-activating the inherited capital as collateral $k_1^B = (1-\lambda)k_0^B + pf(L_1)(B-G) - (1-p)(1-\lambda)k_0^B$. So it can bequeath $y_1^B = k_0^B + (1-\lambda)pk_0^B$, that is more than his ancestor. Again, the participation constraint for a bad firm is trivially satisfied.

Total production is the sum of good and bad firms production

$$y_1 = \lambda(1-\lambda)k_0^B + (1-\lambda)(k_0^B + p(1-\lambda)k_0^B) = (1-\lambda)k_0^B[1+\lambda+p(1-\lambda)] > y_0. \tag{7}$$

We have that y_1 increases with respect to y_0, i.e. we have growth. Indeed, we have that $\lambda + p(1-\lambda) < 1$, that is the additional capital and product received by the village at the end of period 1 is lower than the additional product received at the end of period 0. This happens because bad firms receive a lower rent from the contract as they now face the possibility of returning the accumulated capital in case of failure. In any case growth depends on the existence of bad firms, just like in the previous period positive production occurred because of bad firms.

The bank receives $\lambda G f(L_1^{POOL}) + (1-\lambda)pBf(L_1^{POOL}) + (1-p_\lambda)(1-\lambda)k_0^B - (1-\lambda)k_0^B[1+\lambda+p(1-\lambda)]$ units of capital.

Since now, i.e. at the end of the first period, firms possess the initial endowment $(1-\lambda)k_0^B$ (as given) the bank could exploit the loan size to screen types. To separate, the bank needs the contract $SEP_1 = (R_1^{SEP}, C_1^{SEP})$ where R_1^{SEP} is the sum the firm has to repay if the final product is positive and C_1^{SEP} the collateral transferred after failure. This time, L is chosen such that the participation constraint of a potential good firm and the incentive constraint of a bad firm are satisfied with equality. That is iff

$$\begin{cases} k_1^G = (1-\lambda)k_0^B + Gf(L_1) - R_1 = (1-\lambda)k_0^B & (\mathrm{PC}_1^{\mathrm{G}}) \\ k_1^B = (1-\lambda)k_0^B + p(Bf(L_1) - R_1) - (1-p)C_1 = (1-\lambda)k_0^B. & (\mathrm{IC}_1^{\mathrm{B}}) \end{cases}$$

The above system gives[8]

$R_1 = Gf(L_1)$ and $C_1^{SEP} = \frac{pf(L_1)(B-G)}{1-p}$.

The loan size L_1^{SEP} derives from

$$(1-\lambda)k_0^B = C_1^{SEP} \quad \text{or}$$

$$(1-\lambda)pf(L_0^{POOL})(B-G) = \frac{pf(L_1)(B-G)}{1-p}. \tag{8}$$

This means that the screening collateral C_1^{SEP}, and so the loan quantity, is constrained by the available wealth, $(1-\lambda)k_0^B$, if the bank wants to sort the entrepreneurs. With SEP_1, if a firm applies, it is definitely a good type. On screened firms, the bank makes

$$\pi_1^{SEP} = \lambda[Gf(L_1^{SEP}) - L_1^{SEP}], \tag{9}$$

where the profit is always above zero for (1) but clearly not maximized. Note that (9) represents exactly the first-best profit, that is project expected value minus investment costs. The bank can extract all the capital from good types as in a full information setting. Note also from (8) that $L_1^{SEP} < L_0^{POOL}$, so the separation is achieved at the cost of a reduction in the size of the project.

Good types invest in the final-good production and bequeath what they receive from the past, that is $(1-\lambda)k_0^B$. Bad types, for the assumption of no capital depreciation, also leave $(1-\lambda)k_0^B$.
After a separating, we have that

$$y_1 = (1-\lambda)k_0^B = y_0, \tag{10}$$

as at the end of period 0. No growth occurs therefore if banks can screen types. No surplus stays in the economy. All resources accrue to the bank with the result that the economy becomes a stationary one.

The equilibrium contract
The equilibrium contract depends on the bank's profitability upon the pooling or separating contract. The bank prefers $POOL_1$ when

$$\pi_1^{POOL} \geq \pi_1^{SEP}. \tag{11}$$

If (11) holds, the accumulation carried by bad firms still goes on, while if it does not hold, bad firms get no credit. As a result, in all subsequent periods firms will always have the same initial endowment and the contract will be constantly separating.

If in the previous period the contract was pooling, at the beginning of period 2 the new prospective entrepreneurs have a per-capita endowment equal to y_1. Once again, the bank will choose its

[8] Actually, the bank screens the entrepreneurs slightly modifying the terms such that the incentives are strict and a potential borrower applies only when it is good. Since SEP_1 lies on the individual rationality constraints of each type, the contract is chosen weakly below the good firm line and above the bad one.

preferred contract. If the contact is separating, there will no longer be accumulation of wealth. If it is pooling, firms will accumulate a product,

$$y_2 = (1-\lambda)k_0^B[1+\lambda+\lambda^2+p(1-\lambda)+2p\lambda(1-\lambda)+p^2(1-\lambda)^2] > y_1. \tag{12}$$

So, the final product still increases, but again with a decreasing rate. Since $\lambda + p(1-\lambda) < \lambda^2 + 2p\lambda(1-\lambda) + p^2(1-\lambda)^2$, the additional return in period 2 is less than that in period 1. This implies that, even if the contract is always pooling, the economic growth will come to an end[9]. Note that this result applies even with the assumption of constant returns to scale in the final process. The growth rate decreases because there is less and less additional capital input to invest. Note also that we cannot have a situation where the contract is separating in one year and pooling the next. If the separating is chosen, it will be so for all subsequent periods.

4 NUMERICAL EXAMPLE

Before concluding the paper it is interesting to run a little exercise to see what kind of choice the monopolistic bank makes under different circumstances and what are the implication, as regards the pattern of growth, of that choice. The exercise will be based on a numerical example where everything stays constant except the environment of the system, i.e. the parameter λ.

Take $k_t^G = GL_t^\alpha$ and $k_t^B = BL_t^\alpha$. In figure 1, with $\alpha = 0.5$, $G = 1.7$, $B = 1.8$ and $\lambda = 0.55$ the plot shows that, after the first period, the bank prefers the separating contract. From this period on, the growth rate is constant and equal to zero. In figure 2, with $\alpha = 0.5$, $G = 1.7$, $B = 1.8$ and $\lambda = 0.6$, the separating gives a higher payoff after the second period when firms have a more substantial collateral with the result of reducing the rate of growth to zero anyway. In figure 3, with $\alpha = 0.5$, $G = 1.7$, $B = 1.8$ and $\lambda = 0.65$, the pooling is always preferred. However, after some time the accumulation comes to an end despite the assumption of constant returns to scale on the final-good production function.

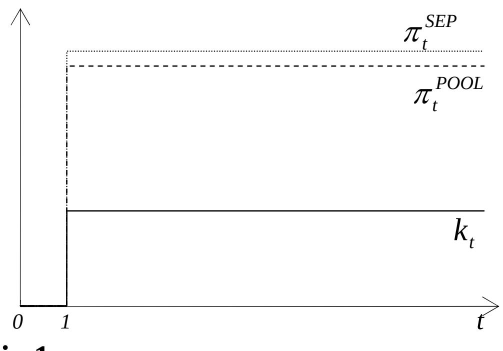

Fig 1 –

[9] We have, indeed, that at $t = n$, the rent accumulated will be

$$y_n = (1-\lambda)k_0^B[1+\lambda+\lambda^2+...+\lambda^n] + (1-\lambda)k_0^B[p(1-\lambda)+p^2(1-\lambda)^2+...+p^n(1-\lambda)^n] +$$

$$+(1-\lambda)k_0^B[2p\lambda(1-\lambda)+3p\lambda^2(1-\lambda)+...+np\lambda^n(1-\lambda)] +$$

$$+(1-\lambda)k_0^B[2p\lambda(1-\lambda)+3p^2\lambda(1-\lambda)^2+...+np^n\lambda(1-\lambda)^n].$$

The term at the end of each square bracket is very close to zero when n is large.

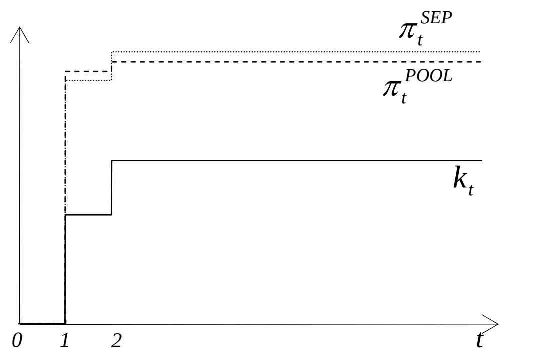

Fig 2 –

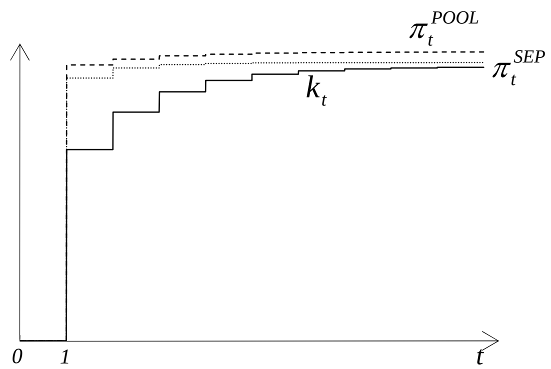

Fig 3 –

The exercise shows that the actual distribution of firms among types determines the pattern of growth of capital and production. In particular, in the numerical example examined, an increase in the proportion of good firms in the economic system turns out to be favorable to growth. However a more general argument needs to be developed.

4 CONCLUSION

The model presented in this paper was designed to show how a particular environment can affect accumulation and growth. The model has a Keynesian flavor as not all saving turns into investment with the result that growth potential may not be achieved. The model also allows for animal spirits to play a role in the system, as a change in the distribution of firm types (λ) will affect the path of growth. Given that firms differ because of their disposition towards risk and, hence, towards the prospect of failure, it is precisely their approach to action rather than inaction that makes up the economic environment. The model has also other distinctive features: apart from being set in an uncertain context it allows for asymmetric information and for a monopolistic bank.

The main implications of the model are: a mechanism which reduces growth to zero apart from diminishing returns and a special role for risky firms which turn out to be essential to growth. The model therefore provides a context where a number of interesting questions can be asked: a) what are the effects on growth of a change in animal spirits, i.e. a change in the distribution of firm types; b) what are the effects on growth of a change in the ability of banks to screen firm types; ….