Investment, inequality, and risk in a closed, poor economy

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Abstract

A characteristic of many poor, underdeveloped economies is their isolation from outside trade and investment. This paper shows that where prices are set by local production, missing credit markets can create barriers to entry which determine the structure of returns in the entire economy. The investment options available to individuals are restricted by their initial endowments, and thus sectors which require larger fixed investments become increasingly oligopolistic. The primary conclusion is that in such a world, the poor assemble investment portfolios which bear both lower returns and higher risk than the wealthy. Consequently inequality increases inexorably, and the introduction of credit markets may exacerbate the problem.

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1 Introduction

The motivation for this paper comes from observation of the way that competition transpires in extreme economic environments such as slums, deep rural areas, or politically unstable countries. Here, formal employment is minimal, and the majority of economic activity consists of informal businesses being run by individuals or households. Further, due to transactions costs of various kinds, the role of outside production or demand in the economy is minimal. We tend to see intense economic activity in any sector which can be entered by the very poor, while high-level investment is carried out by fewer agents and often by those who have contacts outside this micro-economy.

A more specific impetus for the modelling in this paper was a series of conversations with women running micro-businesses in Uganda during 2000-2001. Frequently, entrepreneurial individuals would lament that were they able to acquire larger loans, they would be able to achieve higher net returns. I was puzzled by this assertion, and originally looked for some evidence that the technology they were using displayed increasing returns to scale. Upon further inquiry, however, they made it clear that the credit would be directed to a *different* economic activity, and the reason for doing this was that there existed less competition, and hence greater net profits, in this other sector.

The model presented here is intended to represent isolated economies in which contracting is very weak, and in which financial institutions are imperfect or missing altogether. Where these conditions prevail, sufficient capital does not exist to make all of the investments in the economy which might be profitable, making arbitrage imperfect. This implies that rents will be present in some sectors, and given Cournot competition the quantity of rents is related to a kind of barrier to entry which is not present in liquid economies: the capital barrier.

This barrier generates increasing returns to scale, not in the quantity of investment within a sector, but rather due to differing rates of return across sectors. But what constitutes a capital barrier? The most straightforward example is a fixed-cost present in production where no credit is available. Here an agent must posses a sufficient endowment to enter the sector, meaning that only the wealthier agents can invest in high fixed-cost production technology. Similar barriers may be present in spatial arbitrage; an example from Uganda is a woman retailing charcoal who sought a much larger loan in order to be able to rent a truck to go to the distant area where the charcoal was produced. The fixed cost of this rental had restricted the number of individuals able to provide transportation on the route, and consequently middlemen was capturing an intermediate profit stream that had higher net returns than the retailing. Capital barriers are often generated by, but are not identical to, fixed costs. If, for instance, the provider of capital equipment provides financing, then the equipment represents a fixed cost but not a capital barrier. If any variable costs have to be incurred up-front (prior to production), then they form a capital barrier.

This idea of increasing 'pecuniary' returns to scale differs from the endogenous growth literature (see (Romer 1986), (K. Murphy & Vishny 1989), or (Acemoglu 1996)) where externalities in the stock of an asset generate increasing returns for the economy as a whole. Rather, the idea is that barriers to entry create oligopoly, and so agents' production decisions generate immediate externalities by altering the degree to which other individuals can effect the price of a commodity. The basic idea of convexity in the returns on investment was first put forward by (Sappington 1983). In his model, if the liability of the agent is limited, the principal does not have the incentive to induce socially optimal behavior and thus distortions in the credit market generate convexity.

(Banerjee & Newman 1993) is closer to the spirit of this paper in developing a model where agents choose from four occupational options; subsistence, wage labor, self-employment, and entrepreneurship. Some minimum amount of capital is required to join the latter two enterprises, and agents only choose to enter them if the returns there are higher. Loans will only be taken in order to enter these two activities, and since borrowers can renege on loans there is a collateral constraint. The static implication of this model is equilibrium returns which are increasing in initial endowments, because of the monitoring costs involved in entrepreneurship. This is an extension of the argument in (Bernanke & Gertler 1989) which hinges on the fact that high borrower net worth (collateral) reduces agency costs in the optimal contract. A later, two-sector paper by the same two authors (Banerjee & Newman 1998) posits a rural economy with better information and an urban economy which is more productive. Similarly, (Aghion & Bolton 1997) and (Lloyd-Ellis & Bernhardt 2000) develop multi-sector models where moral hazard makes the initial distribution of assets vital in the subsequent development of the economy. Other papers which show a relationship between the initial distribution of endowments and the evolution of the macro-economy are (Galor & Zeira 1993) and (Mookherjee & Ray 2001).

These models, however, are all complex stories in which it is agency problems that generate convexity. Every one of these models assumes that the price of the output good produced is exogenous. This paper seeks to make a much simpler point, which rests not on moral hazard but on market power. In this case, the rents which producers can extract are a direct function of the number of other agents producing a good, and thus the difference in the rate of return between high-capital and low-capital sectors comes not from agency costs but from an improved ability to influence the price of the output.

The empirical results on the presence of increasing returns in developing markets are scant, and the few studies that exist have mixed results. (McKenzie & Woodruff 2002) find that Mexican micro-businesses with lower capital stocks have much higher returns, even controlling for firm and individual characteristics. (Paulson & Townsend 2001), in a study on Thai households find that there is a significant relationship between investment and wealth, but do not have data on profits. Neither of these studies is a direct test of this hypothesis, however, as this would require examining how returns to capital vary across the capital barrier.

The variance of portfolio returns are also determined by the presence of the capital barrier: the number of different assets which can be included in an investment portfolio is directly determined by initial assets. Thus, agents with high endowments not only achieve higher returns but lower variance because they can simultaneously concentrate and diversify investment.

The introduction of collateralized investment into such an economy will have perverse effects. Specifically, since only those who already have assets are able to leverage any capital, loans only increase the investment advantage of the wealthier and have no effect on those without collateral. Microfinance, which might seem reasonable way to proceed, will not only damage the rents of agents operating in sectors entered by microfinance clients, but is inefficient in the sense that it disaggregates capital in an economy where concentration is an advantage. As such, any quantity of microfinance capital could have achieved greater welfare improvement if it had been invested as a lump-sum and the returns distributed.

2 A Discontinuous Parable

We begin with a simple story which contains the fundamental dynamics of the continuous model that follows it. Traders buy a good in one market and sell it in the next. In the first market, they are presented with baskets full of beads, and each size of basket contains a different kind of bead. The only difference between traders is their endowment of a numeraire bead which is the medium of exchange in the second marketplace. Traders are only able to buy a bead in the first market if they possess enough to buy the whole basket, but they may buy only a single bead. This bead is sold in the second market, where the price of a bead is set by its aggregate supply, of which our traders are the only source. Every agent knows every other agent's endowment, and must choose which type of bead to buy.

Endowments of the numeraire (K_i) are distributed according a probability distribution function $\Phi(K_i)$, and a type of bead s is fully described by the size of the basket in which it comes, $\tilde{I}_s$. The number of agents who are just able to purchase a bead of type s is simply a histogram of the distribution of $\Phi(K_i)$ observed at the values at which baskets are available. We denote the number of such traders in each cell s as η_s. The price for each bead in the second market is set by $p_s(N_s)$, where N_s is the number of traders who actually buy each type of bead, and $p' < 0$.

We solve for the Nash Equilibrium by 'upward induction'; we begin with the agents with the smallest endowments. A number $\eta_{\underline{s}}$ of agents is only able to buy the bead from the smallest basket $\underline{s}$, and this bead will thus sell for a price no higher than $p_{\underline{s}}(\eta_{\underline{s}})$. Next we look at the group of $\eta_{\underline{s}+1}$ agents who are able to purchase the bead in the next-to-smallest basket. They will do so as long as it is the case that $\eta_{\underline{s}} > \eta_{\underline{s}+1}$. A similar logic will now hold for the next sector up, and so on. Thus, if $\Phi(K_i)$ is decreasing in this range, the equilibrium price of beads will increase with

$\tilde{I}_s$.

If, on the other hand, $\eta_{\underline{s}} \leq \eta_{\underline{s}+1}$, then a Nash Equilibrium will require an equal price in the two sectors. If this were not the case, then an agent in the group $\eta_{\underline{s}+1}$ would both desire to and be able to buy a different bead, and thus it could not have been an equilibrium.

By extending this sequential solution of the model upwards to the wealthiest trader, we can make several statements about how equilibrium prices relate to the distribution of endowments.

1. No bead can have a price which is higher than a bead from a bigger basket.

2. Any bead s will have the same price as a bead from a bigger basket $s+$ if $\eta_s < \eta_{s+}$.

3. All beads from baskets smaller than one with the highest η_s (e.g. the mode of the distribution $\Phi(K_i)$) will have equal prices.

4. A uniform distribution of endowments results in an equal price for all beads.

5. If $\Phi(K_i)$ is strictly decreasing above its mode, then all beads above the mode will have prices that increase with $\tilde{I}_s$.

6. All prices are weakly bounded by $p_{\underline{s}}, p_{\bar{s}}$.

Since profit $\pi_i = p_{si}$, the above results indicate that

$$\frac{\Delta \pi_{si}}{\Delta K_i} \geq 0$$

or, that profits cannot decrease as the degree of oligopoly in the good increases.

3 A Continuous Model

We model a finite number N of infinitely-lived agents making a sequence of one-period investment decisions. There exists a finite set $s < N$ of potential productive sectors in the economy, in each of which there is Cournot competition.

The investor's i's problem is to use a stock of capital K_i to maximize utility from returns on investments. All agents have perfect information about the endowments of other agents. In the simplest model, we examine a closed economy, and allow no borrowing or cooperation in investment.

Each period, agents receive net returns π_{si} from investments I_{si} in each sector s. We assume that the technology displays constant returns to scale, and we normalize the units in which the quantity of output is measured so that one unit of investment produces one unit of output. We can then write the profit function for a sector in terms of these investments, so that quantity $q_{si}(I_{si}) = q_s I_{si} = I_{si}$ and costs $c_{si}(I_{si}) = c_s I_{si}$. Prices are linear and are determined by aggregate output in a sector, so $p_s = a - b(\sum_i I_{si})$. What differentiates sectors is the capital barrier, represented by $\tilde{I}_s > 0$; this is the minimum investment required to participate in a sector.

A profit-maximizing investor, then, will solve the following problem:

$$Max \ \sum_s \pi_{si}(I_{si} + \sum_{i'}(I_{si'})) = \sum_s [I_{si} p_s (I_{si} + \sum_{i'} I_{si'}) - c_s I_{si} - F_s]$$

subject to:

1. $\sum_s I_{si} \leq K_i$ (Capital Constraint)
2. $I_{si} \geq \tilde{I}_s$ (Capital Barrier)

The capital barrier altogether excludes an agent from a sector if $K_i < \tilde{I}_s$. Only those sectors in which some agents in the economy are able to clear the capital barrier will see any investment.

Ignoring the capital barrier initially, we study the interior solution of the portfolio investment problem of maximizing total returns subject to the capital constraint.

The first-order condition for investment within each sector is:

$$p_s + I_{si} p_s' (1 + \frac{\sum_{si'} dI_{si'}}{dI_{si}})] - c_s = \lambda_i$$

where λ is the shadow value of capital. The Nash Equilibrium of this market is the intersection of reaction functions, implying that no agent wishes to change his behavior given the actions of others, and so the terms $\frac{dI_{si'}}{dI_{si}}$ are all equal to zero.

Solving this problem for the representative investor (that is, the agent who invests the average quantity in a sector), we can generate the Lerner's Index for the investment in a sector, which shows that

$$LI_{si}(\bar{q}_s) - \frac{\lambda_i}{p_s} = \frac{-1}{N_s \epsilon_s}$$

This shows that an agent will demand a higher rate of return per unit invested as the agent becomes more constrained, and that returns will be increasing in oligopoly power.

Given our demand specification, we can solve explicitly for the equilibrium quantity of production for an individual:

$$I_{si} = \frac{a_s - c_s - \lambda_i \sum_{i'} I_{si'}}{2b_s}.$$

Recognizing that for the representative agent $\sum_{i'} I_{si'} = (N_s - 1)E(I_s)$ we can solve for the quantity produced by this average investor in a sector, which will be:

$$E(I_s) = \frac{a_s - c_s - E(\lambda_s)}{b(N_s + 1)}$$

So, the output of any agent in a sector s will be:

$$I_{si}^* = \frac{2a_s - 2c_s - \lambda_i + \frac{N_s - 1}{N_s + 1} E(\lambda_s)}{2b_s(N_s + 1)} \tag{1}$$

a quantity which is decreasing in an agent's own constraint (because a higher rate of return is demanded) and increasing in the average level of constraint in the sector (because this causes general underproduction and hence encourages an individual to produce more). Both of these effects disappear as the market becomes more competitive, since the agent cannot influence prices at all.

Returning to the analysis of the representative agent, we can see that the net rate of return per unit invested in a sector $p_s - c_s - \frac{F_s}{I_s i}$, evaluated at the equilibrium output will be:

$$ROR_s^* = \frac{1}{N_s + 1}(a_s - c_s) + \frac{N_s}{N_s + 1} E(\lambda_s) - \frac{(N_s + 1) b_s F_s}{a_s - c_s - E(\lambda_s)} \tag{2}$$

Each of these three terms has a separate interpretation. The first is the oligopoly effect, which results from the ability of an individual to effect prices, and disappears as the market becomes competitive. The second is the distortion in the net rate of return arising from the constraint of the average agent; this effect is at its minimum in a monopoly and reaches a maximum in a competitive market. The third term represents the marginal drag of the fixed costs on the net rate of return at production I_s^*.

We note here the close relationship between fixed costs and the capital barrier. Where fixed costs are present, the number of investors in a sector in equilibrium is not infinite; indeed we can solve the above equation for the unconstrained equilibrium and calculate the 'natural oligopoly':

$$\hat{N}_s = \frac{a_s - c_s}{\sqrt{b_s F_s}} - 1$$

which is decreasing in the fixed costs. As long as the number of agents who are able and choose to enter the sector is as large as this, there is no distortion caused by the capital barrier.

The $s-1$ first-order conditions will require that

$$\frac{d\pi_s}{dI_s} = \frac{d\pi_{s'}}{dI_{s'}}$$

or that the rate of return in each sector for which $I_s > 0$ be equal.

With this machinery in place, we are ready to discuss the role that the capital barrier plays in determining the equilibrium rents in a sector. By examining how the equilibrium will change as the capital barrier increases, we can see how the returns in this society are related to initial endowments. The most straightforward effect of the capital barrier is that the number of investors in an economy without credit is bounded from above by the number of agents who have endowments exceeding the capital barrier in that sector.

Let $\tilde{n}_s$ be the maximum number of agents who are able to enter a sector. If $\Phi(K_{it})$ is the CDF of asset distributions in the population of agents, then

$$\tilde{n}_s(\tilde{I}_s) = N * [1 - \Phi(K_{it}) \mid_{\tilde{I}_s}] \tag{3}$$

Because Φ is a CDF, $\tilde{n_s}$ will be strictly non-increasing in the size of investment required to compete in a sector.

$$\frac{\Delta \tilde{n}_s}{\Delta \tilde{I}_s} \leq 0.$$

Taking the partial derivative of ROR_s with respect to N_s, we see that this derivative has the same sign as $E(\lambda_s) - (a_s - c_s)$ which, from the equation for the average investment in a sector, must be negative. This implies that, ceteris paribus, as the capital constraint rises in a sector, the equilibrium profit received by remaining agents in the sector cannot decrease.

From here we can solve for the Nash Equilibrium of this more complex market in a similar fashion as in the bead parable, with the complicating factor that agents will in general invest in multiple sectors. We can write profit per unit invested as $\pi_s(\tilde{I}_s)$, and it must be the case that

$$\frac{\Delta(\sum_s \pi^*_{si}(\tilde{I}_s))}{\Delta K_i} \geq 0$$

or that increasing the endowment of a given individual cannot cause that individual to receive a lower equilibrium rate of return.

4 Portfolio Risk

If agents are risk-averse, they will be willing to accept a portfolio that has lower returns as long as it achieves a sufficient reduction in variance. We take a simple approach to portfolio analysis. Assume that the profit per unit invested, as well as being a function of the capital barrier in that sector, is influenced by some random shifter ξ_s so $\pi_s(\tilde{I}_s, \xi_s)$.

All sectors in the economy have returns which are identically distributed with

$$Var(\pi_s(\tilde{I}_s, \xi_s)) = \sigma^2 \ \forall \ s, \ and \ Covar((\pi_s, \pi_{s'}) = \mu < \sigma^2 \ \forall \ s \neq s'$$

This covariance term can be thought of as a currency risk that effects all sectors in the economy equally.

If an agent invests a share ω in each of M sectors, then the variance of the portfolio will equal:

$$\sigma_p^2 = \sum_{s=1}^{M} \omega_s^2 \sigma^2 + \sum_{s=1}^{M} \sum_{r=s+1}^{M} \omega_s \omega_r \mu$$

If an equal investment is made in each sector M, then the portfolio variance will equal:

$$\frac{1}{M}\sigma^2 + \frac{M-1}{M}\mu,$$

and so in the limit, the perfectly diversified portfolio would have an investment in each sector $I_s = \epsilon$ and variance equal to the currency risk, because $lim_{M \to \infty} = \mu$

So far this is standard portfolio theory; however here again the capital barrier plays a crucial role in generating a non-standard outcome. We have assumed that the capital barrier is strictly positive in every sector. This has several implications:

1. A perfectly diversified portfolio is now unattainable with finite resources, because it is impossible to invest ϵ in each portfolio, and financial instruments do not exist to aggregate investment.

2. The number of sectors in which an agent can invest is strictly non-decreasing in initial endowments. Since $\frac{d\sigma_p^2}{dM} = \frac{\mu - \sigma^2}{M^2} < 0$, the achievable portfolio di-

versification for a poorer individual cannot be better than that of a richer individual.

3. A sector with a higher capital barrier makes up a larger share of any finite investment portfolio than one with a lower barrier. The risk in high-barrier sectors is thus less diversifiable than risk in low-barrier sectors.

5 Utility Maximization

We assume that utility take some mean-variance form which can be written as

$$U_i(\sum_s \pi_{si}) = E(\sum_s \pi_{si}) - \alpha_i(Var(\sum_s \pi_{si}))$$

where α is a positive function which represents an agent's risk aversion.

Solving for the Nash Equilibrium of this model, including the discontinuous sector-switching problem illustrated in the bean parable, the credit-constrained, return-equalizing problem in the continuous model, and the risk-return tradeoff present in utility maximization, is complex to say the least. All that is attempted here is to characterize several features which this equilibrium must display.

First, we note that there is a tradeoff between profit maximization (which requires an agent to concentrate capital) and risk minimization (which requires diversification). How agents resolve this conflict will depend on individual utility structures, but less risk-averse agents should invest in fewer sectors. Second, both risk-minimization and the continuous quantity decision generate reasons for agents to invest in multiple sectors. As compared to single-sector bead parable, investment in multiple sectors greatly strengthens the result that low-barrier sectors see larger numbers of competitors. Thirdly, we observe that point 3 above serves as a 'tie-breaker' between the rate of return in any two sectors. The bead parable displayed perfect arbitrage between sectors when the number of entrants was equal; we see here that, due to a CAPM-type reasoning, the rate of return in a sector with a high capital barrier must be strictly larger than the rate in any lower-barrier sector because agents incur more risk investing in it.

In a perfect markets, CAPM-style framework we are accustomed to a tradeoff between risk and return, since the only way to achieve higher returns is to invest in assets with undiversifiable risk. Here we also see such a tradeoff, but the driving force generating returns in markets is not their covariance with some market portfolio but the concentration of competition in the sector. Agents are torn between concentrating capital to reach more oligopolistic sectors and dispersing it to achieve lower portfolio variance. The key point of a model in which capital barriers play a defining role is that the poor achieve both objectives less successfully than the rich. They have portfolios which not only generate lower net returns, but do so with a greater variance than a portfolio invested by an agent with a high initial capital endowment.

This can be seen by the fact that

$$\frac{\Delta(E(\sum_s \pi^*_{si}(\tilde{I}_s)))}{\Delta K_i} \geq 0 \; and \; \frac{\Delta(Var(\sum_s \pi^*_{si}(\tilde{I}_s)))}{\Delta K_i} \leq 0$$

which means that both arguments of agents' utility increase as their endowment increases.

6 Dynamics

We model the dynamic consequences in the simplest possible fashion. Ignoring consumption and wages, each period is the same as the next, except that capital assets evolve according to the rule:

$$K_{it+1} = K_{it} + \sum_s [(I_{sit})p_{st}(I_{sit} + \sum_i (I_{si't})) - c_s(I_{sit}) - F_s].$$

That is, assets in a period equal the sum of assets and profits in the past period.

This can be expressed as:

$$K_{it+1} = K_{it} + \sum_s ROR^*_{st} I_{sit} \tag{4}$$

We have shown that the equilibrium rate of return in a sector is a strictly increasing function of the capital barrier in that sector, which combined with (4) shows that assetholdings inevitably diverge over time.

Imagine that the economy has some underlying trend rate of growth, by which the returns of all agents are linearly shifted.

If the net rate of return for all agents is positive over time, the stock of assets increases. If the number of potential sectors is finite, competition in the high-barrier sectors will intensify. This depresses the rates of return seen by the richest citizens. In the limit, this process will generate sufficient arbitrage to equalize competition across all sectors, and give all investors an equal rate of return, adjusted for the risk present in the size of investment. No market ever becomes perfectly competitive, but the degree of oligopoly becomes identical across markets. With similar rates of return, inequality in the economy merely ceases to increase; the model has no mechanism for convergence.

If the net rate of return is negative for some citizens, they fall into a 'competition trap' where the number of agents competing in the low-barrier sectors increases. Here, although some agents may become better off and compete in increasingly oligopolistic sectors, the poor realize a negative rate of return, and thus are forced to participate in ever-more perfect competition. For example, the decline of a previously middle-class group into small-scale business would impoverish those poorer than them who had previously sold in those sectors. In this scenario, the sheer number of poor generates a competitive externality which holds them all in perpetual poverty.

7 Introducing Credit Markets

We first examine a formal-sector lender, who enters the economy described above and begins making collateralized loans. This lender will disburse an amount L_i at a positive interest rate r, subject to $L_i \leq K_i(1+\alpha)$, where $\alpha > 0$ represents the collateral constraint.

The condition for the use of a loan to increase returns is that:

$$EU(\sum_s(\pi_i(K_i + L_i)) - L_i(1+r)) \geq EU(\sum_s \pi_i(K_i))$$

or, rearranging, that

$$\frac{EU(\sum_s(\pi_i(K_i + L_i)) - EU(\sum_s \pi_i(K_i))}{L_i} - 1 > r \tag{5}$$

For a risk-neutral individual, this inequality can be rewritten

$$ROR^*(K_i + L_i) - ROR^*(K_i) \geq r \tag{6}$$

The marginal value of capital to an agent without credit will equal the rate of return on the last unit invested. If investment within a sector is increased, the rate of return will decrease (because demand slopes down). The rate of return on additional investment within the same sector is thus bounded from above by the pre-credit rate of return in the sector.

So, we can divide the economy into a high-profit region where $ROR^*_s > r$, and a low-profit region where $ROR^*_s \leq r$. In the high-profit region, agents will find it optimal to take loans and invest in the same sector. Consequently, any agents in this region will borrow the maximum allowable quantity. If the supply of credit within one sector is large enough, returns in this sector will be driven down to the interest rate.

Even within the low-profit region, however, there may be agents for whom small amounts of credit enable them to move up to the next highest sector, which we denote by s^+_{it}. For such agents, although ROR^*_{s+}¡r, they only need to borrow a fraction of their endowment in order to raise the ROR on their entire investment, and consequently (5) is satisfied even though they do not appear to be making sufficient returns to cover their investment. For these agents, the overall rate of return will increase above the pre-credit level and so (6) is satisfied as well. If the sector s^+_{it} is in the low-profit region, agents will borrow only the minimum quantity required to get into the sector, because additional borrowing will not be profitable.

Risk, of course, introduces an entirely different rationale for borrowing. Particularly if the covariance between sectors is small, and if agents maximize a utility function which displays some safety-first characteristic, then agents may be willing to borrow simply to diversify. For such an individual, (5) will be satisfied although (6) is not, and without a clear knowledge of the utility structure it would be impossible for an outsider to verify the 'optimality' of the loan.

The general equilibrium outcome of the introduction of credit of course depends on the specific distribution of assets and on the distribution of the capital barriers across sectors. However, it also depends on two other factors which make solving the equilibrium very difficult. First of all, if there are already agents competing in the sector with the highest capital barrier, the advent of credit will serve to slow the speed of divergence by depressing the returns made by the richest members of society. In this scenario, credit will improve arbitrage. In the limit, the ROR in all high-return sectors will be driven down to the interest rate, leaving only the poor to receive lower returns. If, on the other hand, the use of credit opens up new sectors that had not previously been occupied, then credit can increase the speed of divergence in the economy by disproportionately increasing the returns made by the wealthy. Thus, in an underdeveloped economy, the introduction of credit may exacerbate inequalities which were originally caused by a lack of credit in the economy.

Secondly, when modelling an economy where returns to any agent are contingent on the decisions of all other agents, the optimal use of credit depends on the borrowing decisions of all other agents in the economy. This means that our perfect information assumption has to extend to all agents knowing the precise quantities which other agents would be able to borrow. Failing this, we must admit the possibility of true mistakes: an agent takes a loan to move into a sector on the basis of the previous ROR in that sector; other agents make the same choice and thus collectively drive down the ROR. Consequently all agents made decisions which were suboptimal ex ante under full information.

8 Microfinance

We model microfinance institutions (MFIs) as offering fixed, subsidized loans to a subset of the poor, meaning that the MFI charges an interest rate $r^M < r$. Their potential client base is the subset of agents for whom $K_i \leq K^M$, the richest agent with whom the MFI is willing to work. Because the poor are likely to be operating in 'low-return' sectors, their loans must be subsidized. Even at this lower rate, there will be sectors for which $ROR_s^* < r^M$, and so the 'poorest of the poor' produce in sectors with such high competition that they cannot profitably invest even subsidized credit in their sectors. Thus, only the wealthier subset of these poor agents will find it optimal to borrow the fixed quantity I^M. This mixture of exogenous and endogenous selection guarantees that MFIs will deal only with agents within a narrow wealth band. Since agents cluster in sectors according to their asset endowments, targeting a specific wealth class of agent is equivalent to targeting specific sectors of production.

There are three reactions to microfinance loans:

1. The sector-jumpers, for whom the cost of borrowing enough capital to move into the next sector is lower than the benefit of doing so. They depress returns in the sectors they move into, and (may) increase returns in the sectors they enable clients to vacate.

2. The constrained same-sector investors, where the ROR in their sector exceeds r^M. They will borrow more for use in the same sector, depressing rents in

their own sectors.

3. Non-borrowers. This occurs when an agent is unconstrained in a sector where returns are lower than the interest rate r^M, and when the quantity of the loan is too small to allow them to move to the next sector.

Thus, microfinance will in general benefit borrowers who move up sectors, will hurt non-borrowers who see competition increase in their sectors as a result of credit, and will help non-borrowers in sectors that see competition decrease as a result of credit. Thus, in the sector just above the richest one which MFIs will lend to, the effect is unambiguously negative. In sectors just below, the effect is unambiguously positive, since net competition decreases. In sectors where MFI credit is used in-sector, the net effect is ambiguous as the personal improvements achieved through the use of credit are undermined by the general-equilibrium effect of decreasing price. A clear result of this conceptual framework is that microfinance lenders should be careful to avoid making large numbers of loans to agents in order to engage in the same economic activity. Projects which would have been individually profitable may turn out to be loss-making ex post if too many agents utilize the credit to produce the same good.

There is a deeper problem with the use of microfinance in such an economy, however: this is an economy which rewards aggregation of capital, and so it cannot be optimal to split up a pool of lending capital into small units. If a quantity of capital $\hat{K}$ is to be used to generate income for M individuals, we see that it must be the case that

$$\frac{\sum_s(\pi_s^*(\hat{K}))}{M} > \sum_s(\pi_s^*(\frac{\hat{K}}{M}))$$

and thus investing the lump-sum and distributing the returns will always be preferable to distributing the capital prior to investment.

9 Trade and Foreign Investment

There are two ways that the outside economy might effect the equilibrium we have outlined above. First, tradable foreign goods may be imported into the economy. We assume that each good corresponds to a sector, and that the price of an imported good in our economy will equal $p_s^w + T_s$, where p_s^w is the world price for that good and T_s is the transport cost of bringing the good in. Referring to the closed-economy equilibrium price as $p_s^*(\tilde{I}_s)$ there are three regimes into which trade may now fall:

1. Only local production: $p_s^w + T_s > p_s^*(\tilde{I}_s)$. Here, transport costs are so high that oligopolistic local competition undercuts imports, and so they have no effect.

2. Only imports: $p_s^w + T_s < c_s + \frac{F_s}{Q(p_s^w + T_s)}$. Here, it is impossible for the local producers to make positive returns if the output is sold at the import's price. Consequently, $p_s^* = p_s^w + T_s$.

3. Mixed production: $c_s + \frac{F_s}{Q(p_s^w + T_s)} \leq p_s^w + T_s \leq p_s^*(\tilde{I}_s)$. Now, local producers are efficient enough to compete with imports, but the presence of an import at fixed marginal cost erodes all market power. $p_s^* = p_s^w + T_s$.

This model of imports is related in spirit to the transaction costs price band model of (N. Key & Sadoulet 2000) with the entire economy taking the role of a single producer and local production being the analogy of subsistence.

The second way in which outsiders may influence this economy is by entering it and investing in the same production technology as insiders. We assume the outsiders come from large, liquid economies and are thus unconstrained, but that they must incur a fixed cost F^o in order to invest in a sector. These outsiders also have an opportunity cost of capital r^o which is set by outside investment possibilities. Investments by outsiders will only be made in any sector for which the 'Cross-border constraint' is satisfied:

$$\pi_s^o(I_s^o) > F^o + r^o I_s^o \tag{7}$$

Entry will occur in every sector for which (7) is satisfied, and will continue to occur until it is met with equality; eventually competition in every sector entered by foreigners will bid down rents to the common cost of entry. Thus arbitrage ensues in all these markets, but the arbitrage level of profit is still the highest return available in the economy. Wealthy local investors are now indifferent between all sectors in which outsiders are present.

Clearly, outsiders will enter sectors first which have the highest capital barrier, as these barriers generate rents but are meaningless to outsiders because they are unconstrained. Consequently, outside businesspeople dominate the economy from the top down; where outsider investment is costly they will control only sectors that require massive fixed capital investment. If there were sectors for which the capital barrier exceeded the endowment of the wealthiest individual in the economy, the outsiders will produce goods that were previously unavailable (or not made locally). As the barriers to outsiders fall, their production moves down through the economy but will leave very low-level sectors untouched. We suggest that this pattern helps to explain the dominance of foreign national investors in many underdeveloped economies (the Indians in East Africa, Lebanese in West Africa, Chinese in South-East Asia and the Jews in medieval Europe are but a few examples). In each case, these foreign groups are placed inside poor economies by the vicissitudes of history, but they maintained contacts with a broader economic network which allowed them capital advantages not enjoyed by locals. In each case, their investments in the local economy tend towards capital-intensive investment in productive sectors which are out of reach of the majority of local citizens.

10 Cooperation:

We now wish to introduce cooperative investment into the model. If two agents i and j could costlessly invest their endowments together, then the capital barrier constraint is relaxed to:

$$I_{si} + I_{sj} \geq \tilde{I}_s.$$

We posit a non-symmetric (NxN) matrix with zeroes on the diagonal which expresses the utility cost of any two agents cooperating. An element of this matrix is denoted by m_{ij}.

Agent i will want to cooperate with j iff:

$$EU_i(\sum_s(\pi_{it}(K_{it})) \leq EU_i(\sum_s(\pi it(K_{it} + K_{jt})) - m_{ij}.$$

We use this simple structure to make several basic points:

1. Even if the costs of cooperation are symmetric, the benefits are not, unless two agents have identical endowments. The reason for this is that $EU_i(\sum_s(\pi it(K_{it}+K_{jt}))$ is increasing in K_{jt}, meaning that richer agents are more attractive co-investors than poorer agents.

2. Low cooperation costs can be thought of as 'social capital' in quite a precise

way. An individual who has a low cost of cooperation with numerous other agents is a high social-capital individual and will increase assets over time faster than the an individual with the same initial endowment but higher cooperation costs. If a subgroup within society has lower cooperation costs, they will be more likely to invest cooperatively and thus, over time, will move up in the endowment ranking of society.

3. If costs of cooperation are equal for all agents in society ($m_{ij} = m$), some minimum endowment level exists above which cooperation is always optimal and below which it never is. Thus the wealthy form investment corporations endogenously and the poor compete as individuals, exacerbating inequality.

Suppose that there were a mechanism that brought the cost of cooperation within the economy to zero. We conceive of this mechanism as a kind of idealized domestic stock market. The addition of new agents to collective ventures now bears no cost, and will in general reap rewards for the members of the collective. Since investment can be aggregated costlessly to any scale, capital is eliminated as a barrier to entry. The economy now moves to an equilibrium of perfect arbitrage, where the rate of return in every sector is a function of the number of agents in the economy, the number of sectors, and the average shadow value of capital. Society has now ceased to diverge, because all agents make an identical rate of return on their investments.

11 Conclusion

The purpose of this model is to demonstrate that even if production technology exhibits decreasing returns to scale, that inhibited competition in illiquid economies can lead to increasing returns to the scale of fixed lump-sum investment capital.

Additionally, in such a marketplace diversification is only achievable through investment in multiple sectors, implying that those with low capital endowments assemble portfolios which bear both lower return and higher risk than the wealthy. While imperfect arbitrage is a result of imperfect capital markets, if the economy remains closed so that agents have market power, the introduction of credit can exacerbate the problem.

Empirical validation of the hypotheses put forward here are, obviously, needed. However, the arguments made in this paper are different from the standard rationale for pecuniary convexities, and thus the tests are also different. First of all, any economy which trades extensively with large outside markets would not display the traits described here, no matter how poor or how imperfect the capital markets. Secondly, the appropriate empirical test of this model is not to compare the scale of investment to returns, but rather to compare the capital barrier to returns. The capital barrier is a fairly subtle quantity which will be difficult to calculate without close knowledge of a local economy. For example, a sector requiring vast fixed investment in equipment whose maker is willing to provide financing will not comprise a capital barrier and thus we do not expect oligopoly returns in this sector. (Alternatively, an empirical test could consist of comparing asset endowments to return on investment). Finally, since this model assumes that all investments have a common time horizon, it ignores empirical complexities which will exist in comparing sectors with long-term versus short-term investment.

The question remains where we would expect to observe the world described in this model. Regions such as the African Great Lakes are not only poor, but are landlocked and surrounded by countries with limited demand and shoddy infrastructure. Thus, price-setting mechanisms for a wide range of products are essentially localized, and so the question of entry becomes paramount. Even within countries that trade with the outside, however, if there exist very large numbers of people that have no income options other than investment in low-productivity informal enterprise, markets may come to exist which give these agents returns lower than what the formal economy is willing to bear. So a slum economy may operate underneath the ceiling of the interest rate, with the poorest investing by necessity in crowded markets at sub-market rates of return. If trade with the outside is active but credit is limited, the dynamics of the paper may be found in the market for non-tradeables. Indeed even in wealthy economies, if sectors exist that require fixed investments so large that they form a non-negligible proportion of all investment capital available, these sectors exhibit both the oligopoly and risk arguments of this model. Such factors may have contributed to the emergence of the Gilded-age robber barons, or the persistently super-normal returns in the pharmaceutical sector.

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