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Working Paper No. 78
September 2008
www.carloalberto.org

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[1] I am grateful to Maristella Botticini, Maitreesh Ghatak, Vincenzo Merella, Andrew Newman, Nicola Pavoni and Fabrizio Zilibotti for helpful comments.

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Abstract

This paper presents a theory in which risk-averse heterogeneously talented entrepreneurs are the key agents driving the process of development and modernisation. Entrepreneurial skills are private information, which prevents full risk sharing. In that setup, development to a modern industrial economy might fail to take place, since potentially talented entrepreneurs may refrain from taking on the entrepreneurial risks as a way to avoid income shocks. An interesting feature of the model is that the informational asymmetries in the economy are endogenous to the process of development, as they are related to the heterogeneity in entrepreneurial skills required in the manufacturing activities.

Key Words: Adverse Selection, Development, Entrepreneurship, Risk-Sharing.
JEL Codes: O12, O16, D81, D82.

1 Introduction

Dealing with large swings in consumption represents a central concern in societies. Under complete markets, individuals are able to diversify away all their idiosyncratic risks. However, when markets are incomplete and full risk sharing cannot be achieved, agents may seek to prevent consumption shocks by avoiding certain activities that entail substantial risk, even if those activities should be carried out in a first-best environment. This paper claims that this phenomenon of risk avoidance becomes especially critical in relatively poor economies that intend to start the process of development towards an industrial economy. The argument rests on two main ideas. First, the idea that the behaviour of the poor is highly sensitive to the presence of income risks. Second, the notion that informational asymmetries related to intrinsic skills are more prevalent in the urban industrial economy than in the traditional village economy.

The importance of risk aversion in poor societies is confirmed by the evidence in Townsend (1994) and Udry (1994). More significantly, those articles show that a substantial amount of consumption smoothing is achieved *within* villages. However, the empirical development literature also stresses the fact that risk sharing in poor economies is not usually accomplished via impersonal market exchanges, as modelled by standard economic theory, but tends to be the result of more informal arrangements between village members – see Besley (1995) for a survey on this literature.

One key aspect in which village economies differ from modern industrial ones is how much information is required for their efficient operation and how well it flows around. Within the village, information about peers and their behaviours appears to be quite unpolluted. This is confirmed, for example, by the success of group lending programmes like the Grameen Bank [Stiglitz (1990)].[1] In contrast, in the industrial economy, anonymous markets and informational asymmetries seem to be the commonplace. Furthermore, the relative complexity of entrepreneurial manufacturing activities, compared to traditional agricultural tasks, implies that the selection of the correct individuals to whom finance should be granted becomes a fundamental issue to deal with during the process of industrialisation.

This paper presents a model in which risk-averse individuals are heterogeneous in terms of their entrepreneurial skills. In particular, only some individuals in the economy possess the required skills to become entrepreneurs in the manufacturing sectors. Furthermore, those skills are private information, which generates an adverse selection problem in the financial markets and precludes full insurance against idiosyncratic entrepreneurial risks. In this context, potentially talented entrepreneurs might decide to refrain from investing in entrepreneurial projects (even if those projects would yield high *expected* returns), choosing instead to remain attached to the traditional sector where informational asymmetries are not such a serious impediment to risk sharing. This lack of entrepreneurship retards the development and modernisation of the economy and, in some cases, it may even lead to development traps.

The model features an overlapping-generations economy where agents live for two pe-

[1] See also the direct field evidence for rural villages in northern Nigeria in Udry (1990), where it is argued that informational asymmetries within those villages are unimportant.

riods. The old generation may undertake entrepreneurial projects that are subject to idiosyncratic risks. The probability of success in those projects is related to the entrepreneurial (unobservable) skills. The young generation supplies labour, which is used as an input by the entrepreneurs. Since wages are fixed, all the (uninsured) risks must be borne by the entrepreneurs. Private information prevents full risk pooling, and therefore affects the amount of entrepreneurial investment by the old, which in turn leads to lower labour demand and wages for the young. An important assumption in the model is the fact that individuals display constant relative risk aversion (CRRA). As a result, the poorer they are, the more strongly risk-taking is deterred by the presence of uninsured risk.[2] In the model, this implies that if the old generation is very poor, entrepreneurial investment will be quite low and so will be labour demand and wages. This feedback between entrepreneurial investment and wages means that income will display persistence across generations. Furthermore, when entrepreneurial projects are sufficiently risky, this feedback may become so strong that it may lead to the appearance of poverty traps and multiple long-run equilibria.

Regarding the CRRA assumption (and, more generally, that absolute risk aversion decreases with income), this essentially captures the notion that the poor are particularly vulnerable to negative income shocks. Firstly, this feature seems quite intuitive from pure introspection.[3] Secondly, empirical evidence also confirms the fact that risk aversion is decreasing in income. For example, Rosenzweig and Binswanger (1993) show that poorer farmers choose less risky crops, even if this means sacrificing expected profits, so that to mitigate weather risks. Chiappori and Paiella (2008) find evidence that relative risk aversion is constant for a panel of Italian households. More strikingly, Ogaki and Zhang (2001) find support for the even stronger property of decreasing *relative* risk aversion (DRRA) both using data for Pakistani households and the ICRISAT data for Indian households.[4]

1.1 Related Literature

The main focus here is on the evolution of informational asymmetries along the process of development and its implications on risk-taking and growth. Another paper that investigates those aspects is Acemoglu and Zilibotti (1999), although they look at moral hazard and incentives, instead of adverse selection related to skills heterogeneity. The main idea in their paper is that during development the amount of decentralised information available in the economy increases as a by-product of capital accumulation. More precisely, as the stock of capital grows, larger amounts of it are allocated to each sector in the economy, which (in the presence of sector-specific shocks) increases the precision of relative performance schemes. This, in turn, permits the provision of better incentives within principal-agent

[2] This is actually a property of preferences with decreasing absolute risk aversion (DARA). Since CRRA implies DARA, this property in present in the model.

[3] This is explicitly acknowledged in Kimball (1990) who asserts, "DARA is almost universally considered a reasonable assumption, or even obligatory assumption, since [it implies] investing more in risky securities as one becomes wealthier", footnote 25 therein.

[4] Evidence of DRRA is also found in studies that look at households data on asset holdings; e.g., Morin and Fernandez Suarez (1993) for Canada, Guiso, Jappeli and Terlizzese (1996) for Italy, and Blake (1996) for the UK.

relations. Moreover, since those incentives exploit a trade-off between expected payoffs and insurance, the model also carries interesting implications regarding risk sharing. Capital accumulation is then the ultimate force that drives growth in that paper, while risk-taking responds to the improved contracting environment. In my paper, the main focus is actually on the risk-taking behaviour of talented entrepreneurs when they cannot be easily screened from the whole population by outside financiers. In particular, it investigates under which conditions those agents will still choose to exert their skills and take on risky entrepreneurial activities, which are needed to ignite the process of capital accumulation and development towards a manufacturing economy.[5]

Banerjee and Newman (1991) and Newman (2007) also study the entrepreneurial choice under imperfect insurance due to a moral hazard problem related to effort unobservability. Those two papers have led, however, to results that are quite at odds with reality, namely: the poor become entrepreneurs and bear the entrepreneurial uninsurable risks, while the rich choose safe activities (they either become workers receiving a fixed wage or rentiers investing in a low-return safe asset). This somewhat paradoxical result seems another interesting reason for exploring the implications of alternative sources of asymmetric information (such as adverse selection) on risk sharing and the process of development.[6]

Another strand of related literature is that on credit market imperfections and development: e.g., Banerjee and Newman (1993), Galor and Zeira (1993), Aghion and Bolton (1997), Piketty (1997), Lloyd-Ellis and Berhardt (2000), Ghatak and Jiang (2002), and Mookherjee and Ray (2002). In those articles, credit constraints prevent the poor from starting up investment projects or from accumulating human capital, which would be optimal in a first-best world. As a consequence, the initial wealth distribution plays a determinant role in the development path followed by economies. Here, I focus on the willingness to invest in entrepreneurial projects under imperfect risk sharing, instead of the incapacity to do so owing to lack of funds. Arguably, both insurance and credit are relevant for sustaining a process of development –as stressed by Banerjee (2000)–, and my paper and those articles should accordingly be viewed as complements, rather than substitutes.

Concerning the market failure studied in this paper; this is clearly not new. In particular, the negative effects of adverse selection on the operation of financial markets have long been investigated by both the corporate finance literature [e.g., Leland and Pyle (1977) and Myers and Majluf (1984)] and the credit rationing literature [e.g., Jaffe and Russell (1976) and Stiglitz and Weiss (1981)]. The main contribution of this paper is showing how this adverse selection problem can severely menace the process of development. Furthermore,

[5]Greenwood and Jovanovic (1990), Saint-Paul (1992), and Acemoglu and Zilibotti (1997) also explore the effects on imperfect risk sharing on development. However, in all those papers information is symmetric and imperfect insurance provision arises due tu the presence of technological non-convexities.

[6]A passage in Newman (2007) is worth mentioning here. He states "Since embedding the Knightian theory [of entrepreneurship] into a standard moral hazard framework reveals the fragility of its predictions [regarding risk-bearing], it is natural to ask what happens in the presence of other causes of imperfect insurance." The results of my paper should not be understood as Knightian, though. Adverse selection prevents efficient insurance; hence the rich, who are less risk-averse, take on larger risks. Yet, entrepreneurs here are undertaking a productive task (for which they are particularly talented), and not providing insurance to workers through fixed wages, which seems to be the essence of the Knightian theory.

the informational asymmetry arises endogenously during the process of development, as it is inherently associated to the heterogeneity in entrepreneurial skills in the population.

The rest of the paper is organised as follows. Section 2 describes the set up of the model. Section 3 characterises the static equilibrium under imperfect risk sharing due to the adverse selection problem. Section 4 analyses the dynamics of the economy, specifying the conditions under which poverty traps may arise. Section 5 concludes. Omitted proofs are provided in Appendix A.

2 Environment

Consider an overlapping-generations small open economy in which life evolves over a discrete-time infinite horizon, $t = \{0, 1, ...\infty\}$. Individuals in the economy live up to two periods. In every period t a continuum of individuals with mass normalised to 1 is born. As a result, in every period t the economy is populated (in principle) by two different generations: those who were born in $t - 1$ (the *old* in period t), and those born in t (the *young* in period t).

All individuals are born with an identical endowment of 1 unit of time, which they use entirely to work while they are young. In the second period of life, when individuals are old, they can choose either to retire or to become entrepreneurs. Retiring yields zero income.

Young agents may choose to work in two different occupations: they can work in the agricultural sector, becoming independent labourers working in a communal plot of land; alternatively they can work in the manufacturing sector as employees for old entrepreneurs, earning there a fixed wage v.

Any old agent may decide to become an entrepreneur. However, not all them would be equally good as entrepreneurs. In particular, there exist two *types* (or *qualities*) of entrepreneur indexed by $T \in \{B, G\}$, where B (G) stands for *bad-types* (*good-types*). The good-types represent a fraction $\eta \in (0, 1)$ of the population and possess higher expected productivity as entrepreneurs than the bad-types do, who comprise the remaining fraction $(1 - \eta)$. The fractions of good- and bad-types (η and $1 - \eta$) are constant over time. Types are assumed private information.

2.1 Preferences

Individuals derive utility only from consumption when they are old. However, individuals need to consume (at least) one unit of consumption good while they are young in order to reach the second period of their lives. As a result, all the income above one they earn while young will be saved and invested to provide future consumption.

Conditional on reaching the second period of life, the utility achieved by individual i born in t is given by:

$$u_{i,t} = \ln(c_{i,t+1}). \tag{1}$$

where $c_{i,t+1}$ denotes the consumption in $t + 1$ by agent i born in t. Logarithmic Bernoulli utility implies that individuals are risk averse with CRRA equal to 1.[7]

[7] The main insights of this paper do not strictly depend on either the need to consume 1 unit during youth or the utility function being logarithmic. However, those two specific assumptions –together with the

2.2 Technology

Agricultural Sector: Aggregate production in the agricultural sector (Y) depends on the total amount of communal land (X), and on the mass of young agents working in the agricultural sector (L), following a Cobb-Douglas production function. There are no property rights over land, thus each agricultural labourer obtains as income the average output $y(L) \equiv Y(L)/L$. The amount of land is fixed at $\bar{X} > 0$. Hence, labour productivity is decreasing in L, and Y can be written as follows:

$$Y(L) = L^{\alpha}, \quad \text{where } \alpha \in (0, 1). \tag{2}$$

Manufacturing Sector Technology: Production in the manufacturing sector requires 1 unit of entrepreneurial skill (coming from the *old* generation) and raw labour (coming from the *young* generation). The return of the entrepreneurial projects is random, subject to an idiosyncratic shock. There are only two possible outcomes for the projects: *success* or *failure*. If an old agent hires l units of young labour at the beginning of period t; then, in the event of success, the project yields $\rho\, l$ units of output at the end of t, where $\rho > 0$. On the other hand, in the event of failure, the project yields 0 output regardless of l. A good-type undertaking an entrepreneurial project fails with probability $\phi_G = \phi \in (0, 1)$, whereas a bad-type fails with probability equal to $\phi_B = 1$. Project outcomes are assumed publicly observable at zero cost (this implies that any contract whose payment is conditional on *ex post* project outcomes, for example insurance contracts, can be enforced by an outside court and will always be honoured in equilibrium).

Each entrepreneur is a price taker and must thus pay the market wage υ_t for each unit of labour hired. I assume entrepreneurs must pay workers' wages at the beginning of the production process. As a result, the amount $l_{i,t}\, \upsilon_t$ equals the total investment by entrepreneur i in t.

2.3 Financial Markets

All financial transactions between natives and with the rest of the world are mediated by specialised local firms called *financial intermediaries* (or, for brevity, *financiers*). The local financial market is perfectly competitive and the financial intermediaries enjoy perfect access to international capital markets. Since the economy is small, financiers face then a perfectly elastic supply of loanable funds in the international capital markets at the international (net) interest rate $r = 0$. For the same reason, financiers would be willing to borrow any amount from domestic markets at the same interest rate $r = 0$.

Financial intermediates also finance local entrepreneurial projects. They do so by buying shares of those projects. More precisely, financiers offer to buy a certain amount of shares of a specific project at a pre-arranged price. Each of those shares entitles the shareholder

agricultural production function presented below in equation (2)– greatly help to obtain a simple and neat closed-form solution for the model. In the Appendix B, I provide a brief description of the workings of the model under a more general CRRA utility function and assuming that individuals consume *zero* while they are young.

to ρ units of output in case of success, while in the case of failure shares yield 0 income. Without loss of generality, I assume that each financier $j \in \mathcal{J}$ makes at most one offer to each entrepreneur i. In particular, let $\mathcal{C}_{i,j,t} = \left[\mu_{i,t}, p_{i,t}\right] \in \mathbb{R}^{+} \times \mathbb{R}$ denote the contract offered by j to i in period t, which specifies the number of shares $\mu_{i,t}$ of project i that j offers to buy at the unit price $p_{i,t}$.[8]

Entrepreneurs will receive (in principle) contract offers from several financial intermediaries. Accordingly, let $\mathfrak{Q}_{i,t} = \{\mathcal{C}_{i,j,t}\}_{j \in \mathcal{J}}$ denote the set of all financial contracts offered to entrepreneur i in period t.

When referring to the financial markets, the equilibrium concept used throughout this paper will be the one defined in Rothschild and Stiglitz (1976) – hereafter, for brevity, referred to as *RS*. Because of the well-known potential equilibrium (non-)existence problem, the fraction of bad-types $(1 - \eta)$ will accordingly be assumed large enough so as to ensure always the existence of an *RS*.

Remark: Financiers could as well provide funds to entrepreneurs by means of credit contracts at the interest rate $r = 0$. Yet, as it will become clearer in the next section, in equilibrium no entrepreneur will desire to borrow from financiers via credit contracts. Intuitively, selling shares to financiers strictly dominates the use of credit, since equity markets allow not only to raise funds but also to provide insurance against entrepreneurial risks.

3 Static Equilibrium Analysis

Fix the time in period t and consider the problem faced by the agent i born in $t-1$. Suppose this agent has earned income equal to $\omega_{i,t-1} \geq 1$ while he was young (to reduce notation, for the rest of the paper $\omega_{i,t-1} \geq 1$ will always be implicitly assumed unless otherwise explicitly noted).[9] Then, given υ_t, this agent solves:[10]

$$\max_{s_{i,t}, l_{i,t}, [\mu_{i,t}, p_{i,t}]} : E(u_{i,t-1}) = \phi_T \ln(s_{i,t}) + (1 - \phi_T) \ln\left(s_{i,t} + \rho\, l_{i,t} - \rho\, \mu_{i,t}\right) \tag{3}$$

$$\text{subject to: } s_{i,t} + \upsilon_t\, l_{i,t} = (\omega_{i,t-1} - 1) + p_{i,t}\, \mu_{i,t}, \tag{4}$$

$$\left[\mu_{i,t}, p_{i,t}\right] \in \mathfrak{Q}_{i,t}, \quad \text{and} \quad l_{i,t} \geq 0. \tag{5}$$

Where s_i denotes the amount lent to financial intermediaries at the interest rate $r = 0$.[11]

[8] Implicit in the previous specification is the assumption that contracts cannot be negotiated in advance; in other words, a financial contract agreed in period t only covers events occurring during t.

[9] In any case, as it will be formally proved in Section 4, $\omega_{i,t-1} \geq 1$ will always hold in equilibrium within a full dynamic setting – see Lemma 1 in that section.

[10] Recall that individuals must consume 1 unit of income while they are young. Hence, their disposable income at the beginning of the second period equals $\omega_{i,t-1} - 1$, which appears in the budget constraint in (4).

[11] Notice that the agent i may wish to optimally set $l_i = 0$. We can interpret this decision of i as *retiring* when old. Notice also that the optimisation problem does not actually preclude $s_i < 0$ (that is, borrowing via credit is not ruled out). However, unboundedness implies that $s_i > 0$ will always hold in the optimum.

Let Υ_τ denote the set of *young* agents in period τ, and Θ_τ denote the set of *old* agents in period τ. Define $\;_{t-1} : \Upsilon_{t-1} \to \mathbb{R}^+$ as the function that summarises the income earned by each agent in Υ_{t-1} during his youth. Then, given $\;_{t-1}$, an equilibrium in period t is a collection $\left\{s_{i,t}, l_{i,t}, \left[\mu_{i,t}, p_{i,t}\right], \mathfrak{Q}_{i,t}\right\}_{i\in\Theta_t}$ and a market wage υ_t, such that:

1. The allocation $\left(s_{i,t}, l_{i,t}, \left[\mu_{i,t}, p_{i,t}\right]\right)$, solves (3) subject to (4) and (5) for each $i \in \Theta_t$.

2. Given the set of contracts $\mathfrak{Q}_{i,t}$ offered to each $i \in \Theta_t$: (i) No contract belonging to $\mathfrak{Q}_{i,t}$ makes negative expected profits, and (ii) there exists no other feasible contract $\mathfrak{z} \notin \mathfrak{Q}_{i,t}$, which, if offered in addition to $\mathfrak{Q}_{i,t}$, would make positive expected profits.

3. Each agent i in the set Υ_t selects the occupation in t to maximise $\omega_{i,t}$.

4. The labour market clears; i.e. $\int_{\Theta_t} l_{i,t}\, di = 1 - L_t$.

Young agents will naturally choose the occupation (agricultural labourers vs. manufacturing employees) that yields higher income. Therefore, in equilibrium, $\omega_{i,t} = \max\left\{\upsilon_t, L_t^{\alpha-1}\right\}$ will hold for all $i \in \Upsilon_t$ and all $t \geq 0$. From this expression we can first observe that all individuals of the same generation will earn identical incomes when young, i.e., $\omega_{i,t} = \omega_t$ for all $i \in \Upsilon_t$ and $t \geq 0$. Second, when the young are indifferent between occupations, the wage υ_t must be equal to the average productivity in the agricultural sector. Finally, notice that since $\lim_{L\to 0} L^{\alpha-1} = \infty$, a situation in which $L_t = 0$ (i.e., full manufacturing specialisation) will never hold in equilibrium, as it would require $\upsilon_t = \infty$, which is incompatible with non-negative entrepreneurial profits. Therefore, $\omega_t = L_t^{\alpha-1} \geq \upsilon_t$ will always prevail in equilibrium.

3.1 Financial Contracts and Entrepreneurial Investment

3.1.1 Incentive-Compatible Contracts

Financial intermediaries will *screen* types by restricting the amount of shares on their own projects that entrepreneurs are allowed to sell. More precisely, the level of μ_t will be set low enough so as to dissuade any old bad-type from deviating from his *outside option* and mimic the behaviour of a good-type entrepreneur. These sorts of financial contracts are incentive-compatible, screening out the bad-types. The drawback of this screening policy is that when limiting μ_t below first-best levels (hence, limiting insurance against entrepreneurial failure below full insurance), financiers might also end up discouraging first-best investment by the good-types.

Perfect competition in the financial markets implies that in an RS equilibrium where types are screened, any good-type should receive a price $p_t = (1 - \phi)\rho$ for each of the shares sold to the financiers (that is, each share must command a price equal to its expected payoff when the project is undertaken by a good-type). Denote by l_t^* the level of l_t that solves (3) - (5) for a good type. Note that a bad-type trying to "disguise" himself as a good-type should also hire l_t^* workers (otherwise, he would be assessed as a bad-type by the financiers and would not be offered the *for-good-types-contract*). Incentive-compatibility for any bad-type born in $t - 1$ requires then the following:

$$\ln(\omega_{t-1} - 1) \geq \ln[(\omega_{t-1} - 1) - \upsilon_t \, l_t^* + (1 - \phi)\rho\widehat{\mu}_t]; \tag{6}$$

where $\widehat{\mu}_t$ denotes the maximum number of shares that old agents can sell to the financiers at the unit price $(1 - \phi)\rho$, having hired l_t^* workers.[12]

The right-hand side of (6) shows the utility achieved by an old bad-type when he replicates the portfolio allocation chosen by a good-type (given $\widehat{\mu}_t$). On the other hand, the left-hand side equals the utility that any agent would get by investing all his first-period disposable income in the safe asset at $r = 0$ (that is, by setting $s_t = \omega_{t-1} - 1$); this investment policy represents the outside option available to the old agents in the economy.

The incentive-compatibility constraint (6) can also be re-expressed as follows:

$$\upsilon_t \, l_t^* \geq (1 - \phi)\rho\widehat{\mu}_t; \tag{7}$$

which has a very intuitive interpretation. It essentially requires that, in the state of failure, entrepreneurs should be compensated *at most* for the total amount invested in the project, $\upsilon_t \, l_t^*$; this is clearly the maximum compensation (or insurance) that can be provided to the good-types without attracting the bad-types as well (who fail with probability 1).

3.1.2 Optimal Risk-Taking under Imperfect Financial Markets

From the former discussion on incentive-compatible financial contracts, it follows that the optimisation problem (3) - (5) for any good-type born it $t - 1$ can be rewritten as follows:

$$\max_{l_t \geq 0, \mu_t \geq 0} : E(u_{t-1}) = \phi \ln\left[(\omega_{t-1} - 1) + (1 - \phi)\rho\mu_t - \upsilon_t \, l_t\right] \\ + (1 - \phi) \ln\left[(\omega_{t-1} - 1) + (\rho - \upsilon_t) l_t - \phi\rho\mu_t\right] \tag{8}$$

$$\text{subject to: } \mu_t \leq \widehat{\mu}_t. \tag{9}$$

The solution of the optimisation problem (8) - (9), together with the incentive compatibility constraint (7), yields the following result (the derivation of (10) is provided in Appendix A):

$$l_t^* = \begin{cases} \dfrac{1 - \phi}{\phi} \dfrac{1}{\upsilon_t} (\omega_{t-1} - 1) & \text{if } (1 - \phi)\,\rho > \upsilon_t, \\ \left[0, \dfrac{1 - \phi}{\phi} \dfrac{1}{\upsilon_t} (\omega_{t-1} - 1)\right] & \text{if } (1 - \phi)\,\rho = \upsilon_t, \\ 0 & \text{if } (1 - \phi)\,\rho < \upsilon_t. \end{cases} \tag{10}$$

The expression in (10) summarises the risk-taking behaviour of the good-types born in $t - 1$ when adverse selection prevents full risk-sharing via equity markets. A crucial property of (10) is that –whenever $(1 - \phi)\,\rho > \upsilon_t$– entrepreneurial investment by the good-types (i.e., $\upsilon_t \, l_t^*$) is an increasing function of their initial income, ω_{t-1}. This is due to

[12] Implicit in (6) is the fact that the upper bound on shares, $\widehat{\mu}_t$, binds in the optimum. This result is formally proved in Appendix A – see there Derivation of Equation (10).

the fact that preferences display CRRA, which in turn implies DARA. When preferences exhibit DARA, the total amount invested in riskier assets is increasing in the individual's initial income – see Mas-Colell *et al* (1995), pp. 185-194. Since in this model part of the idiosyncratic risks must be borne by the entrepreneurs so as to comply with (7), investing in the entrepreneurial projects entails a risky decision and will thus increase with the initial income of the good-types.

The equation (10) can alternatively be seen as the individual labour demand function. As it is the usual case, we can observe that labour demand is decreasing in the wage υ_t.[13]

3.2 Equilibrium in the Labour Market

The last variable that remains to be determined in order to characterise fully the equilibrium in period t is the market wage, υ_t. This variable is pinned down in the labour market, where the labour supply derives from the occupational choice of the young generation and the labour demand results from adding up (10) across all good-types born in $t-1$. To avoid the trivial case in which no manufacturing sector ever arises in equilibrium, I impose the following condition:

Assumption 1 $(1-\phi)\,\rho > 1$.

The equilibrium in the labour market in period t is determined by the intersection of the labour demand (l_t^D) and labour supply (l_t^S) correspondences, where:

$$l_t^D = \begin{cases} \eta \dfrac{1-\phi}{\phi}\dfrac{1}{\upsilon_t}\left(\omega_{t-1}-1\right) & \text{if } (1-\phi)\,\rho > \upsilon_t, \\ \left[0, \eta \dfrac{1-\phi}{\phi}\dfrac{1}{\upsilon_t}\left(\omega_{t-1}-1\right)\right] & \text{if } (1-\phi)\,\rho = \upsilon_t, \\ 0 & \text{if } (1-\phi)\,\rho < \upsilon_t. \end{cases} \tag{11}$$

$$l_t^S = \begin{cases} 0 & \text{if } \upsilon_t < 1, \\ 1-\upsilon_t^{-\frac{1}{1-\alpha}} & \text{if } \upsilon_t \geq 1. \end{cases} \tag{12}$$

Notice that when $\upsilon_t \geq 1$, $l_t^S = 1 - y^{-1}(\upsilon_t)$, where $y^{-1}(\cdot)$ is the *inverse* function of the average agricultural output $y(L)$. This is the case because when $\upsilon_t \geq 1$, the young must be indifferent between working in the agricultural or in the manufacturing sector, hence $\upsilon_t = y\left(1-l_t^S\right)$.

Let l_t^* and υ_t^* denote henceforth the labour market equilibrium values of l and υ, and define $\hat{\omega} \equiv 1 + \frac{\rho\phi}{\eta}\left[1-\left(\frac{1}{(1-\phi)\rho}\right)^{\frac{1}{1-\alpha}}\right]$, where notice that $\hat{\omega} > 1$.

Proposition 1 (Labour Market Equilibrium)
(i) Whenever $\omega_{t-1} > 1$, the equilibrium wage υ_t^* is a non-decreasing function of ω_{t-1}. In

[13] There is, though, a difference between (10) and the standard neoclassical labour demand function. In the neoclassical case, labour demand is decreasing in the wage because firms need to adjust the (decreasing) marginal productivity of labour to the higher wage. In this model, the production function ρl is linear then, provided $(1-\phi)\,\rho > \upsilon_t$, labour demand should remain infinite as the wage increases. However, because of imperfect risk-sharing, when υ_t rises, entrepreneurs need to reduce their labour demand in order to achieve better consumption smoothing across states of nature.

particular, if $\omega_{t-1} > 1$, $\upsilon_t^*(\omega_{t-1}) : (1, \infty) \to (1, (1-\phi)\rho]$, *such that: a) for all* $\omega_{t-1} \in (1, \hat{\omega})$, $\upsilon_t^* < (1-\phi)\rho$ *and* υ_t^* *is strictly increasing in* ω_{t-1}*; b) for all* $\omega_{t-1} \geq \hat{\omega}$, $\upsilon_t^* = (1-\phi)\rho$. *Furthermore, whenever* $\omega_{t-1} > 1$, $l_t^* = 1 - (1/\upsilon_t^*(\omega_{t-1}))^{1/(1-\alpha)}$, *thus* $l_t^* \in (0,1)$.
(ii) If $\omega_{t-1} \in [0,1]$, *then* $\upsilon_t^* \in [0,1]$ *and* $l_t^* = 0$.

Figure 1 illustrates the equilibrium in the labour market at four different levels of ω_{t-1}, namely: ω_a, ω_b, $\hat{\omega}$ and ω_c (where, $1 < \omega_a < \omega_b < \hat{\omega} < \omega_c$).[14]

Proposition 1 describes how υ_t^* is influenced by the initial income of the previous generation, ω_{t-1}. Since a larger ω_{t-1} leads to higher risk-taking by the good-types, labour demand turns out to be (weakly) increasing in ω_{t-1}. As labour demand increases with ω_{t-1}, the equilibrium wage υ_t^* must rise to attract some additional young agents from the agricultural sector to the manufacturing sector. This positive impact of ω_{t-1} and υ_t^* represents the key mechanism that may give rise to poverty traps and multiple long-run equilibria in the following section.

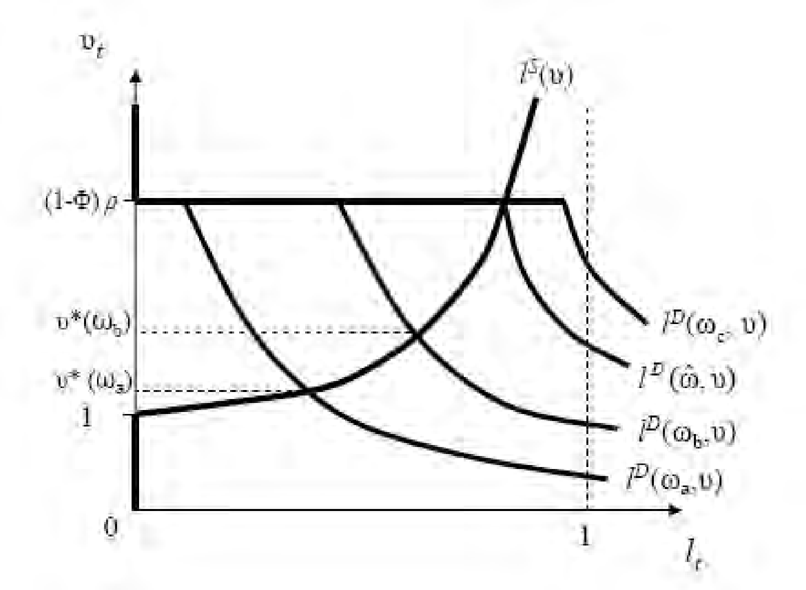

Figure 1: Labour Market Equilibrium.
Labour market equilibrium for four different levels of ω_{t-1}.

4 Dynamic Analysis

In order to characterise the dynamic behaviour of the economy, it proves convenient to start by stating the following result:

Lemma 1 $\omega_\tau \in [1, (1-\phi)\rho]$, *regardless of the value of* $\omega_{\tau-1}$, *for all* $\tau \in \{1, 2, ...\infty\}$.

[14]Although not drawn in Figure 1, when $\omega_{t-1} \in [0,1]$ the labour demand is a straight line along $l_t = 0$ (i.e., $l_t^D(\cdot)$ coincides with the vertical axis). As a result, for all $\omega_{t-1} \in [0,1]$, $l_t^D(\omega_{t-1}, \upsilon_t)$ and $l_t^S(\upsilon_t)$ intersect each other at $l_t = 0$, along the whole segment $\upsilon_t \in [0,1]$; which is the result (ii) in Proposition 1.

Proof. *Firstly, notice that the minimum value ω_τ can take in equilibrium is* 1*, as this is the average productivity of the agricultural sector when* $L_\tau = 1$*. Secondly, observe from* (11) *that if* $\upsilon_\tau > (1 - \phi)\,\rho$*, then* $l_\tau^D = 0$*. As a result, all the young population alive in* τ *should work in the agricultural sector, whose average productivity would then equal* 1*. Therefore,* $\omega_\tau > (1 - \phi)\,\rho$ *cannot hold in equilibrium either.* ■

From Lemma 1, it follows that we can restrict the state space of ω_{t-1} to the interval $[1, (1-\phi)\,\rho]$. When $\omega_{t-1} \in (1, (1-\phi)\,\rho]$, the equilibrium in the (manufacturing sector) labour market encompasses $l_t^* \in (0,1)$. Therefore, young agents alive in t must be indifferent between the two occupations, earning $\omega_t = \upsilon_t = y(1 - l_t^*)$. On the other hand, when $\omega_{t-1} = 1$, labour demand by entrepreneurs falls to zero, and all the young generation must thus go to the agricultural sector, earning income $\omega_t = y(1) = 1$.

Let $\bar{\omega} \equiv \min\{\hat{\omega}, (1-\phi)\rho\}$. We can thus write down the *Law of Motion* for ω_t as follows:

$$\text{Law of Motion:} \quad \begin{cases} \Psi(\omega_{t-1}, \omega_t) \equiv \dfrac{1-\phi}{\phi}\dfrac{\eta}{\omega_t}(\omega_{t-1} - 1) + \left(\dfrac{1}{\omega_t}\right)^{\frac{1}{1-\alpha}} - 1 = 0, & \text{if } \omega_{t-1} \in [1, \bar{\omega}]; \\ \omega_t = (1-\phi)\rho, \quad \text{if } \omega_{t-1} \in (\bar{\omega}, (1-\phi)\rho] \text{ and } (\bar{\omega}, (1-\phi)\rho] \neq \emptyset. \end{cases} \tag{13}$$

If $\hat{\omega} \geq (1-\phi)\rho$, then the implicit function $\Psi(\omega_{t-1}, \omega_t) = 0$ alone depicts the dynamic behaviour of ω_t. Alternatively, if $\hat{\omega} < (1-\phi)\rho$, the dynamics of ω_t are determined by $\Psi(\omega_{t-1}, \omega_t) = 0$ when $\omega_{t-1} \in [1, \hat{\omega}]$, while $\omega_t = (1-\phi)\rho$ when $\omega_{t-1} \in (\hat{\omega}, (1-\phi)\rho]$.

Lemma 2 $\Psi(\omega_{t-1}, \omega_t) = 0$ *yields a mapping* $\omega_t(\omega_{t-1}) : [1, \bar{\omega}] \to [1, (1-\phi)\,\rho]$*, which is strictly increasing and strictly convex in* ω_{t-1}*.*

The value of ω_t is increasing in ω_{t-1} –for $\omega_{t-1} \in [1, \bar{\omega}]$– because entrepreneurial investment in t rises with ω_{t-1}; as explained earlier, this is a direct consequence of preferences with DARA. On the other hand, the convexity of $\omega_t(\omega_{t-1})$ is related to the fact that average agricultural productivity is decreasing in L, which translates into the convex labour supply function (as that plotted in FIGURE 1). More intuitively, as labour demand grows in the manufacturing sector, each additional worker that needs to be drawn from the agricultural sector becomes *increasingly* expensive, because agricultural productivity rises as L diminishes.

We are now able to provide a complete characterisation of the dynamics of the model. Given the specific parametric configuration, we can find three different types of dynamics in terms of their qualitative features and their long-run equilibria.

Proposition 2 (Long-Run Equilibria)
(i) Suppose $\phi/\left[\eta\,(1-\phi)\right] \in (1-\alpha, 1)$*. Then, there exists a threshold level* $\bar{\rho}(\alpha) > 1/(1-\phi)$*, where* $\bar{\rho}'(\alpha) > 0$*, such that:* $\forall\, \rho > \bar{\rho}(\alpha)$*, there exist two (locally) stable stationary equilibria, namely,* $\omega = 1$ *and* $\omega = (1-\phi)\rho$*.*
(ii) Suppose $\phi/\left[\eta\,(1-\phi)\right] \geq 1$*. Then, the only stable stationary equilibrium in the economy is* $\omega = 1$*. Furthermore, if* $\phi/\left[\eta\,(1-\phi)\right] \in (1-\alpha, 1)$ *holds, but* $\rho \leq \bar{\rho}(\alpha)$*, then the only stable stationary equilibrium in the economy is still* $\omega = 1$*.*

(iii) Suppose $\phi/\left[\eta\left(1 \square \phi\right)\right] \leq 1 \square \alpha$*. Then, the only stable stationary equilibrium in the economy is* $\omega = (1 \square \phi)\rho$*.*

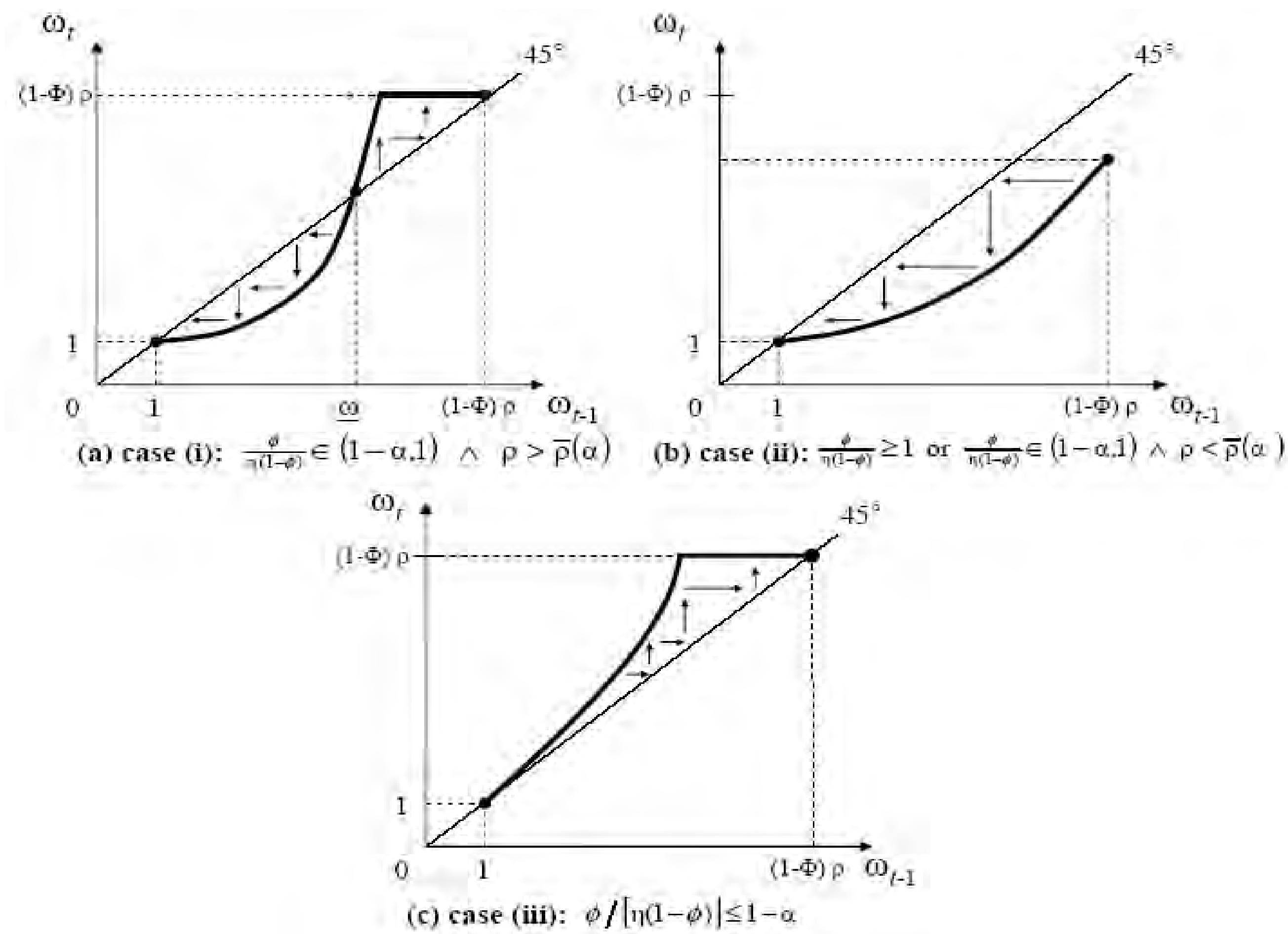

FIGURE 2: Initial income dynamics.

Proposition 2 shows that when $\phi/\left[\eta\left(1 \square \phi\right)\right] \in (1 \square \alpha, 1)$, two (locally) stable long-run equilibria may coexist in the economy. First, we have a *poverty trap* in which $\omega = 1$ and $l = 0$; in other words, an equilibrium where the economy remains poor and fully agricultural. Second, there might be a *high income* long-run equilibrium in which $\omega = (1 \square \phi)\rho$ and $l \in (0, 1)$, (so part of the economy works in the manufacturing sector). This equilibrium arises when ρ is large enough; in other words, when the manufacturing sector is sufficiently productive. This last result seems quite intuitive. Proposition 1 shows that (within a certain range) a larger $\omega_{t \square 1}$ leads to higher wages in period t; when ρ is sufficiently large, the entrepreneurial projects are so productive that the positive impact of $\omega_{t \square 1}$ on ω_t extends over an interval long enough that an additional (stable) stationary point arises in the model.

FIGURE 2 illustrates the three distinct cases presented in Proposition 2. In (a), a situation leading to multiple long-run equilibria is shown. Whenever $\omega_0 > \underline{\omega}$, ω_t will be continuously growing over time, converging monotonically towards $\omega = (1 - \phi)\rho$. During this process, l_t^* will also be rising, meaning both that the manufacturing sector is expanding and that risk-taking by the entrepreneurs is increasing. On the other hand, if $\omega_0 < \underline{\omega}$, the economy will converge towards $\omega = 1$ (a poverty trap), where $l_t^* = 0$. Essentially, in $\omega = 1$ individuals are so poor that they completely shy away from risky projects as a way to avoid the low levels of consumption that would prevail in the event of failure. This, in turn, implies that manufacturing labour demand falls to zero; thus, the entire young generation must resort to agricultural production, driving down its average productivity to $y(1) = 1$. (Therefore, $\omega = 1$ is self-sustaining.)[15]

In Figure 2.(b) the poverty trap represents the unique long-run equilibrium. This situation arises when the failure probability ϕ is sufficiently large. In other words, when entrepreneurial projects are sufficiently risky, imperfect risk sharing prevents the economy from breaking away from the poverty trap in $\omega = 1$.

Finally, in Figure 2.(c), a case in which for any $\omega_0 > 1$ the economy converges to $\omega = \rho(1 - \phi)$ in the long run is plotted. In contrast with the example in Figure 2.(b), this situation appears when ϕ is small enough. Intuitively, when the failure risk is sufficiently low, imperfect risk pooling does not discourage entrepreneurial investment too severely, allowing the economy to grow over time and eventually reach $\omega = \rho(1 - \phi)$.

4.1 Some Comparative Dynamics and Further Discussion

The Risk/Return Trade-Off: From Figure 2 it follows that different economies might experience divergent dynamics, depending on the specific parametric configurations (in terms of ϕ, η, α and ρ) that apply. Of particular interest is case (i), from where it arises that middle-income economies are those especially prone to display divergent dynamics, even when having started off with similar levels of income per capita.[16]

What does the model have to say regarding which middle-income economies are more likely to experience long-run growth and which ones, on the contrary, more likely to face a bleak future.

From (13), we can observe that the stationary point $\underline{\omega}$ that divides the two attraction sinks in Figure 2.(a) stems from the following equation:

$$\eta \frac{1 - \phi}{\phi} = \frac{\underline{\omega} - \underline{\omega}^{-\frac{\alpha}{1-\alpha}}}{\underline{\omega} - 1} \equiv \square(\underline{\omega}). \tag{14}$$

Equation (14) implies, first, that $\underline{\omega}$ is independent of the specific value of ρ –as long as $\rho > \overline{\rho}(\alpha)$, so that $\underline{\omega} < (1 - \phi)\rho$ actually exists–. A second observation that follows from (14) is that $\underline{\omega}$ rises with the risk parameter ϕ (i.e., $\partial\underline{\omega}/\partial\phi > 0$) ; this is the case because the left-hand side is decreasing in ϕ and $\square'(\underline{\omega}) < 0$.[17] In that regard, when case (i) applies,

[15] The point $\omega = \underline{\omega}$ is also a stationary equilibrium in Figure 2.(a), but it is unstable.

[16] Evidence of the world income distribution converging towards a bimodal distribution is provided in Quah (1996). Furthermore, Quah (1993) shows that divergent long-run dynamics are systematically observed among economies whose incomes were initially located around the world average.

[17] A formal proof of $\square'(\underline{\omega}) < 0$ is available from the author upon request.

middle-income economies are especially susceptible to the risk/return trade-off intrinsic to different investment projects. In particular, middle-income economies that have access to relatively safe technologies, even if they are less productive on average, may be in better position to sustain long-run growth than those which can only invest in relatively risky projects, despite the fact that these projects might still exhibit large expected payoffs, $\rho(1 - \phi)$.

Agricultural Productivity: An important feature of the model is the fact that the poverty trap is associated with an agricultural economy. One interesting question that arises then is the following: is a more productive agricultural sector more or less conducive to a process of long-run growth and modernisation?

The answer to the former question is not at all obvious a priori since higher agricultural productivity encompasses two counteracting effects in the model. On the one hand, it increases the incomes of future generations, enhancing thus their willingness to take on risky investment projects (a *wealth effect*). On the other hand, it makes it harder to attract workers to the manufacturing sector, raising wages in the economy which in turn reduces entrepreneurial profits (a *general equilibrium effect*).

A small alteration to the previous model can help shed some light on the relative strengths of each of those two effects when the possibility that an economy gets stuck in a poverty trap is maintained. Let the labour supply (12) be now:

$$l_t^S = \frac{1}{A}\left[1 - \left(\frac{1}{\upsilon_t}\right)^{\frac{1}{1-\alpha}}\right], \quad \text{if } \upsilon_t \geq 1, \quad \text{where } A \geq 1. \tag{15}$$

The parameter A in (15) can be interpreted as an agricultural productivity parameter (the higher A, the more productive the agricultural sector is). The general equilibrium effect is reflected in that the larger A, the higher the wage υ_t that is required to attract a *given* supply of workers to the manufacturing sector. Notice too that the previous specification (deliberately!) keeps the property that $l_t^S = 0$ for $\upsilon_t = 1$. As a consequence of this, the stationary point $\omega = 1$ shown in Figure 2 still survives to $A > 1$ in (15).[18]

The necessary and sufficient condition for the existence of a *stable* poverty trap in $\omega = 1$ is $\left.\frac{d\omega_t}{d\omega_{t-1}}\right|_{\omega_{t-1}=1} < 1$. This condition now requires that $\phi / \left[A\eta\left(1 - \phi\right)\right] > 1 - \alpha$, which becomes harder to comply for larger values of A. From that perspective, economies in the vicinity of $\omega_t = 1$ benefit from increases in agricultural productivity, as this fosters long-run growth through the wealth effect and turns less likely that they end up trapped in $\omega = 1$.

Furthermore, a larger A is also conducive to positive dynamics by shrinking the size of the poverty trap attraction sink when situations like case (i) prevail. This last result can be seen from the condition (14) when $A \geq 1$ is allowed, which reads: $\left[A\eta\left(1 - \phi\right)\right]/\phi = \square(\underline{\omega})$,

[18] Equation (15) stems from an agricultural production function with average output: $y(L) = [AL - (A - 1)]^{\alpha - 1}$, which is increasing in A for any $L < 1$. As before, $y(1) = 1$. A minor caveat with this specification is the fact that $y(1 - A^{-1}) = \infty$; hence average output goes to infinity before L reaches zero if $A > 1$. In case the reader finds this property a bit bothersome, the rest of the analysis in this subsection restricts the attention to values of L where $y(L)$ is finite and, in particular, relatively low.

implying $\partial\underline{\omega}/\partial A < 0$. Therefore, increasing agricultural productivity not only seems to improve long-run growth prospects for very poor economies, but also for middle-income ones located near $\underline{\omega}$.

Endogenous Interest Rate: Throughout the model the interest rate in the economy has been kept exogenously fixed. Although fully endogenising the local interest rate is beyond the scope of this paper, a brief discussion of its potential implications is worth attempting.

Notice that an increase in the interest rate, r, means that the expected return of risky projects, $\rho(1 - \phi)$, declines relative to that of the safe asset. In that sense, a higher r or a lower ρ should carry similar consequences, as both changes would lead to a portfolio re-allocation with a larger share placed on the safe asset.

One possibility that can be envisaged is r falling along the growth path. This would be the case if r includes a country-risk component (affecting both the lending and borrowing rates) and this risk tends to fall as the economy becomes richer. In this scenario, a declining r should create an additional source of non-convexity in the model, making it more likely to display multiple long-run equilibria.

A different scenario arises if the small economy assumption is dropped, and we let r go up as the economy grows and demands more financing. In this case, an increasing r would actually counteract the wealth effect implicit in the model, dampening (at least partially) the non-convexity implied by (13). My conjecture is that, as long as the interest rate does not respond too much to income increases, the convex portion of the mapping $w_t(w_{t-1})$ should not be completely overturned, at least when w_{t-1} lies still in the vicinity of 1. In that regard, since arguably the economy is reasonably well represented by the assumption of small economy while it is still poor, in fact, in that region r should not be too sensitive to income variations, and the main results presented earlier for a poor economy should still qualitatively hold.

5 Concluding Remarks

This paper has presented a model in which, along the path of development, the economy evolves from a small-scale rural economy to an entrepreneurial manufacturing one. Such a virtuous sequence is however not guaranteed because private information about skills prevents full risk sharing of idiosyncratic shocks in the manufacturing sector. The model shows that development to an industrial economy tends to fail to take place when entrepreneurial activities carry very high risks, since those are the cases in which insurance is most needed.

In terms of risk-bearing, some results are in contrast with those of Banerjee and Newman (1991) and Newman (2007), where poorer agents bear the risks, while richer agents choose safer activities. Their results are driven by the fact that riskier activities require agents to exert (unobservable) effort. Since effort is assumed to enter linearly in a separable utility function, whereas marginal utility of consumption is decreasing, the marginal rate of substitution of leisure for consumption is increasing in initial wealth. As a result, it is easier to incentivize poorer agents to exert high effort in the risky activity. From an empirical point of view, it is clear that initial wealth represents a major determinant of entrepreneurial choice due to the presence of financial markets imperfections – see, for example, Evans and Jovanovic (1989). In that respect, this paper contributes to the past literature by suggesting that *adverse selection* may represent a key market failure that keeps the poor away from entrepreneurial activities.

The result that risk-bearing increases during development is also present in Acemoglu and Zilibotti (1999) for some of their parametric configurations –see their Proposition 6–. The underlying mechanism is quite different, though. In their paper, the trade-off between insurance and incentives changes with capital accumulation. Hence, under certain conditions, as the quality of information improves, it pays off for the principal to further sacrifice insurance in order to provide more powerful incentives to the agent. In my paper, it is the change in agents' *intrinsic* attitudes towards risk what induces further risk-bearing and spurs growth.

In terms of policy implications, policies that foster competition are growth-enhancing in Acemoglu and Zilibotti (1999), as they increase the amount of information available in the economy. In my paper, in contrast, at early stages of development, when individuals are still quite sensitive to imperfect insurance, unfettered competition may not be totally advisable. In particular, unrestricted competition implies that all types of agents may try to undertake entrepreneurial projects, generating adverse selection problems in the financial markets. In that regard, a policy recommendation could be to charge an entry fee to entrepreneurial activities and use the proceeds to pay a compensation to those who decide to stay away from those activities, as a way to clean the pool of entrepreneurs.

As a final remark, this paper could yield additional insights for the phenomenon of under-migration from small villages to the city, which was studied before by Banerjee and Newman (1998), though they look at credit motives rather than insurance. In that regard, migrating to the city could be interpreted as investing in a risky asset that yields higher expected income. The local village, on the other hand, has the advantage of providing its inhabitants with deep social networks that protect them from idiosyncratic shocks [Das Gupta (1987) and Hugo (1982)]. This interpretation seems also consistent with the view that information inside the villages flows better, hence adverse selection problems there would be less troublesome than in the cities.

Appendix A: Omitted Proofs

Derivation of Equation (10). I proceed here to derive each one of the expressions in (10). It proves convenient to first state the following preliminary results:

Lemma A.1. If $(1 - \phi)\rho > v_t$, the constraint $\mu_t \leq \widehat{\mu}_t$ in problem (8) - (9) must bind in the optimum.

Proof. Suppose (9) did not bind. In that case, first-order conditions would yield: $\mu_t = l_t > 0$.[19] But, this means (7) would be violated. Therefore, the constraint (9) must necessarily bind. ‖

[19] Notice that when $\mu_t = l_t$, full insurance against entrepreneurial risk is achieved.

Lemma A.2. Suppose $(1 - \phi)\,\rho > \upsilon_t$. Then, in the optimum, the problem (8) – (9) yields:

$$l_t^* = \frac{1}{\upsilon_t}\left[\frac{(1-\phi)\,\rho - \upsilon_t}{\rho - \upsilon_t}\,(\omega_{t-1} - 1) + \frac{(1-\phi)^2\,\rho + 2\,\phi\,\upsilon_t - \upsilon_t}{\rho - \upsilon_t}\,\rho\widehat{\mu}_t\right] \tag{16}$$

Proof. Since the constraint $\mu_t \leq \widehat{\mu}_t$ must bind, we can fix $\mu_t = \widehat{\mu}_t$ an optimise over l_t only. As a result, the following first-order condition for l_t obtains:

$$\frac{(1-\phi)\,(\rho - \upsilon_t)}{(\omega_{t-1} - 1) + (\rho - \upsilon_t)\,l_t^* - \phi\rho\widehat{\mu}_t} - \frac{\phi\upsilon_t}{(\omega_{t-1} - 1) - \upsilon_t l_t^* + (1-\phi)\,\rho\widehat{\mu}_t} = 0.$$

Finally, from this expression, (16) immediately follows after some simple algebra. ‖

Lemma A.3. Suppose $(1 - \phi)\,\rho > \upsilon_t$. Then, in equilibrium, $\widehat{\mu}_t = \dfrac{\upsilon_t\, l_t^*}{\rho(1-\phi)}$.

Proof. Suppose that (7) does not bind. In that case, financiers could actually offer a contract carrying $\mu_t > \widehat{\mu}_t$, which would still screen out the bad-types and that will make all the good-types better off (since it would provide them with better consumption smoothing). Hence, in equilibrium, $\widehat{\mu}_t = \upsilon_t\, l_t^*/\rho(1-\phi)$ must necessarily apply. ‖

By using the results in Lemmas A.2 and A.3, we can next replace $\widehat{\mu}_t = \upsilon_t\, l_t^*/\rho(1-\phi)$ into (16), to finally obtain $l_t^* = \frac{1-\phi}{\phi}\upsilon_t^{-1}\,(\omega_{t-1} - 1)$ when $(1-\phi)\,\rho > \upsilon_t$.

Suppose now $\upsilon_t = (1-\phi)\,\rho$. Replacing υ_t by $(1-\phi)\,\rho$ into (6), yields $\widehat{\mu}_t \leq l_t$. In equilibrium, $\widehat{\mu}_t = l_t$ will hold, for a similar argument as in Lemma A.3. Then, good-types will optimally set $\mu_t^* = l_t$, which implies that the optimal l_t^* can be found by solving: $\max_{l_t \geq 0} : \{\ln(\omega_{t-1} - 1)\}$. This last problem can be trivially maximised by any $l_t \geq 0$. In particular, any $l_t \in \left[0, \frac{1-\phi}{\phi}\upsilon_t^{-1}\,(\omega_{t-1} - 1)\right]$, may solve the previous optimisation problem.

Finally, when $(1-\phi)\,\rho < \upsilon_t$, l_t^* trivially equals zero, since by investing the entire disposable first-period income $(\omega_{t-1} - 1)$ in the safe-asset, good-types can obtain a higher expected return without bearing any risks.

Proof of Proposition 1. Part (i). Inspecting (11) and (12) we can observe that, for all $\omega_{t-1} \in (1, \hat{\omega})$, υ_t^* is pinned down by the following equation:

$$\eta\frac{1-\phi}{\phi}\frac{1}{\upsilon_t^*}\,(\omega_{t-1} - 1) = 1 - \left(\frac{1}{\upsilon_t^*}\right)^{\frac{1}{1-\alpha}}; \tag{17}$$

as equation (17) yields indeed $\upsilon_t^* \in (1, (1-\phi)\,\rho)$, $\forall\, \omega_{t-1} \in (1, \hat{\omega})$. Next, totally differentiating (17), we obtain:

$$\frac{d\upsilon_t^*}{d\omega_{t-1}} = \eta\frac{1-\phi}{\phi}\left[\eta\frac{1-\phi}{\phi}\frac{\omega_{t-1} - 1}{\upsilon_t^*} + \frac{1}{1-\alpha}\left(\frac{1}{\upsilon_t^*}\right)^{\frac{1}{1-\alpha}}\right]^{-1} > 0.$$

In addition, since $\upsilon_t^* \in (1, (1-\phi)\,\rho)$, from (12) it follows that $l_t^* = 1 - (1/\upsilon_t^*(\omega_{t-1}))^{1/(1-\alpha)}$, for all $\omega_{t-1} \in (1, \hat{\omega})$. Hence, $l_t^* \in (0, 1)$.

Now, let $\omega_{t-1} = \hat{\omega}$ and note that $l_t^S((1-\phi)\rho) = 1 - \left[\frac{1}{(1-\phi)\rho}\right]^{\frac{1}{1-\alpha}} = (\phi\rho)^{-1}\eta(\hat{\omega}-1)$. Furthermore, observe thus that: $l_t^S((1-\phi)\rho) < (\phi\rho)^{-1}\eta(\omega_{t-1}-1)$ for any $\omega_{t-1} > \hat{\omega}$. Therefore, since $l_t^D = 0$ for all $\upsilon_t > (1-\phi)\rho$, and $l_t^D = \left[0, (\phi\rho)^{-1}\eta(\omega_{t-1}-1)\right]$ for $\upsilon_t = (1-\phi)\rho$; then, for any $\omega_{t-1} \geq \hat{\omega}$, the labour market equilibrium yields $\upsilon_t^* = (1-\phi)\rho$ and $l_t^* = (\phi\rho)^{-1}\eta(\hat{\omega}-1)$. ‖

Part (ii). For all $\omega_{t-1} \in [0,1]$, labour demand equals zero. Therefore, in equilibrium, l_t^S must equal zero too; which requires $\upsilon_t^* \in [0,1]$. ■

Proof of Lemma 2. From $\Psi(\omega_{t-1}, \omega_t) = 0$ in (13) we may obtain: $\omega_{t-1} = \frac{\phi}{\eta(1-\phi)}\left(\omega_t - \omega_t^{-\frac{\alpha}{1-\alpha}}\right)$.

Differentiating that equation leads to:

$$\frac{d\omega_t}{d\omega_{t-1}} = \frac{\eta(1-\phi)}{\phi}\frac{1}{1+\dfrac{\alpha}{1-\alpha}\omega_t^{-\frac{1}{1-\alpha}}} > 0. \tag{18}$$

Next, from (18), bearing in mind $d\omega_t/d\omega_{t-1} > 0$ and $\alpha > 0$, it immediately follows that: $d^2\omega_t/(d\omega_{t-1})^2 > 0, \forall\, \omega_{t-1} \in [1, \bar{\omega}]$. ■

Proof of Proposition 2. Part (i). First of all, notice that the point $\omega_t = 1$ represents *always* a stationary point of (13), since $\Psi(1,1) = 0$. Next, given the statement in Lemma 2, it follows that a necessary and sufficient condition for $\omega = 1$ to be locally stable is that the first derivative in (18) computed at $\omega_{t-1} = 1$ is strictly smaller than 1. Thus, replacing $\omega_{t-1} = \omega_t = 1$ into (18), we get:

$$\left.\frac{d\omega_t}{d\omega_{t-1}}\right|_{\omega_{t-1}=1} = \eta\frac{(1-\phi)}{\phi}(1-\alpha).$$

Therefore, $\phi/[\eta(1-\phi)] > 1-\alpha$ implies $\left.\frac{d\omega_t}{d\omega_{t-1}}\right|_{\omega_{t-1}=1} < 1$.

Second, since $\omega_t = (1-\phi)\rho$ for all $\omega_{t-1} \in (\bar{\omega}, (1-\phi)\rho]$, whenever this interval is non-empty; in order to show that $\omega_t = (1-\phi)\rho$ is also a locally stable stationary equilibrium, it suffices to prove that, under the stipulated conditions, $\hat{\omega} < (1-\phi)\rho$. From the expressions in (11) and (12), we can observe that:

$$\hat{\omega} < (1-\phi)\rho \quad \Leftrightarrow \quad \underbrace{\eta\frac{1-\phi}{\phi}\frac{(1-\phi)\rho-1}{(1-\phi)\rho}}_{M(\rho)} > \underbrace{1-\left[\frac{1}{(1-\phi)\rho}\right]^{\frac{1}{1-\alpha}}}_{N(\rho,\alpha)}. \tag{19}$$

From (19), it follows that:

$$\lim_{\rho\to 1/(1-\phi)} M(\rho) = \lim_{\rho\to 1/(1-\phi)} N(\rho,\alpha) = 0, \tag{20}$$

$$\lim_{\rho\to\infty} M(\rho) = \frac{\eta(1-\phi)}{\phi} > \lim_{\rho\to\infty} N(\rho,\alpha) = 1. \tag{21}$$

Differentiating $M(\rho)$ and $N(\rho,\alpha)$ with respect to ρ, we obtain: $dM/d\rho = \eta/\phi\rho^2$, and $\partial N/\partial\rho = [(1 \square \alpha)\,\rho]^{\square 1}\left[\frac{1}{(1\square\phi)\rho}\right]^{\frac{1}{1\square\alpha}}$. Therefore:

$$\frac{dM}{d\rho} \gtreqless \frac{\partial N}{\partial\rho} \quad \Leftrightarrow \quad \frac{\eta(1\square\phi)}{\phi}\,(1\square\alpha) \gtreqless \left[\frac{1}{(1\square\phi)\rho}\right]^{\frac{\alpha}{1\square\alpha}}. \tag{22}$$

Denote by $\hat{\rho}(\alpha)$ the value of ρ that solves (22) with strict equality; that is:

$$\eta\frac{(1\square\phi)}{\phi}\,(1\square\alpha) \equiv \left[\frac{1}{(1\square\phi)\hat{\rho}}\right]^{\frac{\alpha}{1\square\alpha}}, \tag{23}$$

where it can be observed that $\hat{\rho}(\alpha) > 1/(1\square\phi)$. Then, the expression in (22), together with (23) and the fact that $\phi/\left[\eta\,(1\square\phi)\right] > 1\square\alpha$, imply:

$$1)\text{ for all } \rho \in \left(1/\left(1\square\phi\right), \hat{\rho}(\alpha)\right)\text{:}\quad dM/d\rho < \partial N/\partial\rho \tag{24}$$

$$2)\text{ for all } \rho > \hat{\rho}(\alpha)\text{:}\quad dM/d\rho > \partial N/\partial\rho \tag{25}$$

$$3)\text{ when } \rho = \hat{\rho}(\alpha)\text{:}\quad dM/d\rho = \partial N/\partial\rho. \tag{26}$$

As a result, combining (24) and (26) with the result in (20), we can deduce that $M(\rho) < N(\rho,\alpha)$ for all $\rho \in \left(1/\left(1\square\phi\right), \hat{\rho}(\alpha)\right]$. Furthermore, because of (25) and the result in (21), we can observe that: $\exists\,\bar{\rho} > \hat{\rho}(\alpha)$, such that $M(\bar{\rho}) = N(\bar{\rho},\alpha)$, and $M(\rho) > N(\rho,\alpha)$ for all $\rho > \bar{\rho}$, while $M(\rho) < N(\rho,\alpha)$ for all $\rho < \bar{\rho}$. Using again (19), we can observe that $\bar{\rho}$ must solve:

$$\eta\frac{1\square\phi}{\phi}\frac{(1\square\phi)\bar{\rho}\square 1}{(1\square\phi)\bar{\rho}} = 1\square\left[\frac{1}{(1\square\phi)\bar{\rho}}\right]^{\frac{1}{1\square\alpha}}; \tag{27}$$

from where it follows that $\bar{\rho} = \bar{\rho}(\alpha)$. This completes the proof that $\exists\,\bar{\rho}(\alpha) > 1/\left(1\square\phi\right)$, such that for all $\rho > \bar{\rho}(\alpha)$ there exists another locally stable stationary point at $\omega = (1\square\phi)\,\rho$.

Finally, totally differentiating (27), we get:

$$\frac{d\bar{\rho}}{d\alpha} = \frac{\frac{1}{(1\square\alpha)^2}\left[\frac{1}{(1\square\phi)\bar{\rho}}\right]^{\frac{1}{1\square\alpha}}\ln\left[(1\square\phi)\bar{\rho}\right]}{\frac{\eta}{\phi\bar{\rho}^2}\square\frac{1}{(1\square\alpha)\bar{\rho}}\left[\frac{1}{(1\square\phi)\bar{\rho}}\right]^{\frac{1}{1\square\alpha}}}. \tag{28}$$

Given that at $\rho = \bar{\rho}$, $dM/d\rho > \partial N/\partial\rho$, the denominator in the right-hand side of (28) must thus be positive. Furthermore, the numerator in the right-hand side of (28) is also positive, because $\bar{\rho} > 1/\left(1\square\phi\right)$. As a result, it follows that $d\bar{\rho}/d\alpha > 0$. $\|$

Part (*ii*). Note first that $\partial N/\partial\alpha > 0$. As a result, if (19) does not hold for $\alpha \to 0$, it will then not hold for any $\alpha \in (0,1)$ either. Taking the limit on the expressions in (19) as $\alpha \to 0$:

$$\text{if } \alpha \to 0\text{:}\;\; \hat{\omega} < (1\square\phi)\,\rho \quad \Leftrightarrow \quad \tfrac{\eta(1\square\phi)}{\phi}\left[1\square\tfrac{1}{(1\square\phi)\rho}\right] > 1\square\tfrac{1}{(1\square\phi)\rho} \tag{29}$$

Therefore, if $\phi/\left[\eta\,(1\square\phi)\right] \geq 1$, (29) implies that $\hat{\omega} \geq (1\square\phi)\,\rho$ when $\alpha \to 0$, and thus the only stable stationary point is $\omega = 1$.

Lastly, the proof that if $\phi/\left[\eta\left(1 - \phi\right)\right] \in (1 - \alpha, 1)$ holds, but $\rho \leq \bar{\rho}(\alpha)$, then the only stable stationary equilibrium is the point $\omega = 1$, follows directly from the proof of Part (i). $\|$

Part (iii). If $\phi/\left[\eta\left(1 - \phi\right)\right] \leq 1 - \alpha$, then: $\left.\frac{d\omega_t}{d\omega_{t-1}}\right|_{\omega_{t-1}=1} \geq 1$. As a consequence, the fixed point $\omega = 1$ is locally unstable. Moreover, because $\Psi(\omega_t, \omega_{t-1}) = 0$ yields an increasing an convex function in ω_{t-1}, it follows that:

$$\frac{d\omega_t}{d\omega_{t-1}} > 1, \quad \forall\, \omega_{t-1} \in [1, \bar{\omega}]. \tag{30}$$

Given (30), and given that $\omega = 1$ is a fixed point, it follows that $\omega_t > \omega_{t-1}$ for all $\omega_{t-1} \in (1, \bar{\omega}]$. Therefore, $\hat{\omega} < \bar{\omega}$, and $\omega = (1 - \phi)\rho$ thus represents the unique *stable* fixed point of (13). ■

Appendix B: Alternative Utility Specification

Let us now drop the assumption that individuals need to consume one unit of income while they are young (hence, they will consume the entire ω_{t-1} in period t). In addition to that, assume that: $u_{i,t} = c_{i,t+1}^{1-\sigma}/(1 - \sigma)$; that is, utility displays CRRA, where $\sigma > 0$ denotes the coefficient of relative risk aversion. From now onwards, restrict the attention to $1 < \omega_{t-1} < (1 - \phi)\,\rho$ and use the fact that, in equilibrium, $v_t = \omega_t$. In this setup, the optimisation problem for a good-type born in $t - 1$ is given by:

$$\max_{l_t \geq 0, \mu_t \geq 0} \; : \; E(u_{t-1}) = \phi \frac{\left[\omega_{t-1} - \omega_t l_t + (1 - \phi)\,\rho\mu_t\right]^{1-\sigma}}{1 - \sigma} + (1 - \phi)\, \frac{\left[\omega_{t-1} + (\rho - \omega_t) l_t - \phi\rho\mu_t\right]^{1-\sigma}}{1 - \sigma}$$
$$\text{subject to:} \quad \mu_t \leq \widehat{\mu}_t. \tag{31}$$

Where the value of $\widehat{\mu}_t$ is still pinned down by (7). Problem (31) yields:

$$l^* = \frac{(1 - \phi)}{(1 - \phi)\,\rho - \omega_t} \left\{ \left[\frac{(1 - \phi)\,(\rho - \omega_t)}{\omega_t \phi} \right]^{\frac{1}{\sigma}} - 1 \right\} \omega_{t-1} \equiv \Pi(\omega_t)\, \omega_{t-1}. \tag{32}$$

Remark. Notice that when $\sigma = 1$ (i.e., when utility is logarithmic) the expression in (32) boils down to: $l^* = \dfrac{(1 - \phi)}{\phi} \dfrac{\omega_{t-1}}{\omega_t}$, which is what would be obtained in the benchmark model if individuals consumed zero income in the first period of their lives.

Let $\varepsilon(\omega_t)$ denote the wage-elasticity of labour demand in (32); that is: $\varepsilon(\omega_t) \equiv -\dfrac{\Pi'(\omega_t)}{\Pi(\omega_t)} \omega_t$.

Lemma A.4. *(i)* $\sigma > 1 \Leftrightarrow \varepsilon(\omega_t) < 1$, *(ii)* $\sigma < 1 \Leftrightarrow \varepsilon(\omega_t) > 1$, *(iii)* $\sigma = 1 \Leftrightarrow \varepsilon(\omega_t) = 1$.

Proof. Available upon request.

Since labour supply remains the same, the law of motion can be written as follows:

$$\omega_{t-1} = \frac{1 - \omega_t^{-\frac{1}{1-\alpha}}}{\Pi(\omega_t)}. \tag{33}$$

Thus,

$$\frac{d\omega_t}{d\omega_{t-1}} = \Pi(\omega_t)\left[\frac{1}{1-\alpha}\omega_t^{\frac{\alpha-2}{1-\alpha}} - \left(1-\omega_t^{-\frac{1}{1-\alpha}}\right)\frac{\Pi'(\omega_t)}{\Pi(\omega_t)}\right]^{-1}. \tag{34}$$

Replacing (33) into (34) leads to:

$$\frac{d\omega_t}{d\omega_{t-1}} = \frac{\Pi(\omega_t)}{\frac{1}{1-\alpha}\omega_t^{\frac{\alpha-2}{1-\alpha}} - \omega_{t-1}\Pi'(\omega_t)}. \tag{35}$$

From where we can observe that $d\omega_t/d\omega_{t-1} > 0$ still holds true under this new setup.

Next, dividing and multiplying the RHS in (34) by ω_t yields:

$$\frac{d\omega_t}{d\omega_{t-1}} = \frac{\Pi(\omega_t)\omega_t}{\frac{1}{1-\alpha}\omega_t^{-\frac{1}{1-\alpha}} + \left(1-\omega_t^{-\frac{1}{1-\alpha}}\right)\varepsilon(\omega_t)}. \tag{36}$$

Let us, for the moment, focus on the case in which $\sigma = 1$, so that to compare the results when all ω_{t-1} is consumed in t to those previously obtained in the main text. Bearing in mind that $\sigma = 1$ implies $\varepsilon(\omega_t) = 1$, which in turn also means that $\Pi(\omega_t)\omega_t$ is a constant, we can observe from (36) that $d^2\omega_t/\left(d\omega_{t-1}\right)^2 > 0$ still holds true in this alternative setup.[20]

Therefore, dynamics similar to those depicted in FIGURE 2.(b) and (c) are still possible with logarithmic utility, even if individuals consume *all* their initial income, ω_{t-1}, when they are old. In other words, this alternative version of the model can still yield dynamics with poverty traps (similar to those in case (ii) in Proposition 2) or with successful long-run growth (similar to case (iii) in Proposition 2).[21]

However, to obtain dynamics where multiple equilibria *coexist* for a given set of parameters –like those in FIGURE 2.(a)–, a slightly stronger condition is required, namely: $\sigma > 1$. To see this, notice that a *necessary* condition for multiple equilibria to coexist is that: $d\omega_t/d\omega_{t-1} > 1$ when $\omega_t = \omega_{t-1}$, at least once. (So that the mapping $\omega_t(\omega_{t-1})$ crosses the 45° line at least once from below.)

Set thus $\omega_{t-1} = \omega_t = \omega$ and replace it into (35). Then, using the fact that $\varepsilon(\omega_t)\Pi(\omega_t) \equiv -\Pi'(\omega_t)\omega_t$, we may obtain:

$$\left.\frac{d\omega_t}{d\omega_{t-1}}\right|_{\omega} = \frac{\Pi(\omega)}{\frac{1}{1-\alpha}\omega^{\frac{\alpha-2}{1-\alpha}} + \varepsilon(\omega)\Pi(\omega)};$$

from where we can immediately observe that $\varepsilon(\omega) < 1$ is a necessary condition for that derivative to be larger than 1. To grasp some intuition for this result, suppose we are on the 45° line, so $\omega_{t-1} = \omega_t = \omega$. If $\varepsilon(\omega_t) \geq 1$, an increase in ω_{t-1} cannot lead to an even larger increase in ω_t, since that would actually reduce labour demand in (32) –leading to a

[20] It must also be quite intuitive to observe that convexity, i.e. $d^2\omega_t/\left(d\omega_{t-1}\right)^2 > 0$, should be even stronger if $\sigma > 1$, since in this case $\varepsilon(\omega_t) < 1$ and the numerator in (36) becomes increasing in ω_t.

[21] One difference with respect to the model in the main text is that the poverty trap would encompass $\omega > 1$. However, this is just owing to the fact that $y(1) = 1$, and may be accommodated with different specifications for the agricultural production function that still exhibit decreasing marginal productivity.

lower ω_t, rather than a larger one–. In contrast, when $\varepsilon(\omega_t) < 1$, an increase in ω_{t-1} can in fact lead to an even larger increase in ω_t, since in this case the negative effect of the higher wage need not completely revert the positive effect induced by a larger ω_{t-1}.[22]

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