DISCUSSION PAPER SERIES

No. 5184

LAND REFORMS AND ECONOMIC DEVELOPMENT

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INSTITUTIONS AND ECONOMIC PERFORMANCE (FORMERLY TRANSITION ECONOMICS)

Centre for Economic Policy Research

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ISSN 0265-8003

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Discussion Paper No. 5184
August 2005

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CEPR Discussion Paper No. 5184

August 2005

ABSTRACT

Land Reforms and Economic Development*

We demonstrate that there is a nexus between land transfers and human capital formation. A sequence of land redistributions enables the beneficiaries to educate their children and thus to escape from poverty and to overcome child labour. We find that open access to land markets should be prohibited for beneficiaries for some time. Moreover, a temporary state of inequality among the poor is unavoidable. Finally, a successful land reform allows for the transition of a society from an agriculture-based state of poverty to a human capital-based developed economy.

JEL Classification: I28, I38, O11, O15 and Q15
Keywords: land market access, land reforms, migration, poverty and transition

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Submitted 01 August 2005

*We would like to thank Olaf Hölzer, Panu Poutvaara, Michael Rimmler, Julian Spiegel, and partic-ipants at the Annual Meeting of the Verein für Socialpolitik in Zürich in 2003 and the 59th European Meeting of the Econometric Society (ESEM) 2004 in Madrid as well as participants at seminars at the CEBR in Copenhagen and at the University of Heidelberg for very helpful discussions and comments. We gratefully acknowledge financial support from the Deutsche Forschungsgemeinschaft (DFG) at the Graduate Programme 'Environmental and Resource Economics' of the Universities of Heidelberg and Mannheim.

1 Introduction

Half of the world's population lives on less than 2 US-$ per day and 23.4 percent on less than 1 US-$.[1] The first of the Millennium Goals of the United Nations stipulates that the proportion of people who live on less than 1 US-$ a day and the proportion who suffer from hunger should be halved between 1990 and 2015. 75 percent of these poor live in rural regions and in many underdeveloped countries agriculture is the largest sector.[2] Therefore, policies against poverty have in large measure to focus on rural areas, where agriculture is prevalent and land is an important factor of production. The World Bank states that inefficient land use is widespread in developing countries and that the lack of land ownership is one major source of poverty. Hence, land reforms are likely to be a fruitful path to fighting poverty.

At the same time, human capital is vital to competing in today's knowledge-driven global markets. Education enables the poor to come to informed decisions and is a major element in a development towards democratic societies. Article 26 of the Universal Declaration of Human Rights states that education is a human right and seminal works like Lucas (1988) emphasize the important role of human capital for growth. The second Millennium Goal therefore demands that children all over the globus should be able to complete a full course of primary schooling by 2015. Psacharopoulos (1994) and Tilak (1989) found evidence that inefficient under-investment in human capital is widespread in developing economies. About 1 billion adults are illiterate, which represent approximately 25 percent of the world population. Over one hundred million children in the world have no access to schooling.[3] We believe that there exists a so far neglected nexus between land reforms on the one hand and fighting poverty and attaining education on the other. In developing countries there often does not exist an effective tax system, so that redistribution policies via a tax/subsidy scheme are hard to implement in practice and hence not available. It follows that land reforms might be the only policy tool to directly increase the incomes of the poor in such countries. Land reforms were attempted in many places, but most were not successful. Never-

[1] Cf. World Bank's *World Development Indicators 2004* (see WDI (2004)). The thresholds must be interpreted as US-dollar in 1985 prices, that is, the current per-day dollar-incomes have to be adjusted for purchasing power parity.

[2] Cf. <http://www.weltbank.org>, feature stories, *Reaching the Rural Poor*, and Burgess and Stern (1993), p.784.

[3] Cf., respectively, Ho (2003), Background Information.

theless, land reforms remain a top priority in the policy agenda of many countries and have experienced a renaissance after less attention in the 1980s.[4] The major aim of proposals in the political debate about land reforms is to improve equity in the sense that a "just" distribution of land should be established. We believe that the main aim of land reforms ought to go beyond (only) improving equity. The objective is to generate sustainable growth. A restricted focus on equity (and lowering political pressure) might have been one source of failure of land reforms in the past.

Although economic growth, development and education are dynamic phenomenons, there exists only one (recent) dynamic analysis of land reforms, Horowitz (1993). However, the paper focuses on the question of how much land can be redistributed without social conflict. In contrast, we elaborate on how land reforms can be carried out to fight poverty and to attain economic growth. Hence, our works complement each other. Fighting poverty often means trying to escape poverty traps, i.e. locally stable steady states. A standard example of a poverty trap is the failure to build human capital [see, e.g., Galor and Zeira (1993)]. In developing countries, children cannot attend school because they have to contribute to a family's income by child labor in order to secure survival. Perfect capital markets would enable parents to borrow against expected future earnings achieved by education and thus to invest in the human capital of their children; even the children themselves would be able to do so. The poor in developing countries do not have access to capital markets, however, and children's education must be financed by the household's current earnings and assets. Insufficient income and assets leads to the failure of human capital formation, which then perpetuates itself. In this context, the most important asset and source of income in developing countries is land, because these are mostly agrarian economies. Since rural poverty and lack of land ownership go hand in hand,[5] land reforms are likely to be a promising tool in fighting poverty and the associated problems of education, child labor, and starvation. As the difficulties of imposing taxation increase with the share of agriculture in GDP (see Burgess and Stern (1993), pp. 775-776, and the literature cited there), our analysis is most important for agrarian economies.

To analyze how to design a land reform that allows a society to overcome poverty traps and attain growth by education, we consider a two-sector economy with overlapping

[4] A dramatic example is the land dispute in Zimbabwe following a new Land Act Reform [see for instance Godwin (2003)].

[5] Cf. for instance Ravallion and Sen (1994).

generations, where each generation consists of a continuum of individuals. Parents have altruistic preferences regarding their children. They only invest in the education of their children if their income exceeds a particular level. Land enables households to enter a higher income bracket which may ensure the education of children and relieve poverty. The experiences with the reforms in the Philippines, for instance, tend to support our model. The land reform there had a strong impact on investment in human and physical capital and on long-term growth of income, productivity, and investment [Deininger, Olinto, and Maertens (2000), p. 12].

Our main results are as follows. There is a nexus between land reform, fighting poverty and education. Successful land reforms consist of a sequence of land transfers. In order to accumulate human capital, only a (small) part of the society should receive land transfers at a particular point in time. This enables beneficiaries to receive a sufficient size of land. Moreover, allowing for open access to land markets increases efficiency in rural production, but may induce a decline of human capital formation over time due to socially adverse land sales. This may cause the failure of the reform. Therefore, beneficiaries of land reforms ought not to be allowed to sell land for a particular period of time; land purchases, however, should not be restricted.

The remainder of the paper is organized as follows. In the next section we outline the relation to the literature. Section 3 introduces the model. Section 4 gives a comprehensive analysis of how a successful land reform must be designed, without the land market, and which consequences the reform may have referring to transition and inequality. In section 5, the implications of the access to land markets are identified. Section 6 concludes.

2 Relation to the Literature

Our paper is related to several strands of literature. Our focus on human capital goes back to Galor and Zeira (1993).[6] In an environment where the capital market is imperfect and human capital investment is indivisible, the distribution of wealth affects the macro-economic outcome as households with too low wealth do not invest in human capital. This link also appears in our model. For developing countries,

[6] See also Birchenall (2001), Eicher and García-Peñalosa (2001), Swinnerton and Rogers (1999), Sylwester (2000), Viaene and Zilcha (2001), or Aghion, Caroli, and García-Peñalosa (1999).

Deininger and Olinto (2000) and Bigsten and Levin (2000) state that large inequality of asset distribution, for instance of land, seems harmful for growth due to credit rationing. Our results suggest that temporary inequality of land holdings and income is necessary for inducing growth.

There exist only a few recent models on land reforms. Bell (2003) and Gersovitz (1976) stress that the effect of land reforms on aggregate output and factor prices are ambiguous and depend on particular conditions. Contrary to our work, these analyses are static. Dasgupta and Ray (1986, 1987) and Ray and Streufert (1993) show that unemployment and undernourishment may be rooted in the inequality of the initial land ownership. This suggests that land reforms can mitigate unemployment and undernourishment. Similar to our results, they find that small land transfers will have no long-term effect. Moene (1992) also emphasizes the connection between labor productivity and nourishment, i.e. income, but demonstrates that via general equilibrium effects land reforms may only reduce poverty in countries where land is scarce. Finally, within a cooperative game theory approach, Horowitz (1993) considers a model where the agents can decide to accept a land reform proposal or enter a conflict. Similar to our results, the optimal reform consists of a sequence of redistributions. However, while Horowitz aims on preventing social conflict, we aim on overcoming poverty traps and describe how the sequence of redistributions should be designed, so that both works complement each other. Moreover, our work is the only analysis that emphasizes the positive *dynamic effects* that land reforms may provide, namely human capital formation that provides growth. Hence, our objective goes beyond generating a more egalitarian distribution of landownership.

Discussions of the main issues in the context of land reforms have been dealt with in excellent survey articles, for example by Banerjee (1999), Deininger (1999), de Janvry and Sadoulet (1996), Lundberg and Squire (1999), Conning and Robinson (2001), Deininger and May (2000). This literature suggests that access to assets like land improves the access to credit markets, because land can be used as collateral, can provide benefits as an insurance to consumption fluctuations and enables the poor to undertake indivisible productive investments.[7] Overall, land reforms should improve equity, efficiency and hence aggregate growth. Our analysis suggests that only a sequence of

[7]These include human capital investments and productive assets like wells, bullocks etc. The lack of collateral makes it impossible to undertake even highly profitable investments, therefore poverty persists.

partial land transfers with barriers to selling land can deliver the gains associated with such a reform.

There is also a vast number of empirical studies reviewing historical experiences of land reforms [see Benjamin and Brandt (2000), Deininger (1999), Deininger and Feder (1998), Díaz (2000), Alston, Libecap, and Mueller (2001, 1999), or Fearnside (2001)]. Attwater (1997), Deininger and Feder (1998), Fearnside (2001), and Platteau (1992) stress the importance of the role of well-defined property rights and identify advantages of some communally-owned property. Finally, new types of land reforms are discussed by Besley and Burgess (2000), Banerjee (1999), and Deininger (1999). Key sources of land reform failure have been imperfect capital, insurance and land markets which led to insufficient investments, made macroeconomic shocks very dangerous for land reform beneficiaries and forced corresponding distress sales. Additionally, beneficiaries' lack of knowledge about agriculture reinforced the danger of failure. We demonstrate that, even without distress sales, open access to land sales markets endangers the success of the land reform as a whole.

3 Model

Our model builds on Uzawa (1965), Lucas (1988), Basu (1999), and Bell and Gersbach (2001). It is also related to the dual economy developed by Drazen and Eckstein (1988). There are two sectors producing a common single (high aggregated) consumption good.[8] As we analyze developing countries, we neglect capital markets in modeling the credit constraints faced by the poor (imperfect capital market). Consider an OLG structure in which individuals live for two periods: childhood and adulthood. Each generation consists of a continuum of households represented by interval $[0, 1]$. Each individual gives birth to one child. Thus, each household is a family comprising one adult and one child. Each individual is endowed with one unit of time. Human capital has to be formed in childhood. Let the portion of childhood devoted to education in period t be denoted by $e_t \in [0, 1]$. The residual time, $1 - e_t$, is used for child labor. Adults spend all their time working.

[8] Similarly, one could consider that both sectors produce goods which are perfect substitutes for each other.

3.1 Human Capital and Consumption Good Production

3.1.1 Human Capital Formation

An adult $i \in [0,1]$ possesses λ_{it} efficiency units of labor in period t, where $\lambda \geq 1$ is a natural measure of an adult's human capital. $\lambda = 1$ represents pure, unskilled labor. Human capital is formed in childhood by schooling. Additionally, in the course of rearing a child, the adult provides the child with a certain capacity to build human capital for adulthood, and thus enforces the effect of schooling. We assume that this additional effect increases with the level of the parents' human capital λ_{it}. Let $h(e_{it})$ measure the effect of school attendance e_{it} on human capital formation, when household i's adult is uneducated, i.e., when $\lambda_{it} = 1$. $h(e_{it})$ is assumed to be a continuous, increasing and differentiable function on $[0,1]$, i.e. $h'(e_t) > 0$ for all $e_t \in [0,1)$. We suppose $h(0) = 0$. Correspondingly, the child's endowment of efficiency units of labor on reaching adulthood at time $t+1$ is given by the following difference equation:

$$\lambda_{i(t+1)} = h(e_{it})\lambda_{it} + 1 \tag{1}$$

Equation (1) in combination with assumption $h(0) = 0$ implies that $\lambda_{i(t+1)} = 1$, unless $e_{it} > 0$.

3.1.2 Consumption Good Production

Let there be one high aggregated consumption good that is produced in two sectors, which are labeled by $j = (1,2)$. Sector 1 is a land-based sector, such as agriculture, producing the aggregated output good solely using land and effective labor (human capital). We assume that all farms are family-based. Moreover, family farmers cannot work simultaneously part-time in sector 2. Hence, labor is segmented into landless workers in sector 2 and the family farm group.[9] Household i's, $i \in [0,1]$, possession of land in period t is denoted by n_{it}. Besides the adult's level of human capital λ_{it}, each child is endowed with human capital of level $\gamma \in (0,1)$. Thus, the total supply of effective labor (human capital) of a single household i is $[\lambda_{it} + (1-e_{it})\gamma]$. The output

[9] We assume in particular that it will not be worthwhile to employ day-laborers in sector 1 or being a family farmer to work as day-laborer in sector 2 part-time because there exist prohibitive frictions in developing countries in transporting oneself from one sector to the other. Furthermore, the amount of land a family owns may not so large that day-laborers could earn more income in sector 1 than in the non-agrarian sector; the corresponding sufficient condition is given in footnote 15. A justification of the assumption can be found in Gersovitz (1976, p. 84).

in period t per household i, denoted by y_{it}^1, is described by the following production function with constant returns to scale:[10]

$$y_{it}^1 = A_1 \left[\lambda_{it} + (1 - e_{it})\gamma\right]^{\alpha} \cdot (n_{it})^{1-\alpha} \tag{2}$$

with A_1 representing the technical status quo of the sector and $\alpha \in (0, 1)$ being the production elasticity of the human capital input.

The second sector is solely human capital-based and represents a non-land-based technology (industry & service sector). Let there be a proportional relationship between output and input of effective labor. A_2 represents the fixed productivity of a unit of effective labor. Then output per household i in period t, labeled y_{it}^2, is given by:

$$y_{it}^2 = A_2[\lambda_{it} + (1 - e_{it})\gamma] \tag{3}$$

We denote income of household i that is located in sector j in period t by w_{it}^j. Thus, neglecting any production costs, we arrive at:

$$w_{it}^j = y_{it}^j \tag{4}$$

3.2 Household's Behavior

3.2.1 Consumption and Education

Due to imperfect capital markets, households cannot raise loans, i.e. poor households do not receive credit for the education of their children. This assumption is standard and justified by the theory of credit rationing [cf., for instance, Baland and Robinson (2000); Basu (2003), chap. 13; Bell (2003), chap. 15; Ranjan (2001); Ray (1998), chap. 14]. Furthermore, let there be no other form of bequest than land.[11] Following Ray and Streufert (1993), we assume that upon the decease of the adult the child inherits the household's land. The inter-generational transfer via child rearing and education e_{it} are other forms of gifts. The household's allocative decision is determined by the household's adult. The adult's decision concerning consumption and education is determined by utility maximization. The level of utility of adult i in period t is

[10] Deininger and Feder (1998), p. 16, report that a large number of empirical studies were unable to reject the hypothesis of constant returns to scale in agricultural production.

[11] Baland and Robinson (2000) and Ranjan (2001) discuss credit constraints and bequests in the context of child labor. On page 665, Baland and Robinson remark that ".. the importance of the nonnegativity constraints on both bequests and savings arises from capital market imperfection."

denoted by u_{it}. Without loss of generality we neglect the child's consumption in our analysis. We assume that the adult i's utility is determined by the period's consumption of the aggregated good c_{it} (where it does not matter whether the good unit stems from sector 1 or 2) and by the level of education of the child, i.e. $u_{it} = u(c_{it}, e_{it})$. We assume that adults have identical convex preferences that satisfy the usual assumptions of positive but decreasing marginal utility and non-satiation. Moreover, we assume that the child's schooling time e_{it} spends utility to the adult i. Hence there is a certain degree of altruism that determines the time-allocation decision for the child. Obviously, since child labor contributes to the household's income, education causes income losses and household's consumption in period t is maximized by choosing $e_{it} = 0$. In order to opt for $e_{it} > 0$, the altruistic tie between child and parent must, therefore, be sufficiently strong. It will turn out that this description of preferences suffices, and further details would only ballast our analysis unnecessarily.[12] The household's budget constraint in sector j (under consideration of non-satiation) is:

$$c_{it} = w_{it}^j$$

In sector 1, the household's income is given by $w_{it}^1 = w^1(n_{it}, \lambda_{it}, e_{it})$ and in sector 2, we have $w_{it}^2 = w^2(\lambda_{it}, e_{it})$. Therefore, the resulting household's demand, denoted by (e_{it}^o, c_{it}^o), is in sector 2 solely determined by the level of the adult's human capital λ_{it}, and in sector 1 additionally by the level of land ownership n_{it}. Equations (2) and (3) demonstrate that schooling lowers household income. The marginal opportunity cost of education is, in sector 1, equal to $\alpha\gamma A_1(\frac{n_{it}}{\lambda_{it}+(1-e_{it})\gamma})^{1-\alpha}$, and in sector 2 equal to γA_2. We can now state that the highest possible consumption level, $\overline{c}$, (i.e. when $e^o = 0$) and the lowest possible consumption, $\underline{c}$, (i.e. when $e^o = 1$) are given by:

$$\overline{c}_{it}^j = \begin{cases} \overline{c}^1(n_{it}, \lambda_{it}) = A_1[\lambda_{it} + \gamma]^\alpha n_{it}^{1-\alpha} & \text{if } j = 1 \\ \overline{c}^2(\lambda_{it}) = A_2(\lambda_{it} + \gamma) & \text{if } j = 2 \end{cases} \tag{5}$$

$$\underline{c}_{it}^j = \begin{cases} \underline{c}^1(n_{it}, \lambda_{it}) = A_1\lambda_{it}^\alpha n_{it}^{1-\alpha} & \text{if } j = 1 \\ \underline{c}^2(\lambda_{it}) = A_2\lambda_{it} & \text{if } j = 2 \end{cases} \tag{6}$$

We assume that both goods are non-inferior. Hence an increase in land property (in sector 1) and in human capital, *ceteris paribus*, increases the household's income. Then it is plausible to assume that there are two consumption thresholds, denoted by c^a and c^S, in the following way. As long as the household's budget does not allow consumption

[12] This type of preferences were also used in Galor and Zeira (1993) and Basu and Van (1998).

c_{it} higher than c^S, the adult chooses full-time child labor and the child does not attend school at all: $e_{it} = 0$. However, once $c_{it} > c^S$ is affordable the child will attend school at least part-time; in particular, $e_{it} > 0$ only occurs if $\overline{c}_{it}^j > c^S$. Finally, if the household can afford a consumption level of $c_{it} \geq c^a$, then the child will attend school full-time and the child does not have to work: $e_{it} = 1$. This means in particular that $\underline{c}_{it}^j \geq c^a$.

The degree of this specific form of altruism increases when these thresholds fall. Given the strength of altruism of the household's parent towards the child, in sector 2, these thresholds are solely determined by the parent's level of human capital. Notice that the optimal demand of a household's adult in sector 2 is hence described by:

$$(c_{it}, e_{it}) = \begin{cases} (\overline{c}^2(\lambda_{it}), 0) & \text{for all} \quad \lambda_{it} \leq \lambda^S \\ (c_{it}^o, e_{it}^o) & \text{for all} \quad \lambda^S < \lambda_{it} < \lambda^a \\ (\underline{c}^2(\lambda_{it}), 1) & \text{for all} \quad \lambda_{it} \geq \lambda^a \end{cases} \tag{7}$$

where the locus (c_{it}^o, e_{it}^o) is increasing in λ_{it} for all $\lambda_{it} \in (\lambda^S, \lambda^a)$, and $\lambda^S = \frac{c^S}{A_2} - \gamma$ and $\lambda^a = \frac{c^a}{A_2}$. In sector 1, income is determined by the adult's level of human capital and land ownership simultaneously. Referring to the optimal choice, our assumptions imply:

$$(c_{it}, e_{it}) = \begin{cases} (\overline{c}_{it}^j, 0) & \text{if} \quad \overline{c}_{it}^j \leq c^S \\ (c_{it}^o, e_{it}^o) & \text{if} \quad \overline{c}_{it}^j > c^S \quad \text{but} \quad \underline{c}_{it}^j < c^a \\ (\underline{c}_{it}^j, 1) & \text{if} \quad \underline{c}_{it}^j \geq c^a \end{cases} \tag{8}$$

where the locus (c_{it}^o, e_{it}^o) is, *ceteris paribus*, increasing in λ_{it} and n_{it}, as long as $\overline{c}_{it}^j > c^S$ but $\underline{c}_{it}^j < c^a$. There exist certain levels of human capital with which the household must be endowed in order to choose $e_{it}^o > 0$ or $e_{it}^o = 1$, given a particular property of land, n_{it}. This is made clear in figure 1. We state:

$$(c_{it}, e_{it}) = \begin{cases} (\overline{c}^1(n_{it}, \lambda_{it}), 0) & \text{for all} \quad \lambda_{it} \leq \lambda^S(n_{it}) \\ (c_{it}^o, e_{it}^o) & \text{for all} \quad \lambda^S(n_{it}) < \lambda_{it} < \lambda^a(n_{it}) \\ (\underline{c}^1(n_{it}, \lambda_{it}), 1) & \text{for all} \quad \lambda_{it} \geq \lambda^a(n_{it}) \end{cases} \tag{9}$$

with $\lambda^S(n_{it}) = \left(\frac{c^S}{A_1(n_{it})^{1-\alpha}}\right)^{1/\alpha} - \gamma$ and $\lambda^a(n_{it}) = \left(\frac{c^a}{A_1(n_{it})^{1-\alpha}}\right)^{1/\alpha}$; the locus (c_{it}^o, e_{it}^o) increases in λ_{it} for all $\lambda_{it} \in \left(\lambda^S(n_{it}), \lambda^a(n_{it})\right)$ and in n_{it}, respectively, *ceteris paribus*. Note that for sufficiently high n_{it}, also for $\lambda_{it} = 1$, the household's consumption crosses c^S so that $e_{it}^o > 0$ is chosen. Hence, for $\lambda^S(n_{it}) < 1$, no lower threshold exists. Additionally, with high enough n_{it}, even $e_{it}^o = 1$ is chosen for all levels of $\lambda_{it} \geq 1$ (i.e.

$\lambda^a(n_{it}) \leq 1$). We define the corresponding levels of land, given a certain level of human capital, by $n^S(\lambda_{it})$ and $n^a(\lambda_{it})$ respectively:

$$n^S(\lambda_{it}) = \left[\frac{c^S}{A_1(\lambda_{it}+\gamma)^\alpha}\right]^{\frac{1}{1-\alpha}} \quad (10)$$

$$n^a(\lambda_{it}) = \left[\frac{c^a}{A_1(\lambda_{it})^\alpha}\right]^{\frac{1}{1-\alpha}} \quad (11)$$

We obtain:

$$\begin{aligned} \tfrac{d\,n^a(\lambda_{it})}{d\,\lambda_{it}} < 0, \quad \tfrac{d\,n^S(\lambda_{it})}{d\,\lambda_{it}} < 0 \\ \tfrac{d\,\lambda^a(n_{it})}{d\,n_{it}} < 0, \quad \tfrac{d\,\lambda^S(n_{it})}{d\,n_{it}} < 0 \end{aligned} \quad (12)$$

That is, land transfers lower the level of human capital required for the adult choosing $e_{it} > 0$ or $e_{it} = 1$. Therefore, land transfers may increase schooling.

3.2.2 Location and Migration

Finally, we must analyze the household's sector choice. We assume that the migration decision solely depends on sectoral income comparison, given the household's endowment with land, n_{it}, and human capital, λ_{it}. Households move without cost between the sectors. In a single period, it is impossible to work in both sectors. If a household does not possess any land, it must work in sector 2. For very small plots of land agriculture output is very low. Therefore the fully uneducated only opt for agriculture if the following holds:[13]

$$n_{it} > \left(\frac{A_2}{A_1}\right)^{\frac{1}{1-\alpha}}(1+\gamma) \equiv \tilde{n} \quad (13)$$

If sufficient land is possessed the children of a lineage in sector 1 will enjoy a basic education ($e_{it} = 1$) and human capital will be accumulated over time. Due to decreasing marginal returns in sector 1, sector 2 may again turn out to be an attractive alternative for educated households. Given $e_{it} = 1$ and the assumption that land becomes valueless once sector 1 is left,[14] a household i will opt for sector 2 as soon as its level of human capital fulfills:

$$\lambda_{it} > \left(\frac{A_1}{A_2}\right)^{\frac{1}{1-\alpha}} \cdot n_{it} \equiv \tilde{\lambda}(n_{it}) \quad (14)$$

[13]Note that the poorest parents display $\lambda = 1$ and choose $e = 0$.

[14]Later on it will become clear why we restrict ourselves to this scenario.

That is, once a household has accumulated more than $\tilde{\lambda}(n_{it})$, human capital intensity per unit of land, $\frac{\lambda_{it}}{n_{it}}$, is so high that a sector change becomes profitable.[15]

3.3 Dynamics

The dynamics described here are equal for all households and we drop index i. It will turn out that the specific pattern of the dynamics is not crucial for our results. Hence we here only outline the pattern of dynamics.[16]

3.3.1 Sector 1

To establish the dynamics in sector 1, we have to analyze (1) in the light of (9):

$$\lambda_{t+1} = \begin{cases} 1 & \forall\, \lambda_t \leq \lambda^S(n_t); \\ h(e^o(n_t, \lambda_t))\lambda_t + 1 & \forall\, \lambda_t \in (\lambda^S(n_t), \lambda^a(n_t)); \\ h(1)\lambda_t + 1 & \forall\, \lambda_t \geq \lambda^a(n_t). \end{cases} \tag{15}$$

For our analysis, we assume $h(1)\lambda^a(n_t) + 1 > \lambda^a(n_t)$, that is, one period of full-time schooling suffices for the child, once grown up, to choose full-time schooling. The dynamics depends on the curvature of $h(e_t^o(\cdot))$, i.e. on the curvature of the demand $e^o(\cdot)$ and on the curvature of $h(e_t)$. The size of estate n_t is determined exogenously by the policy maker and therefore assumed to be constant in the course of time.

The main paths of the difference equation are illustrated in figures 1 to 6. Suppose, for instance, a household possesses land of size n_t and displays $\bar{c}_t^1 < c^S$. From the latter it directly follows that $\lambda_t < \lambda^S(n_t)$. Thus, $e_t = 0$ is chosen, which causes $\lambda_{t+1} = 1$. Therefore there is a poverty trap at $\lambda = 1$. Let there also be a medium steady state at a level λ^* as in figure 3 or 6, so that the poverty trap area, from which we are trying to escape from, is the interval $\lambda \in [1, \lambda^*(n)]$. Demand e_t^o monotonously increases in λ_t and for $\lambda_t \geq \lambda^a(n_t)$ we obtain $e_t^o = 1$. Then growth rate $\frac{\lambda_{t+1}-\lambda_t}{\lambda_t}$ is given by $(h(1) - 1) + \frac{1}{\lambda_t}$ and the output growth rate by $\left(h(1) + \frac{1}{\lambda_t}\right)^\alpha - 1$. Therefore, following AK models, long-term growth is achievable if $h(1) \geq 1$, wherefore we refer to this case as the *growth-case*. Otherwise, $h(1) < 1$, the economy converges, independent of its starting point, to a steady state with per-capita growth rates of zero. If full-time schooling

[15] Coming back to our assumption that it is not worthwhile to employ day-laborers in sector 1, neglecting any fixed cost or frictions, we assume that $A_2 \geq A_1\lambda_{it}^\alpha n_t^{1-\alpha}\left[((\lambda_{it}+1)/\lambda_{it})^\alpha - 1\right]$.

[16] A detailed description of the dynamics in sector 1 is performed in appendix C; for sector 2, the detailed dynamics were provided in Bell and Gersbach (2001) and Siemers (2005).

is chosen, the economy converges to a high-income steady state at $\lambda = \frac{1}{1-h(1)}$, as a developed economy. The task of a land reform will be to enable supported households to end up in this high-income steady state or with long-term growth. Notice that graphically the size of $h(1)$ decides on whether the linear part of the trajectory runs above the 45°-line or has a point of intersection. In the case that there is a point of intersection, this point represents the high-income steady state at $\lambda = \frac{1}{1-h(1)}$. The situation of a backward adult ($\lambda = 1$) who receives sufficient land such that full-time basic schooling is chosen is depicted in figure 5.

3.3.2 Sector 2

Combining equation (1) with (7) we arrive at:

$$\lambda_{t+1} = \begin{cases} 1 & \forall\, \lambda_t \leq \lambda^S; \\ h(e_t^o(\lambda_t))\lambda_t + 1 & \forall\, \lambda_t \in (\lambda^S, \lambda^a); \\ h(1)\lambda_t + 1 & \forall\, \lambda_t \geq \lambda^a. \end{cases} \tag{16}$$

In view of the (plausible) assumption that $\lambda^S > 1$, it follows from the first part of (16) that the state of backwardness ($\lambda = 1$) is a locally stable, low-income steady state, establishing a poverty trap. We assume $h(1)\lambda^a + 1 > \lambda^a$ and concentrate on cases where there exists at least one medium steady state. Thus, the dynamic system has at least two steady states, namely a particular $(\lambda^*, e^o(\lambda^*))$ and $(1, 0)$, where the former is unstable and the latter again represents the locally stable poverty trap. The reader can consider the convex trajectory illustrated by figure 6.

As in sector 1, $h(1)$ determines whether we can obtain long-term growth. In the case of $h(1) < 1$, the highest stationary state is again characterized by $\lambda = \frac{1}{1-h(1)}$. Overall, it is important for our analysis to notice the following growth patterns:

Growth Patterns

(i) Consider a household i with $e_{it} = 1$ in sector 1. If $h(1) \geq 1$, the level of human capital per capita will grow asymptotically with $h(1) - 1 > 0$ infinitely. Agriculture output per capita will grow asymptotically with $[h(1)]^\alpha - 1 > 0$. Otherwise, $h(1) < 1$, the household will end up in the steady state at $\lambda = \frac{1}{1-h(1)}$ where both growth rates are equal to zero.

(ii) *Consider a household i with $e_{it} = 1$ in sector 2. If $h(1) \geq 1$, the human capital per capita and the output per capita will grow asymptotically with $h(1) - 1 > 0$. Otherwise, $h(1) < 1$, the household will end up in the steady state at $\lambda = \frac{1}{1-h(1)}$ where both growth rates are equal to zero.*

Thus, our growth model allows for "neoclassical convergence" as well as for long-term growth patterns.[17] We denote growth rates by g_k with k representing the variable considered.

4 Land Reforms without Land Markets

Bell and Gersbach (2001) propose a tax-and-subsidy scheme to overcome child labor and poverty. Many under-developed countries are, at least in rural areas, not endowed with an effective infrastructure to collect taxes and to pay subsidies. Hence, land reforms may represent an effective alternative, especially in agrarian economies. Therefore, we analyze how land reforms can be designed in order to overcome under-development due to human capital accumulation. This allows for the amount of poverty, illiteracy and child labor to diminish. We start with the situation where land markets do not exist. The whole country's endowment of suitable land is denoted by N. Let there be a social planner who is free to distribute land N among the society. To enjoy the fruits of growth as soon as possible, the aim of the social planner is to educate the society as fast as possible. Formally, we define:

Definition 1
A society is educated in a particular period $t = T$, if there exists a land distribution $\{n_{it}\}_{i=0}^{1}$ such that all households in sector 1 display $\lambda_{it} \geq \lambda^a(n_{it})$ and all households in sector 2 $\lambda_{it} \geq \lambda^a$.

The sequence of events is as follows: At the beginning of a period t, an adult i is endowed with human capital λ_{it} and land n_{it}. A household i may or may not be

[17] In the intensive form with $e_t = 1$, we obtain in sector 1 $\frac{y_t^1}{n_t} = A_1(\frac{\lambda_t}{n_t})^\alpha$. If the individual land property n_t is fixed, we obtain $\frac{y_t^1}{n} = \tilde{A}_1 \cdot \lambda_t^\alpha$ with $\tilde{A}_1 = \frac{A_1}{n^\alpha}$ and $\lambda_{t+1} = h(1)\lambda_t + 1$. The output per household and square-meter soil increases infinitely with growth rate $g_{(\frac{y}{n})} = g_y - g_n = [h(1)]^\alpha - 1 > 0$, if $[h(1)]^\alpha > 1$. Thus the size of the term $[h(1)]^\alpha$ decides upon long-term growth (AK model) or long-term steady state (Solow-Swan). If n_t is individually variable (via a land market) we obtain a two factor model with an optimal relation between λ_t and n_t, similar to the broadly defined capital concept (cf. Barro and Sala-i-Martin (1995), Section 5.1.1). This case is dealt with in section 5.

selected as a beneficiary of the land reform. As a beneficiary the household receives a plot of land of size $\overline{n}_{it} > 0$. If not selected, it may be forced to donate land of size $n^{\tau}_{it} \geq 0$ to the state for redistribution (dispossession); in this case, we have $\overline{n}_{it} = -n^{\tau}_{it} < 0$. If some land is seized, the remaining plot is of size $n_{it} - n^{\tau}_{it}$. After land redistribution, all adults $i \in [0, 1]$ decide in which sector they will work, on consumption c_{it} and on the child's education e_{it}. This cycle is repeated until the aim of the land reform is accomplished.

Since the social planner redistributes land in each period t, we have, in effect, a property right system that is comparable to a system called "leasehold in judicial terms", but without charging any lease: a household obtains land and receives full property rights. However, after a particular span of time, or when the household does not use the land, it may all or in part fall back to the state.[18]

4.1 The Optimal Land Reform without a Land Market

In order to educate a society as fast as possible, it is *a priori* not clear which land transfers are "optimal". To define our concept of optimal land reforms, we assume that the size of land transferred to a beneficiary i in period t, $\overline{n}_{it}$, fulfills $e^o(\lambda_{it}, n_{it}+\overline{n}_{it}) = 1$.[19] The assumption is based on Bell and Gersbach (2001) and Siemers (2005), who provide social welfare analyses concerning the education of a society for models like ours and deduce that full-time schooling of beneficiaries is optimal, at least at the beginning. The necessary size of land, denoted by $n^a(\lambda_{it})$, is given by equation (11) above. Hence, having been allocated land of size $n^a(\lambda_{it})$ the household decides to educate the child full-time. We denote the period in which a household receives a land gift by $\bar{t}$. The next period's level of human capital is thus given by:

$$\lambda_{i(\bar{t}+1)} = h(1)\lambda_{i\bar{t}} + 1 \tag{17}$$

Choosing $n^a(\lambda_{it})$ means turning λ_{it} into $\lambda^a(\overline{n}_{it})$, so that we end up in a situation illustrated by figure 5. Since $h(1)\lambda^a(n_{it}) + 1 > \lambda^a(n_{it})$, we know that, *ceteris paribus*, continuous human capital accumulation is ensured. Therefore, beneficiaries' incomes will continuously grow over time. Hence, for all households that received plots in

[18]That is, the social planner determines the distribution of land at the beginning of each period anew. Recall that in our model a period is the complete productive life of an adult.

[19]Deviating from this assumption does not change the basic results given in the conclusions.

a period $\bar{t}$, we obtain $w^1_{i(\bar{t}+1)} = \underline{c}^1_{i(\bar{t}+1)} > c^a$, which allows for a "taxation" of size $\underline{c}^1_{i(\bar{t}+1)} - c^a > 0$. Overall, this fact allows taxation via expropriations of all previous beneficiaries of size $\underline{c}^1_{it} - c^a$ per household. Thus, in each period, we have to check how much land the already supported households still require for sustaining full-time schooling, and dispossess the rest. This tax in the form of land is denoted by $n^{\tau}_{it}(\lambda_{it})$:

$$n^{\tau}_{it}(\lambda_{it}) = \max\{0, n_{it} - n^a(\lambda_{it})\} = \max\left\{0, n_{it} - \left(\frac{c^a}{A_1 \lambda^{\alpha}_{it}}\right)^{\frac{1}{1-\alpha}}\right\} \tag{18}$$

where the case $n^{\tau}_{it}(\lambda_{it}) = 0$ holds for all the households not yet supported. For all others the remaining plot of land of size $n_{it} - n^{\tau}_{it}(\lambda_{it})$ is exactly equal to $n^a(\lambda_{it})$. The seized land is free to be redistributed to the poor anew.

Consider the worst case where initially, i.e. in period $t = 0$, all households live in a state of backwardness, i.e., $\lambda_{i0} = 1$ and $n_{i0} = 0$ for all $i \in [0, 1]$. We denote the fraction of the society as yet allocated with land by μ_t. Hence, $\mu_t - \mu_{t-1}$ represents the fraction of households allocated land by the social planner in period t. We define:

Definition 2
The optimal land reform is characterized by a sequence of land redistributions, given by $\left\{\{\overline{n}_{it}\}^1_{i=0}\right\}^{T-1}_{t=0}$, *that fulfill:*

(i) $\lambda_{iT} \geq \lambda^a(n_{iT})$, *respectively* $e^o_{iT} = 1 \quad \forall i \in [0, 1]$

(ii) $\int_0^1 \overline{n}_t(i)\, di = N$ *for* $t = 0$ *and* $\int_0^1 \overline{n}_t(i)\, di = 0 \quad \forall t = 1, \ldots, T-1$

(iii) $\left\{\overline{n}_{it} = n^a(\lambda_{it}) \quad \forall i \in (\mu_{t-1}, \mu_t]\right\} \quad \forall t$ *with* $\mu_{-1} \equiv 0$

(iv) There does not exist any other sequence $\{\{\overline{n}_{it}\}^1_{i=0}\}^{T'-1}_{t=0}$*, with* $T' < T$*, that fulfills the three conditions above.*

Condition *(i)* requires that in period T all households are endowed with sufficient human capital such that full-time schooling for the children results. Condition *(ii)* is the land resource constraint and condition *(iii)* states that all beneficiaries have to be allocated with exactly sufficient land to enable full-time schooling for the child; transferring more land represents a waste of resources. Finally, condition *(iv)* requires that there exists no other dynamic land redistribution scheme that allows the education of the society in a shorter span of time. We can state:[20]

[20]Since we have assumed that $n^a(\lambda_{it})$ is allocated to the beneficiaries, we have a *constrained optimal* concept of land reforms.

Proposition 1

There exists an optimal dynamic land redistribution scheme $\{\{\overline{n}_{it}\}_{i=0}^{1}\}_{t=0}^{T-1}$. *The education of a society is feasible in finite time, i.e.* $T < \infty$.

The proposition is proved in the appendix. The essential features of the optimal land reform are as follows. Educated households can be dispossessed as long as this dispossession of land does not endanger the full-time schooling of the household's child; this ensures the maximum amount of land to be distributed to the so far uneducated. This land has to be distributed to as many households as possible, given the constraint that each single supported household establishes the optimal level of schooling for the household's child. This ensures the fastest possible education process. As this policy scheme generates continued human capital accumulation, the number of educated households grows from period to period so that in a particular period $T < \infty$ the society is educated. Note that the optimal scheme is indeterminate in the following sense: it does not matter which particular uneducated household i is selected as a beneficiary in a particular period t. Notice also that the initial equality of income and human capital of the poor will be disturbed. The creation of inequality is in addition a necessary condition to escape backwardness. This issue is further highlighted in the next section.

4.2 Migration, Transition and Inequality

A land reform beneficiary has land of size $n^a(\lambda_{it})$ in each period, i.e., sector 1 income is c^a. A beneficiary is indifferent between sector 1 and sector 2 if $A_2\lambda_{it} = c^a$, so that $\tilde{\lambda} = \frac{c^a}{A_2} = \lambda^a$ is the critical threshold value. If $\lambda_{it} > \tilde{\lambda}$, the household will switch to sector 2. Accordingly we find:

Proposition 2

Each beneficiary of the land reform alike stays for l *periods in sector 1 before it switches sectors, where* l *is determined by:*

$$\min_{l>0} \sum_{k=0}^{l} [h(1)]^k > \lambda^a$$

Proposition 2 follows directly from combining equation (14), $\tilde{\lambda} = \lambda^a$, and equation (39) in the appendix. A migration equilibrium prevails, if no household has an incentive to switch sectors. Let a_{it} denote the sector choice of household i. The variable a_{it} takes the value 1 (0) if household i is located in sector 1 (2), respectively.

Proposition 3

Suppose that an optimal land reform is applied. Then there exists a migration equilibrium in period t with:

$$a_{it}^* = \left\{ \begin{array}{ccccc} 1 & \textit{if} & \{\lambda_{it} < \lambda^a & \textit{and} & n_{it} > 0\} \\ 0 \textit{ or } 1 & \textit{if} & \{\lambda_{it} = \lambda^a & \textit{and} & n_{it} > 0\} \\ 0 & \textit{if} & \lambda_{it} > \lambda^a & \textit{or if} & n_{it} = 0 \end{array} \right\} \quad \textit{for all} \quad i \in [0,1]$$

The proof of the proposition is given in the appendix. Turning to the corresponding transition pattern, we have to distinguish the cases $h(1) \geq 1$ and $h(1) < 1$. In the latter case, long-term growth is not possible and there exists a high-level steady state at $\lambda = 1/(1 - h(1))$. Let us assume an optimal land reform has been accomplished and denote the period in which the last cohort of land reform beneficiaries reaches $\lambda = 1/(1 - h(1))$ by T^{ss} (in the case of $h(1) < 1$). Equivalently, a superscript "ss" indicates variables corresponding to the steady state. The general long-term migration calculus is illustrated by figure 7. We obtain:

Proposition 4

(i) Suppose $h(1) < 1$. In the steady state, we obtain:

$$a_i^{ss} = \left\{ \begin{array}{ccc} 1 & \textit{if} & \lambda_{i(T-1)} < \left[\lambda^a \big(1 - h(1)\big)^{1-\alpha}\right]^{\frac{1}{\alpha}} \\ 0 & \textit{if} & \lambda_{i(T-1)} > \left[\lambda^a \big(1 - h(1)\big)^{1-\alpha}\right]^{\frac{1}{\alpha}} \\ 0 \textit{ or } 1 & \textit{if} & \lambda_{i(T-1)} = \left[\lambda^a \big(1 - h(1)\big)^{1-\alpha}\right]^{\frac{1}{\alpha}} \end{array} \right.$$

(ii) Suppose $h(1) \geq 1$. Then all households will, asymptotically, leave sector 1 and end up in sector 2, that is, $a_{it} = 0$ for all $i \in [0,1]$, when $t \to \infty$.

The proof is given in the appendix. In the case where $h(1) < 1$, at the end, all households have the same level of human capital. Hence, the size of land determines sector location. The size of estate, in turn, is determined by the social planner via formula (11). It follows that households with low human capital in period $T - 1$ (the last period in which land is redistributed) have much land, and therefore earn a higher income in sector 1. However, in the case where $h(1) \geq 1$, the level of human capital increases infinitely and therefore always crosses the migration threshold.

If $h(1) \geq 1$ a household's level of human capital will grow infinitely with rate $h(1)+1/\lambda_t$. As this rate diminishes with λ_t all households will have the same level of human capital in period $t \to \infty$ (convergence). Additionally, we have shown that all households will end up in sector 2. Hence, the required inequality will disappear at the end. In the case of $h(1) < 1$, all households' levels of human capital are equal to the steady state level, given by $\lambda = 1/(1-h(1))$. That is, at the end, there will be income equity among the households in sector 2. However, if some cohorts are located in sector 1, the existing inequality of land ownership will cause income inequality in sector 1. Moreover, in the steady state, sector 1 income will only be equal to the income in sector 2 if the owned plot of land is equal to $n_i^{ss} = 1/(1-h(1)) \cdot (A_2/A_1)^{1/(1-\alpha)}$. This happens for at most one cohort of beneficiaries. It follows that in the case of $h(1) < 1$, inequality is likely to persist in the long-term.

5 The Effects of Open Access to Land Markets

The purpose of this section is to examine whether or not to allow beneficiaries of land reforms access to the land market.

5.1 The Demand for Land and Land Market Equilibrium

Suppose that there is a competitive land market where beneficiaries can sell or buy land at the given land market price, labeled q_t. Since all households are initially landless and imprisoned in the poverty trap, only land reform beneficiaries can be located in sector 1. Land transfers induce full-time schooling. Consequently, all households in sector 1 choose $e_{it} = 1$. The household optimization now involves the gross demand for land in sector 1, which we denote by n_{it}^d. Since land *per se* does not spend utility, the utility maximizing level of land input n_{it}^d is equivalent to the income maximizing level of n_{it}^d. The optimal demand for land in sector 1 is determined by:[21]

$$\max_{\{n_{it}^d\}} \; w_{it}^1 = A_1(\lambda_{it})^\alpha (n_{it}^d)^{1-\alpha} - q_t(n_{it}^d - n_{it})$$

We obtain:

$$n^d(q_t, \lambda_{it}) = \left(\frac{(1-\alpha)A_1}{q_t}\right)^{\frac{1}{\alpha}} \lambda_{it} \tag{19}$$

[21] Recall that the social planer determines the distribution of land at the beginning of each period anew.

$$\frac{\partial\, n^d(q_t,\lambda_{it})}{\partial\,\lambda_{it}} > 0 \quad , \quad \frac{\partial\, n^d(q_t,\lambda_{it})}{\partial\, q_t} < 0 \tag{20}$$

If human capital is accumulated, this lowers the marginal productivity of an efficiency unit of labor, and increases the productivity of land. The optimal land human capital ratio is given by $\frac{n^d_{it}}{\lambda_{it}} = \left(\frac{(1-\alpha)A_1}{q_t}\right)^{1/\alpha}$. If a household's level of human capital increases, it is, *ceteris paribus*, optimal to buy additional land on the land market, and *vice versa*. In accordance with our assumption of imperfect capital markets, we assume that poor households cannot raise credit to purchase a plot of land.[22] Consequently, poor households that are not beneficiaries of the land reform, are excluded from agriculture, and thus cannot migrate to sector 1. The land market equilibrium price, denoted by q^*_t, is found by:

$$\int_{i=0}^{1} n^d\left(q^*_t, \lambda_t(i)\right)\, \mathrm{d}i \;=\; N \tag{21}$$

which can be simplified to

$$\int_{0}^{\mu_t} n^d_t(i)\, \mathrm{d}i = N, \tag{22}$$

since only land reform beneficiaries are able to demand or offer land. Substituting (19) we obtain:

$$q^*_t(\Lambda^1_t) = A_1(1-\alpha)\left(\frac{\Lambda^1_t}{N}\right)^{\alpha} \tag{23}$$

where $\Lambda^1_t = \int_0^{\mu_t} a_t(i)\lambda_t(i)\,\mathrm{d}i$ is the stock of human capital supplied in sector 1. Obviously Λ^1_t depends on migration, and we therefore analyze this mutual relationship in the next section. There is a direct positive correlation between the land price and human capital, given by $\frac{\partial q^*_t(\Lambda^1_t)}{\partial \Lambda^1_t} > 0$. Thus, all other things equal, the education of the society via a land reform continuously increases the land price. Substituting this equilibrium price into the land demand, we find:

$$\frac{n^d_{it}}{\lambda_{it}} = \frac{N}{\Lambda^1_t} \tag{24}$$

The higher the individual i's share of human capital stock in the land market, the higher the demand for land, since $\frac{\partial^2 y^1_{it}}{\partial n_{it}\partial\lambda_{it}} > 0$. The education of the society increases the degree of relative land scarcity.

[22] As beneficiaries of the land reform can use their existing plot of land as collateral to buy further land, we assume that they do not face constraints on land acquisition.

5.2 Land-Market-Cum-Migration-Equilibrium

To identify how Λ_t^1 is determined, we must again elaborate on when a household opts for a particular sector. In order for a household i to leave sector 1 in favor of human capital-based sector 2, the following condition must hold:[23]

$$q_t > (1-\alpha)\left(\frac{\alpha(A_1)^{1/\alpha}}{A_2}\right)^{\frac{\alpha}{1-\alpha}} \equiv \tilde{q} \tag{25}$$

At the "switch-threshold" a considered household earns identical income in both sectors and is indifferent between working in sector 1 or 2. In the case without land market access, we arrived at $\tilde{\lambda} = \lambda^a$. Consequently, as long as $\lambda_{it} < \lambda^a$, no beneficiary moves to town sector 2. However, with land market access, the household will receive additional income from the land sale if it emigrates to sector 2. A migration equilibrium is established when no household wishes to migrate from one sector to another. The migration equilibrium thus requires $q_t^* \leq \tilde{q}$.[24] Substituting land market equilibrium price (23) in (25), we arrive at:

$$\Lambda_t^1 > \left(\alpha\frac{A_1}{A_2}\right)^{\frac{1}{1-\alpha}} N \equiv \tilde{\Lambda}^1 \tag{26}$$

That is, given land market equilibrium, each single household opts to change to sector 2 as soon as the stock of human capital in sector 1 crosses level $\tilde{\Lambda}^1$. A land-market-cum-migration equilibrium therefore demands $\frac{\Lambda_t^1}{N} \leq \left(\alpha\frac{A_1}{A_2}\right)^{\frac{1}{1-\alpha}}$.

The land market equilibrium derived in subsection 5.1 is contingent on the human capital stock in agriculture, which is, in turn, contingent on migration. If the stock of skills crosses $\tilde{\Lambda}^1$, households will move to sector 2. The process of migration continues until there is no longer an incentive to move: migration lowers the net demand for land, and the land price diminishes to establish a land market equilibrium. A low enough land price, in turn, stops migration. This mutual adjustment of land market and migration equilibrium comes to an end when both equilibria are established simultaneously. Accordingly, we define

Definition 3

A simultaneous land market and migration equilibrium in period t is characterized by a tuple $\left\{q_t^*, \{a_{it}^*\}_{i=0}^{i=1}\right\}$ such that

[23] This condition is equivalent to $A_1(\lambda_{it})^\alpha(n_{it}^d)^{1-\alpha} + q_t^* \cdot (n_{it} - n_{it}^d) < q_t^* \cdot n_{it} + A_2\lambda_{it}$.

[24] Note that in the case of $q_t < \tilde{q}$, the assumption that the poor do not receive credit prevents the landless poor in sector 2 from being in a position to migrate to sector 1.

(i) $\int_0^1 n^d(q_t^*, \lambda_t(i))\, di = N$;

(ii) for $a_{it} = 1$, $n_{it}^* = n^d(q_t^*)$ and
for $a_{it} = 0$, $n_{it}^* = 0$;

(iii) $a_{it}^* = 1$ if $w_{it}^1(\lambda_{it}, q_t^*, n_{it}^*) > w_{it}^2(\lambda_{it}, q_t^*, n_{it}^*)$;
$a_{it}^* = 0$ if $w_{it}^1(\lambda_{it}, q_t^*, n_{it}^*) < w_{it}^2(\lambda_{it}, q_t^*, n_{it}^*)$; and
$a_{it}^* = 0$ or $a_{it}^* = 1$ if $w_{it}^1(\lambda_{it}, q_t^*, n_{it}^*) = w_{it}^2(\lambda_{it}, q_t^*, n_{it}^*)$.

where $w_{it}^1(\lambda_{it}, q_t^*, n_{it}^*) = A_1 \lambda_{it}^{\alpha} (n_{it}^*)^{1-\alpha} - q_t^*(n_{it}^* - n_{it})$ *and* $w_{it}^2(\lambda_{it}, q_t^*, n_{it}^*) = A_2 \lambda_{it} + q_t^* n_{it}$.

Part *(i)* calls for land market equilibrium. Part *(ii)* simply says that in equilibrium, the optimal land ownership of households in sector 1 equals the optimal land input, n^d, and in sector 2 zero, since land is useless in sector 2 and the level of consumption would be lowered by owning land. Finally, part *(iii)* describes the necessary conditions for the migration equilibrium. If, in equilibrium, a household earns a higher income in sector 1 than in sector 2, then this household will work in sector 1, and *vice versa*. If it earns an identical income in both sectors, then the household is indifferent between working in sector 1 or 2.

We now introduce variable $\hat{\delta}_t$ as the fraction of households that can be endowed with land of size $n^a(1)$ in period t, given the "normal" land dispossessions when no household migrates. That is,

$$\hat{\delta}_t \equiv \frac{\int_0^1 a_{t-1}(i) n^{\tau}(\lambda_t(i))\, \mathrm{d}i}{n^a(1)} \tag{27}$$

where $n^{\tau}(\lambda_t(i)) = n^a(\lambda_{i(t-1)}) - n^a(\lambda_{it})$. Analogically we define $\hat{\mu}_t \equiv \mu_{t-1} + \hat{\delta}_t$. $\hat{\delta}_t$ describes a hypothetical scenario and is not necessarily the actual δ_t, since the government receives further land plots if some households in sector 1 decide to switch to sector 2. The equilibrium is characterized by the following proposition.

Proposition 5

a) *If* $\int_0^{\hat{\mu}_t} \lambda_t(i)\, di \leq \tilde{\Lambda}^1$, *there exists a land-market-cum-migration equilibrium in period* t *with*

$$q_t^* = (1-\alpha) A_1 \left(\frac{\int_0^{\hat{\mu}_t} \lambda_t(i)\, di}{N} \right)^{\alpha} \leq \tilde{q} \quad \text{and} \quad \Lambda_t^{1*} \leq \tilde{\Lambda}^1,$$

$$\text{and} \qquad a_{it}^* = \begin{cases} 1 & \text{for all} \quad i \in [0, \hat{\mu}_t] \\ 0 & \text{for all} \quad i \in (\hat{\mu}_t, 1] \end{cases}$$

b) If $\int_0^{\hat{\mu}_t} \lambda_t(i)\, di > \tilde{\Lambda}^1$, there exists a land-migration equilibrium characterized by:

$$q_t^* = \tilde{q} = (1-\alpha)\Big(\frac{\alpha(A_1)^{1/\alpha}}{A_2}\Big)^{\frac{\alpha}{1-\alpha}} \quad \text{and} \quad \Lambda_t^{1*} = \tilde{\Lambda}^1, \qquad \text{for all } t$$

and a set of migration decisions $\{a_{it}^*\}_{i=0}^1$ such that

$$\int_0^1 a_t^*(i)\lambda_t(i)\, di = \tilde{\Lambda}^1.$$

The proof can be found in the appendix. The economic intuition of proposition 5 is the following. Due to human capital accumulation, the land reform causes the global sector productivity of human capital to decrease and the land price to rise, since the relative scarceness of land increases. Therefore, at a particular point in time an incentive to change sector location arises. At this point, *all* households want to change sectors, and migration occurs. The land price and the level of human capital in sector 1 fall until a simultaneous equilibrium of migration and land market is reached at $\tilde{\Lambda}^1$ and $\tilde{q}$. An immediate consequence is:

Corollary 1

a) If $\int_0^{\hat{\mu}_t} \lambda_t(i)\, di \leq \tilde{\Lambda}^1$, we uniquely find $\{a_{it}^*\}_{i=0}^1$, $\delta_t = \hat{\delta}_t$, and $\mu_t = \hat{\mu}_t$.

b) If $\int_0^{\hat{\mu}_t} \lambda_t(i)\, di > \tilde{\Lambda}^1$, $\{a_{it}^*\}_{i=0}^1$, δ_t and μ_t are indeterminate.

The proof is given in the appendix. Corollary 1 is rooted in the fact that the distribution of households between the non-migrating part that accumulates a mass of human capital of $\tilde{\Lambda}^1$ and the migrating part that represents the "excess mass" of human capital above $\tilde{\Lambda}^1$ is not decisive. This result has a very crucial consequence. Migration occurs independent of individual-specific human capital and thus it is completely open as to who those migrating households are. Therefore, there is a real threat to human capital accumulation if low-skilled persons migrate and their level of human capital is below the critical threshold λ^* in sector 2; we will continue this discussion in more detail in the next section.

One might wonder why the incentive to switch sectors arises irrespective of individual parameters (conditions (25) and (26)). The reason for this is the constant returns to scale technology for family farm production. Deininger and Feder (1998), p. 16, report that the hypothesis of constant returns to scale cannot be rejected for most agricultural production in developing countries. As a consequence, the scale of inputs, like the amount of human capital, does not change the *relative* productivity of an input. One can show that, in case of decreasing returns to scale, the higher-skilled households leave the agriculture sector for the industry sector, whereas the opposite occurs for increasing returns to scale. However, as there is evidence for constant returns to scale in the agriculture of developing countries, proposition 5 states what we should expect in reality.

5.3 Access to Land Market: Pros and Cons

In this section, we examine the consequences of allowing beneficiaries open access to the land market. We begin by briefly discussing related literature, e.g. Platteau (1992) and Deininger and Feder (1998).[25]

On the one hand, if there exist differences in skills and endowment of production factors, land markets allow for the re-allocation of land in a direction towards the overall highest productivity, and thus for *efficiency gains*. However, land markets may decrease efficiency if the large farmers' advantage in accessing credit offsets this effect (*credit market distortions*). In this context, the additional efficiency gains due to an improved access to credit markets for land reform beneficiaries is questionable for smaller farmers, as even with land as collateral, the high transaction costs connected with small credits may leave small farmers rationed in the credit, and hence in the land market. Therefore, the argument that land market access causes efficiency gains, is not necessarily convincing. On the other hand, unrestricted access to land markets bear the risk that a short-term shock, for instance a bad crop, in an environment with deficient insurance, an imperfect credit market, and poverty, leads to *distress sales*, with the consequence of a loss of productive assets.[26] Hence, the farmers may fall back into the poverty trap. We show that open access may cause the failure of the reform even in a world without uncertainty, where distress sales cannot happen. Nonetheless, we also identify an advantage of open access to the land market.

[25] See Galal and Razzaz (2001) for the issue of reforming land markets.

[26] Deininger and Feder (1998), for example, report that 60% of land sales in Bangladesh were undertaken for food and medicine. If the sale is caused by a non-diversifiable macro-shock, land must be sold at a low price, because of a massive excess supply of land.

5.3.1 Pros

Initially all households are identical. In the first period of the reform, beneficiaries thus obtain a plot of land of size $n^a(1)$. It follows that the land market equilibrium forces $n^d_{i0} = n^a(1)$. At the beginning of the next period, however, the poor become heterogenous. The second cohort of beneficiaries is endowed with more land and less human capital than the first, wherefore the first cohort will buy land from the second at the equilibrium price. In general, in any period cohorts with a higher level of human capital than average buy land from the cohorts with less human capital (as long as they are located in sector 1), in order to establish the optimal factor relation, given by N/Λ^1_t. In spite of the dispossessions, the households use the land market for optimizing the factor allocation: each single household establishes the optimal factor intensity. This is an advantage of open access to land markets.[27] Given land market access, one can show that the for $e = 1$ required size of land, $n^a(\cdot)$, becomes a function of the land price:

$$n^a(q_t, \lambda_{it}) = \frac{1}{q_t}\left(c^a - \alpha\lambda_{it}\left(A_1\left(\frac{1-\alpha}{q_t}\right)^{1-\alpha}\right)^{\frac{1}{\alpha}}\right) \tag{28}$$

Substituting (23), we find:

$$n^a(\Lambda^1_t, \lambda_{it}) = \left(\frac{N}{(1-\alpha)\Lambda^1_t}\right)\cdot\left[\frac{c^a}{A_1}\left(\frac{\Lambda^1_t}{N}\right)^{1-\alpha} - \alpha\lambda_{it}\right] \tag{29}$$

Thus, we find:

Proposition 6

With land market access of land reform beneficiaries, the required land transfer to a household i in period t, n^a_{it}, is weakly lower than without land market access. That is,

$$n^a(\Lambda^1_t, \lambda_{it})\begin{cases} < n^a(\lambda_{it}) & \textit{if} \quad \lambda_{it} \neq \breve{\lambda}_{it} \\ = n^a(\lambda_{it}) & \textit{if} \quad \lambda_{it} = \breve{\lambda}_{it} \end{cases}$$

where $\breve{\lambda}_t \equiv c^a A_1^{\frac{1-2\alpha}{\alpha}}\left(\frac{\Lambda^1_t}{N}\right)^{1-\alpha}$.

The proof is given in the appendix. We conclude that with the land market open to beneficiaries of the land reform, (static) efficiency increases, and the society might be educated in a shorter span of time. Since if land reform beneficiaries have access to

[27] If there remain market distortions, then this advantage will turn out to be less strong, or it will even be reversed, that is, land market access of beneficiaries would bear disadvantages.

the land market, they will maximize income by selling or buying land, given the land transferred by the land reform. If a household possesses no land and receives land of size $n^a(1)$, this household is free to stay at $n^d = n^a(1)$, so that the household's consumption will be at least as high as c^a, and full-time schooling is ensured. Consequently, for all $n^d_{it} \neq n^a(\lambda_{it})$ household's consumption will be strictly higher than c^a, and the land transfer can be reduced. Therefore, with access to land markets, we may allocate each single beneficiary with less land than without access to land markets and the education of the society may be accomplished quicker.

Referring to static efficiency, "harmful" expropriations of higher-skilled households are "healed" by the land market, because the optimal factor relation can be established despite the redistribution of land – without reversing the targeted effect. Hence, the land market ensures the efficient production factor allocation. However, as we will now demonstrate, this increased static efficiency might be bought at the expense of *dynamic* efficiency.

5.3.2 Cons

Having identified the typical advantage of markets, we now show a potential risk for allowing access to the land markets. For this purpose, we label the period in which a household changes location by $\tilde{t}$.

Lemma 1

Open access to the land market is adverse to household i's level of education, i.e. $e^o_{i(\tilde{t}+1)} < e^o_{i\tilde{t}}$, *if*

$$\lambda_{i(\tilde{t}+1)} < \lambda^a.$$

Proof : The choice $e^o_{i\tilde{t}}$ is determined by $w^2_{i\tilde{t}} = A_2\lambda_{i\tilde{t}} + q_{\tilde{t}}(n_{i\tilde{t}} - n^{\tau}_{i\tilde{t}}) > w^1_{i\tilde{t}} = c^a$, so that $e^o_{i\tilde{t}} = 1$. $e^o_{i(\tilde{t}+1)}$ is determined by $w^2_{i(\tilde{t}+1)} = A_2(h(1)\lambda_{i\tilde{t}} + 1) = A_2\lambda_{i(\tilde{t}+1)}$. If $\lambda_{i(\tilde{t}+1)} < \lambda^a$, we obtain $w^2_{i(\tilde{t}+1)} < c^a$ and thus $e^o_{i(\tilde{t}+1)} < e^o_{i\tilde{t}}$.

□

Note that it is not sufficient that $w^2_{i\tilde{t}} > w^2_{i(\tilde{t}+1)}$. If this is the case, it is fully possible that $w^2_{i\tilde{t}} > w^2_{i(\tilde{t}+1)} \geq c^a$, and that therefore $e^o_{i(\tilde{t}+1)} = 1 = e^o_{i\tilde{t}}$. As long as $\lambda_{i(\tilde{t}+1)} > \lambda^*$, the household's potential drop in education (described by lemma 1) does not undo the education target. However, if $\lambda_{i(\tilde{t}+1)} < \lambda^*$, then the migrated household i will end up in the poverty trap of sector 2 (for instance in urban slums), and adverse land sales will cause the failure of the land reform. Therefore,

Proposition 7

Beneficiaries of the land reform have to be prohibited from selling land if, but only if:

$$h(1) + 1 \leq \lambda^*$$

Due to condition (26) the incentive to switch sectors is present in all households, regardless of their education level. It is clear that in period $\tilde{t}$, beneficiaries display $e^o_{it} = 1$. Hence, if $h(1) + 1 < \lambda^*$, members of the latest group of land receivers that directly change sectors will stay in the poverty trap. If on the contrary $h(1) + 1 \geq \lambda^*$, even sector switches by members of the latest group do not cause the failure of the land reform. However, if $h(1) + 1 = \lambda^*$, members of the last group will not slip back into poverty, but will remain at the instable equilibrium at λ^*, where negative shocks cause those households to slip back into the poverty trap.

Since we have a continuum of households we expect that fully backward households will switch to sector 2 if there is migration: suppose, for instance, that the probability of migrating is the same across all households in sector 1, as is suggested by proposition 7. Then the relative share of migrating households are the same for uneducated and educated households in sector 1.[28] If $h(1) + 1 \leq \lambda^*$, then the reform will be unsuccessful.[29]

One must carefully weigh the pros and cons of allowing land reform beneficiaries access to the land sell market. Even if, after a location switch, the household does not fall back into the poverty trap, $\lambda_{i(\tilde{t}+1)} > \lambda^*$, the potential drop in education, $e_{\tilde{t}+1} < e_{\tilde{t}}$, might slow down the education of the society. To ensure the success of the reform, we may have to jeopardize the potential advantage of efficient land allocation through the land market. However, there is no reason to forbid land purchases, since these do not risk the success of the reform but do promote efficiency.

[28]This is a consequence of the *law of large numbers* applied to a continuum of households.

[29]Of course, one could say that, in practice, the land sale might bear such high revenue that bequests to the child might mitigate this effect. However, it is by no means ensured that the land sale revenues are high enough that the loss of land is compensated for sufficiently. The literature suggests that one-time revenues, like land sale revenues, are likely to be used for expensive consumption goods.

5.4 Transition

The following proposition highlights the structural change that our land reform may induce in the case of open access to the land market; the proof is given in the appendix.

Proposition 8

Consider beneficiaries have land market access and a land reform is applied successfully.

(a) *Suppose* $h(1) < 1$. *Then a strictly positive fraction of size* $\int_0^1 a^{ss}(i)\,di \in [0,1]$ *remains in sector 1 infinitely, while all other households are located in sector 2, where*

$$\int_0^1 a^{ss}(i)\,di = \min\left\{1, (1-h(1))\tilde{\Lambda}^1\right\}$$

(b) *Suppose* $h(1) \geq 1$. *Then the share of households ending up in sector 2 asymptotically approaches the whole society, that is, sector 1 disappears.*

Thus, overall, both propositions concerning transition – proposition 4 and proposition 8 – express very similar results: if $h(1) \geq 1$, there will be a transition of the society from a poverty trap to a high(er)-skilled economy. During transition the agriculture sector shrinks, because in the end (asymptotically) all households will have switched to the industry & services sector 2. In the case $h(1) < 1$, agriculture may exist in the long run, but probably as a small, minor sector.

6 Discussion and Conclusions

We have seen that there may be an important nexus between land reforms and human capital accumulation that so far was not considered in land reform debates. We showed that it is possible to use land reforms as a means of inducing the transition of a society caught in a poverty trap to a (higher) developed, skill-based economy where agriculture plays a minor role. The optimal land reform consists of a sequence of land transfer episodes rather than only a one-time event. Hence, producing (temporary) inequality among the poor is a necessary condition of optimal land reforms. Inequality is required because land is scarce and land transfers have to ensure not only a viable farm size but also human capital formation. To come up against this problem one has to support the poor in certain regions while being forced not to support other regions, so that inequality within single regions remain small.

Our major finding is that the access of beneficiaries to land markets must be restricted. The reason is that the incentive to sell the received land and migrate occurs irrespective of the individual skill level. Hence, with open access to land markets, parents may prefer to sell the land and switch sectors too early, i.e. when they have not yet accumulated enough human capital. This will result in the failure of the land reform as their descendants stay in (or fall back into) the poverty trap. To prevent these inefficient land sales a (temporary) prohibition of land sales for beneficiaries of the reform seems necessary.[30] Notice that this danger of open access arises in an environment without uncertainty. Therefore, even if we exclude distress sales due to macro shocks, open land market access may endanger the success of the reform. However, land purchases should be allowed, since these can promote the efficiency of countryside production and equality.

An open question in future research is to what extent property rights should go to the beneficiaries of the land reform. The advantage of doing so is that it increases the incentive of participants to develop it and to make it more productive (effort and investment) and that land can be used as collateral. On the other hand, strict property rights undermine the possibilities of further land redistribution. In our model, beneficiaries of the land reform should be given property rights as part of the transferred land while the remaining part is only given on a temporary basis. Hence, the incentive effect of property rights can be at work, but not to the full extent, and a collateral is at hand.

There are a variety of fruitful extensions to our model that promise to yield further insights. The role of international trade in agricultural goods is an important aspect that might further necessitate or caution the large scale redistribution of land in poor societies.[31] Our analysis is solely deterministic and agriculture typically involves risk or uncertainty so that these aspects and the role of imperfect insurance markets might bear further perceptions. The most interesting extension may be to analyze our model in a political economy framework, so that expropriations are endogenous and the question of which land redistribution schemes are politically feasible is highlighted.[32]

[30] Deaton and Laroque (2001) and Drazen and Eckstein (1988) argue for different reasons that land markets are inimical to growth: savings in the form of land crowds out growth-enhancing capital formation. Deaton and Laroque demonstrate that the Golden Rule allocation, however, can be established by nationalizing land and "renting" it out at no charge.

[31] We suggest that the likelihood of a successful land reform depends positively on the promotion of free trade **when** free trade comes along with higher farmer incomes in developing countries.

[32] First results for this issue have been derived in Horowitz (1993).

A Proofs

Proof of Proposition 1: We prove the proposition by deducing the optimal dynamic land redistribution scheme. To achieve the optimal full-time schooling we must transfer each beneficiary i a plot of size $n^a(\lambda_{it})$. In the first period, $t = 0$, the government allocates land to a certain share of households of the society, which we denote by δ_0. Similarly, δ_t denotes the fraction of the society entitled in a period t. As a supported household should establish $e^o = 1$ and we have to fulfill the constraint that we can only distribute land of size N, δ_0 amounts to:

$$\delta_0 = \frac{N}{n^a(1)} \tag{30}$$

The land transfers can be summarized by:

$$\overline{n}_{i0} = \begin{cases} n^a(1) & \text{if} \quad i \in [0, \delta_0] \\ 0 & \text{else} \end{cases} \tag{31}$$

This results in human capital formation in the following way:

$$\lambda_{i1} = \begin{cases} h(1) + 1 & \forall \quad i \in [0, \delta_0] \\ 1 & \text{else} \end{cases} \tag{32}$$

with $h(1) + 1 > 1$. In the following period, the share δ_0 can be expropriated according to $n^{\tau}_{i1}(\lambda_{i1}) = n^a(1) - n^a(h(1) + 1)$. Clearly, the human capital intensity increases after the expropriation; so possibly the group δ_0 may wish to switch to sector 2 (see condition (14)). We introduce the sector identification variable $a_1^{\delta_0}$ in the following way: consider the households that were receiving a plot of land in period 0. If these households are farmers in sector 1, they display $a_1^{\delta_0} = 1$. If these families are located in sector 2, on the contrary, they are labeled with $a_1^{\delta_0} = 0$:

$$a_1^{\delta_0} = \begin{cases} 1 & \text{if} \quad \frac{\lambda_{\delta_0 1}}{n_{\delta_0 1} - n^{\tau}_{\delta_0 1}} \leq \left(\frac{A_1}{A_2}\right)^{\frac{1}{1-\alpha}} \\ 0 & \text{else} \end{cases} \tag{33}$$

In general, $a_t(i)$ identifies the sector location of a household i in period t. As all households are initially identical, households can be grouped by the period of being entitled to land, labeled $\bar{t}$, via $\delta_{\bar{t}}$. So for all $i \in (\delta_{\bar{t}-1}, \delta_{\bar{t}}]$ we have $a_t(i) = a_t^{\delta_{\bar{t}}}$. Applying equation (11), we obtain for group $i \in [0, \delta_0]$:

$$n^{\tau}_1(\lambda_{i1}) = \begin{cases} \left(\frac{c^a}{A_1}\right)^{\frac{1}{1-\alpha}} \cdot \left(1 - \left(\frac{1}{h(1)+1}\right)^{\frac{\alpha}{1-\alpha}}\right) & \text{if} \quad a_1^{\delta_0} = 1 \\ \left(\frac{c^a}{A_1}\right)^{\frac{1}{1-\alpha}} & \text{else} \end{cases} \tag{34}$$

so that beneficiaries who leave the land-based sector loosen the claim on the received plot of land. For all $i \notin [0, \delta_0]$, of course, $n_1^\tau(\lambda_{i1}) = 0$. Thus, the government will have the following amount of land at its disposal in period 1:

$$\int_{i=0}^{1} n_1^\tau(\lambda_1(i))\ \mathrm{d}i = \delta_0 \left[a_1^{\delta_0} \left[\left(1 - \left(\frac{1}{h(1)+1} \right)^{\frac{\alpha}{1-\alpha}} \right) \left(\frac{c^a}{A_1} \right)^{\frac{1}{1-\alpha}} \right] + (1 - a_1^{\delta_0}) \left(\frac{c^a}{A_1} \right)^{\frac{1}{1-\alpha}} \right]$$

The resulting land redistribution scheme is:

$$\overline{n}_{i1} = \begin{cases} -n_{i1}^\tau(h(1)+1) \quad \text{for} \quad i \in [0, \delta_0] \\ n^a(1) \quad \text{for} \quad i \in (\delta_0, \delta_0 + \delta_1] \\ 0 \quad \text{else} \end{cases} \tag{35}$$

where $\delta_1 = \frac{\int_{i=0}^{1} n_1^\tau(\lambda_1(i))\ \mathrm{d}i}{n^a(1)}$. We denote the measure of households already entitled to land by μ: $\mu_t = \sum_{k=0}^{t} \delta_k$. So $\mu_0 = \delta_0$, $\mu_1 = \delta_0 + \delta_1$ etc. Thus within fraction μ_1 all households display $e^o = 1$ and income c^a (unless the households of group δ_0 display $a(i) = 0$). The period 1's land transfers have to fulfill the land constraint:

$$\delta_1 n^a(1) = \int_0^1 n_1^\tau(\lambda_1(i))\ \mathrm{d}i = \mu_0\, n_1^\tau(h(1)+1)$$

Therefore, $\delta_1 = \frac{\mu_0 n_1^\tau(h(1)+1)}{n^a(1)}$. For the human capital levels in $t = 2$ we obtain:

$$\lambda_{i2} = \begin{cases} h(1)(h(1)+1)+1 \quad \text{for} \quad i \in [0, \delta_0] \\ h(1)+1 \quad \text{for} \quad i \in (\delta_0, \mu_1] \\ 1 \quad \text{else} \end{cases} \tag{36}$$

In general, in any period t land redistribution must take the following form:

$$\overline{n}_{it} = \begin{cases} -n_{it}^\tau(\lambda_{it}) \quad \text{for} \quad i \in [0, \mu_{t-1}] \\ n^a(1) \quad \text{for} \quad i \in (\mu_{t-1}, \mu_t] \\ 0 \quad \text{else} \end{cases} \tag{37}$$

where $n_{it}^\tau(\lambda_{it})$ can be grouped by the particular households that were entitled in the same period: all $i \in (\mu_{\bar{t}-1}, \mu_{\bar{t}}]$ belong to the group $\delta_{\bar{t}}$. The location choice of a group $\delta_{\bar{t}}$ can be described by:

$$a_t^{\delta_{\bar{t}}} = \begin{cases} 1 \quad \text{if} \quad \frac{\lambda_{(\delta_{\bar{t}})t}}{n_{(\delta_{\bar{t}})t}} \leq \left(\frac{A_1}{A_2} \right)^{\frac{1}{1-\alpha}} \\ 0 \quad \text{else} \end{cases} \tag{38}$$

So for all $i \in (\delta_{\bar{t}-1}, \delta_{\bar{t}}]$, $\bar{t} \geq 0$ and $\delta_{-1} = 0$, we have $a_t(i) = a_t^{\delta_{\bar{t}}}$. To generalize a period's expropriation scheme we have to recognize that the general process of human capital accumulation can be summarized as follows:

$$\lambda_{it} = \begin{cases} \sum_{k=0}^{t-\bar{t}_i} \big(h(1)\big)^k & \text{for} \quad t \geq \bar{t}_i \\ 1 & \text{for} \quad t < \bar{t}_i \end{cases} \tag{39}$$

Additionally, note that without introducing migration, $n_{it}^{\tau}(\lambda_{it})$ is given by the term:

$$\max\left\{0, n^a(\lambda_{i(t-1)}) - n^a(\lambda_{it})\right\} = \max\left\{0, \left(\frac{c^a}{A_1 \lambda_{i(t-1)}^{\alpha}}\right)^{\frac{1}{1-\alpha}} - \left(\frac{c^a}{A_1 \lambda_{it}^{\alpha}}\right)^{\frac{1}{1-\alpha}}\right\} \tag{40}$$

However, we have to keep in mind the household's location choice. As soon as some supported groups choose to work in sector 2 the government obtains all remaining land of these groups.

$$n_{it}^{\tau} = \begin{cases} \left(\frac{c^a}{A_1}\right)^{\frac{1}{1-\alpha}} \left[\left(\frac{1}{\sum_{k=0}^{t-\bar{t}_i-1}(h(1))^k}\right)^{\frac{\alpha}{1-\alpha}} - \left(\frac{1}{\sum_{k=0}^{t-\bar{t}_i}(h(1))^k}\right)^{\frac{\alpha}{1-\alpha}}\right] & \text{if} \quad a_t(i) = 1 \\ \left(\frac{c^a}{A_1\left[\sum_{k=0}^{t-\bar{t}_i-1}(h(1))^k\right]^{\alpha}}\right)^{\frac{1}{1-\alpha}} \quad \text{if} \quad (a_t(i) = 0 \text{ and } a_{t-1}(i) = 1) \\ 0 \quad \text{else} \end{cases} \tag{41}$$

Hence, the share of the society that can be entitled to obtain $n^a(1)$ in a period t is given by:[33]

$$\delta_t = \frac{\int_0^1 n_t^{\tau}(i)\,\mathrm{d}i}{n^a(1)} \tag{42}$$

Due to $n_{it}^{\tau} > 0$ we infer $\mu_t > \mu_{t-1}$ for all periods t in which the redistribution scheme is applied and $\mu_{t-1} < 1$. Since $\mu_t - \mu_{t-1}$ is bounded away from zero, it follows that $T < \infty$.

□

Proof of Proposition 3: Households with $n_{it} = 0$ are imprisoned in the poverty trap and have $\lambda_{it} = 1$. Hence, all non-beneficiaries display $a_{it} = 0$ and, due to $y^1 = 0$ for $n = 0$, have no incentive to switch sectors. Land reform beneficiaries own a plot

[33]Neglecting migration, the general land constraint in any period t is given by:

$$\delta_t = \frac{1}{n^a(1)}\left\{\left[\sum_{j=1}^{t}\left(n^a(\sum_{k=0}^{t-j}(h(1))^k\right) - n^a\left(\sum_{k=0}^{t-j+1}(h(1))^k\right)\right]\delta_{j-1}\right\}$$

of land of size $n^a(\lambda_{it})$, i.e., they earn an income of c^a. Applying $\tilde{\lambda} = \lambda^a$, it is clear that $\lambda_{it} > \lambda^a$ leads to $a^*_{it} = 0$ in equilibrium and that $\lambda_{it} < \lambda^a$ causes $a^*_{it} = 1$ in equilibrium. If $\lambda_{it} = \lambda^a$, household i earns the same income in both sectors, and is therefore indifferent between sector 2 and sector 1, that is, it has no incentive to switch sectors.

□

Proof of Proposition 4: Independent of the size of $h(1)$, a household i will switch sectors towards sector 2 as soon as $\lambda_{it}/n_{it} > \big(A_1/A_2\big)^{1/1-\alpha}$. If $h(1) < 1$, each educated household will have reached the stationary state at $\lambda = \frac{1}{1-h(1)}$ in period T^{ss}, where a household's human capital no longer grows. The land property of a household i in period T^{ss} is determined by $n_{i(T-1)}$, that is, by the property in the last period in which land redistribution took place:

$$n_{iT^{ss}} = n_{i(T-1)} = n^a\big(\lambda_{i(T-1)}\big) = \left(\frac{c^a}{A_1\big(\lambda_{i(T-1)}\big)^{\alpha}}\right)^{\frac{1}{1-\alpha}}$$

Moreover, we know that $\lambda_{iT^{ss}} = \frac{1}{1-h(1)}$. Consequently, we have $a_{it} = 0$ in period $t = T^{ss}$ (and in all the following periods), if:

$$\lambda_{i(T-1)} > \left[\lambda^a\big(1-h(1)\big)^{1-\alpha}\right]^{\frac{1}{\alpha}}$$

If $h(1) \geq 1$, human capital grows infinitely and therefore the human capital land ratio will cross the migration threshold $\big(A_1/A_2\big)^{1/1-\alpha}$ at a certain point in time, so that all households will end up in sector 2, which proves part *(ii)* of the proposition.

□

Proof of Proposition 5: $\tilde{\Lambda}^1$ is the migration threshold given (partial) equilibrium in the land market (condition (26)). If $\int_0^{\hat{\mu}_t} \lambda_t(i)\,\mathrm{d}i \leq \tilde{\Lambda}^1$, there is no incentive to migrate in period t, and a land-market-cum-migration equilibrium is established at:

$$q^*_t = A_1(1-\alpha)\left(\frac{\int_0^{\hat{\mu}_t} \lambda_t(i)\,\mathrm{d}i}{N}\right)^{\alpha} < \tilde{q}$$

Since $\lambda_{ik} \geq \lambda_{i(k-1)}$ for all $i \in [0, \hat{\mu}_t]$ and $k = \{1, 2, ..., t\}$, and $\lambda_{ik} = \lambda_{i(k-1)} = 1$ otherwise, we conclude that $a^*_{it} = 1$ for all $i \in [0, \hat{\mu}_t]$, and $a^*_{it} = 0$ for all other poor households. If $\int_0^{\hat{\mu}_t} \lambda_t(i)\,\mathrm{d}i > \tilde{\Lambda}^1$, the partial land market equilibrium, given by (23), would lead to migration. If, and only if, $\Lambda^1_t = \tilde{\Lambda}^1$, a migration equilibrium is obtained, and the land-market-cum-migration equilibrium is established at $q^*_t = \tilde{q}$ and $\Lambda^{1*}_t = \tilde{\Lambda}^1$, where no strict migration incentive prevails. Consequently the set $\{a^*_{it}\}^1_{i=0}$ has to fulfill:[34]

$$\int_0^1 a^*_t(i)\lambda_t(i)\,\mathrm{d}i = \tilde{\Lambda}^1.$$

□

Proof of Corollary 1: Part *a)* is obvious. Due to equilibrium condition $\Lambda^1_t = \tilde{\Lambda}^1$ in case *b)*, set $\{a^*_{it}\}^1_{i=0}$ has to fulfill $\int_0^1 a^*_t(i)\lambda_t(i)\,\mathrm{d}i = \tilde{\Lambda}^1$. Therefore, there exist arbitrarily numerous measurable sets $\{a^*_{it}\}^1_{i=0}$ that fulfill the equilibrium condition, unless (i) $\tilde{\Lambda}^1 = 0$ ($a_{it} = 0$ for all $i \in [0,1]$ would be clear) or (ii) $\int_0^1 \lambda_t(i)\,\mathrm{d}i = \tilde{\Lambda}^1$ ($a_{it} = 1$ for all $i \in [0,1]$ would be clear). Since $\tilde{\Lambda}^1 = \left(\alpha\frac{A_1}{A_2}\right)^{\frac{1}{1-\alpha}} N > 0$, case (i) cannot occur, and case (ii) belongs to item *a)* of the corollary. Hence, $\{a^*_{it}\}^1_{i=0}$ is indeterminate – and thus also the size of land that is additionally available for redistribution due to migration. Therefore, δ_t and μ_t are indeterminate.

□

Proof of Proposition 6: First, both $n^a(\lambda_{it})$ and $n^a(q_t, \lambda_{it})$ guarantee household i an income of c^a:

$$A_1(\lambda_{it})^\alpha(n^a(\lambda_{it}))^{1-\alpha} = c^a = A_1(\lambda_{it})^\alpha(n^d_{it})^{1-\alpha} + q_t(n^a(q_t,\lambda_{it}) - n^d_{it})$$

with $n^d_{it} = \lambda_{it}\left((1-\alpha)A_1/q_t\right)^{1/\alpha}$. If $n^d_{it} = n^a(q_t,\lambda_{it})$, then it clear that $n^a(q_t,\lambda_{it}) = n^a(\lambda_{it})$. This will be the case if

$$n^d_{it} = \lambda_{it}\left(\frac{(1-\alpha)A_1}{q_t}\right)^{\frac{1}{\alpha}} = \left(\frac{c^a}{A_1(\lambda_{it})^\alpha}\right)^{\frac{1}{1-\alpha}} = n^a(\lambda_{it}),$$

that is, if $\lambda_{it} = c^a\left(\frac{1}{A_1}\left(\frac{q_t}{1-\alpha}\right)^{1-\alpha}\right)^{1/\alpha} \equiv \breve{\lambda}_t$. Substituting the equilibrium level of land price, $q_t = A_1(1-\alpha)\left(\Lambda^1_t/N\right)^\alpha$, we arrive at $\breve{\lambda}_t = c^a A_1^{\frac{1-2\alpha}{\alpha}}\left(\Lambda^1_t/N\right)^{1-\alpha}$. If $\lambda_{it} > \breve{\lambda}_t$, then household i displays $n^d_{it} > n^a(\lambda_{it})$. The household hence purchases additional land. Since n^d_{it} maximizes household i's income, the household is endowed with an income

[34]We assume that the set of non-migrating households $\{i \in [0,1] : a^*_{it} = 1\}$ is measurable in the sense of *Lebesque*.

higher than c^a. It follows that there is no need to transfer as much land as $n^a(\lambda_{it})$, and $n^a(\Lambda_t^1, \lambda_{it}) < n^a(\lambda_{it})$. Similarly, if $\lambda_{it} < \breve{\lambda}_t$, then household i will sell part of the transferred land. Since n_{it}^d maximizes income, household i's income again will be higher than c^a, and we obtain $n^a(\Lambda_t^1, \lambda_{it}) < n^a(\lambda_{it})$.

□

Proof of Proposition 8: As long as $\Lambda_t^1 < \tilde{\Lambda}^1$, beneficiaries stay in sector 1 (see condition (26)), and they are indifferent to switching sectors if:

$$\Lambda_t^1 = \tilde{\Lambda}^1 = N\left(\alpha(A_1/A_2)\right)^{1/(1-\alpha)} \tag{43}$$

Initially, the society is backward and Λ_t^1 is smaller than $\tilde{\Lambda}^1$ (right-hand-side of equation (43)). The land transfers cause human capital accumulation and Λ_t^1 moves towards the constant term $N\left(\alpha(A_1/A_2)\right)^{1/(1-\alpha)}$. Once Λ_t^1 crosses this migration threshold, households move to sector 2 until the migration-cum-land-market equilibrium is established anew. Eventually, all households $i \in [0,1]$ receive land. If $h(1) \geq 1$, human capital increases incessantly so that asymptotically the mass of households will leave sector 1: sector 1 disappears. If $h(1) < 1$, at skill level $\lambda = \frac{1}{1-h(1)}$, the steady state is reached. Since the migration-cum-land-market equilibrium demands $\Lambda_t^1 \leq \tilde{\Lambda}^1$, the distribution of households between sector 1 and sector 2 in the steady state is determined by

$$\tilde{\Lambda}^1 = \frac{1}{1-h(1)} \int_0^1 a^*_{T^{ss}}(i)\ \mathrm{d}i,$$

if $\int_0^1 \lambda^{ss}(i)\mathrm{d}i = \frac{1}{1-h(1)} > \tilde{\Lambda}^1$, while if $\frac{1}{1-h(1)} \leq \tilde{\Lambda}^1$, all households $i \in [0,1]$ stay in sector 1 in steady state.

□

B Figures

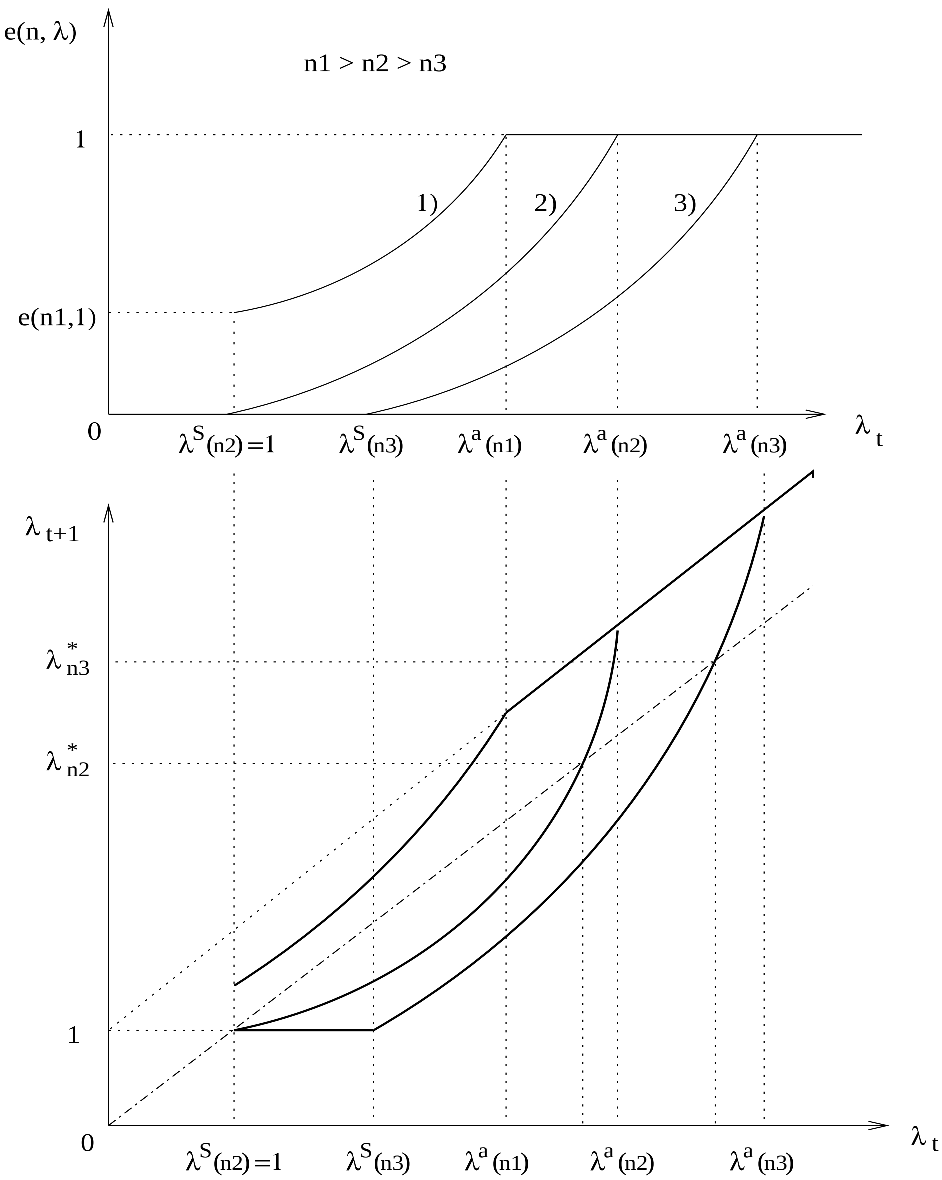

Figure 1: Convex human capital technology in sector 1 for different levels of land that establish $\lambda^S(n) < 1$, $\lambda^S(n) = 1$, and $\lambda^S(n) > 1$

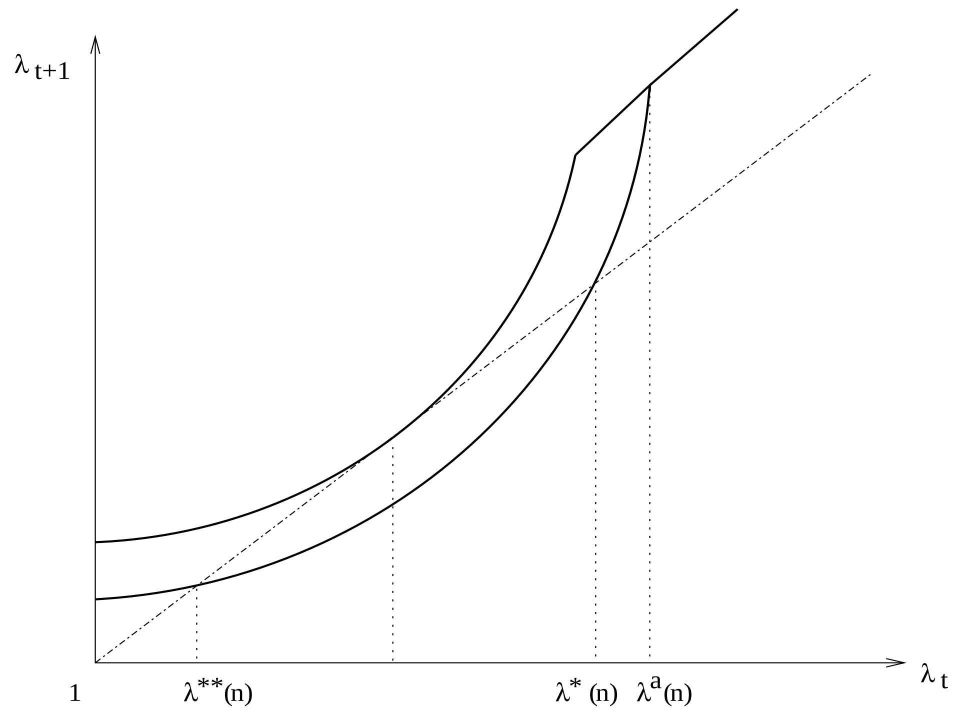

Figure 2: Convex human capital technologies in sector 1 for the case where $\lambda^S(n)$ does not exist, $\lim_{\lambda_t \to 1} \frac{d\,\lambda_{t+1}}{d\,\lambda_t} < 1$, $h(1)\lambda^a(n) + 1 > \lambda^a(n)$, and $h(1) > 1$

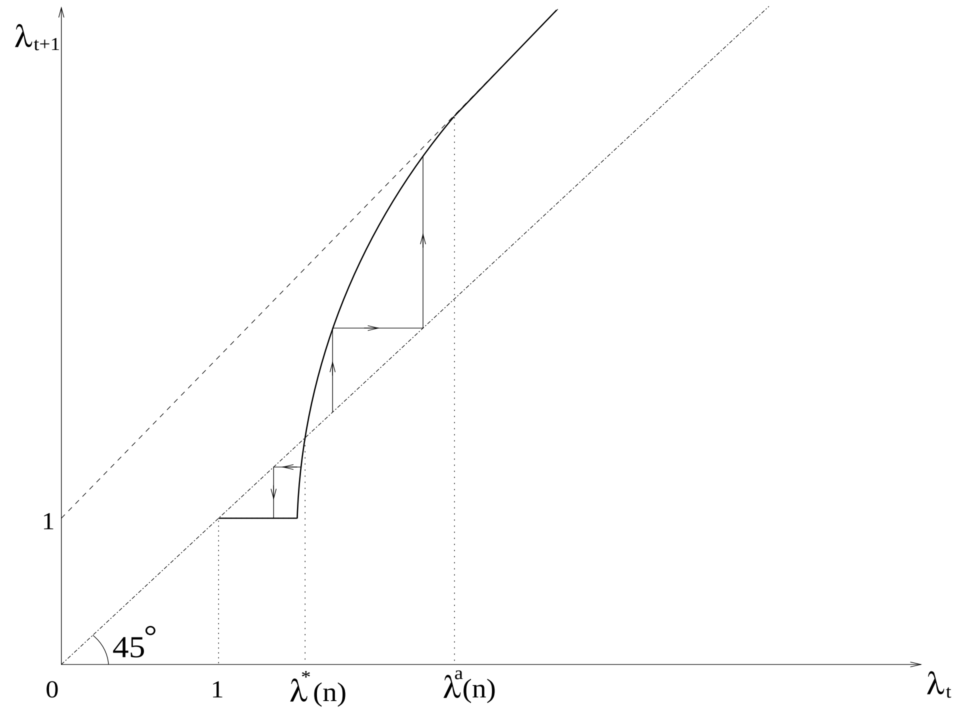

Figure 3: Concave human capital technology in sector 1 with $\lambda^S(n) > 1$, $h(1)\lambda^a(n)+1 > \lambda^a(n)$, and $h(1) > 1$

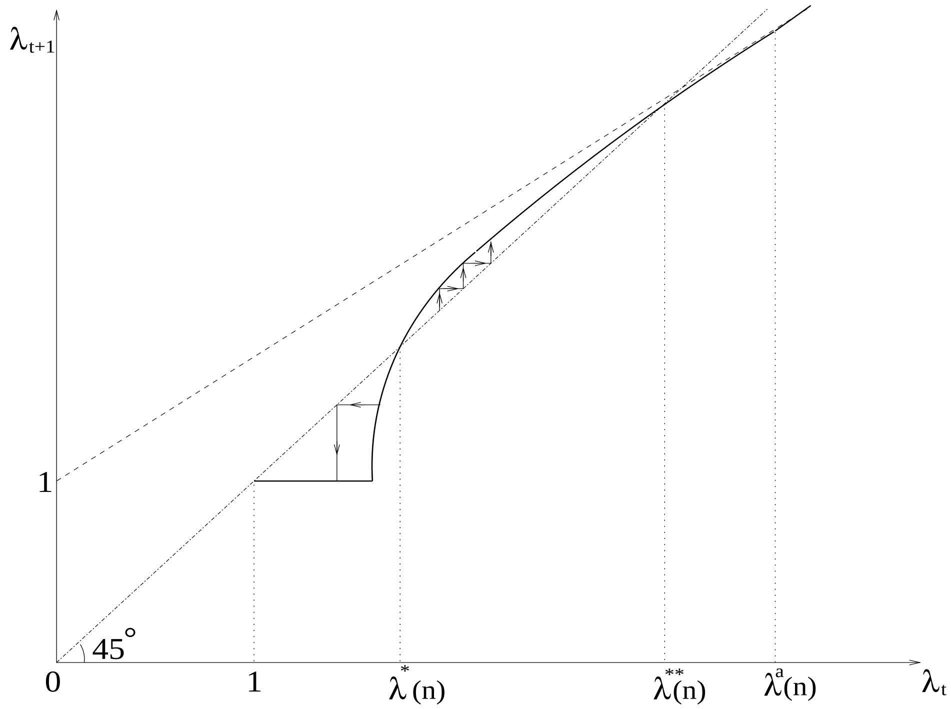

Figure 4: Concave human capital technology in sector 1 with $\lambda^S(n) > 1$, $h(1)\lambda^a(n)+1 < \lambda^a(n)$, and $h(1) < 1$

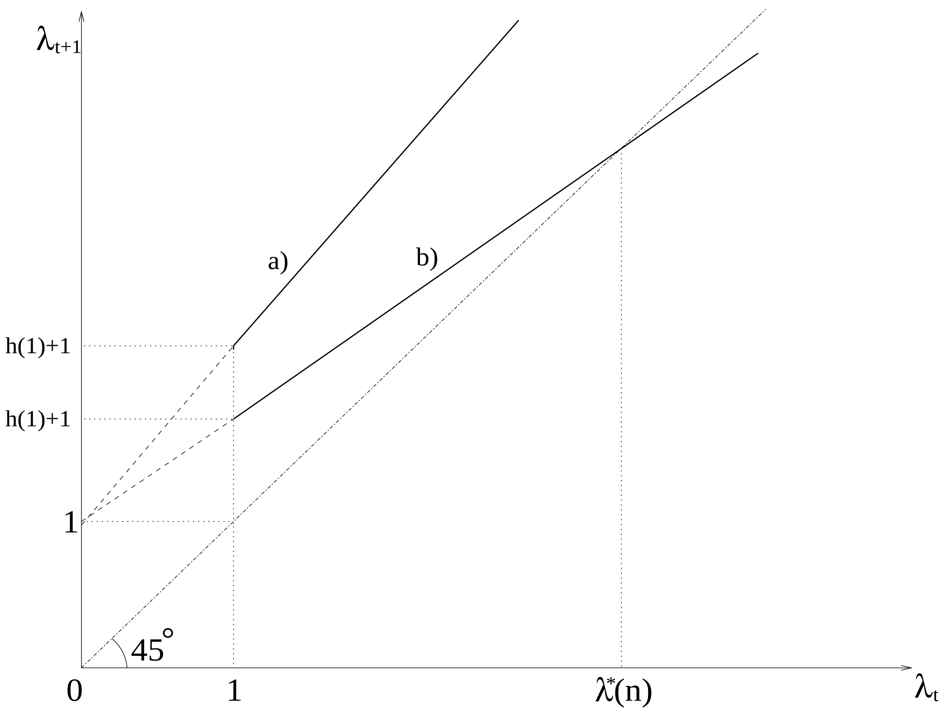

Figure 5: The case where in sector 1 n is so large that even $\lambda^a(n)$ does not exist

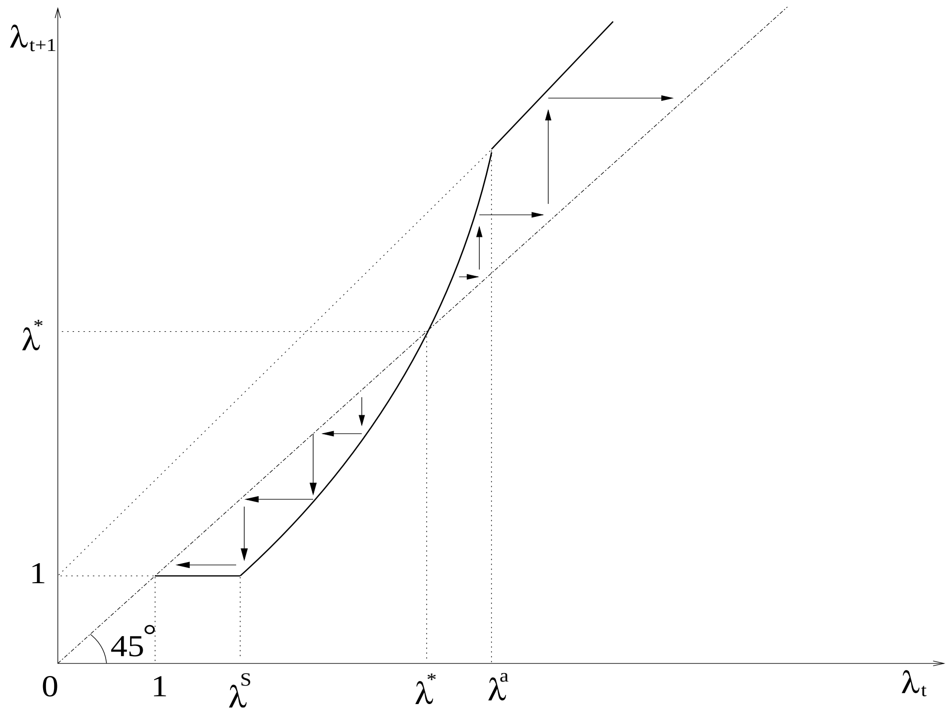

Figure 6: Convex human capital technology in sector 2 with $\lambda^S > 1$, $h(1)\lambda^a + 1 > \lambda^a$, and $h(1) > 1$

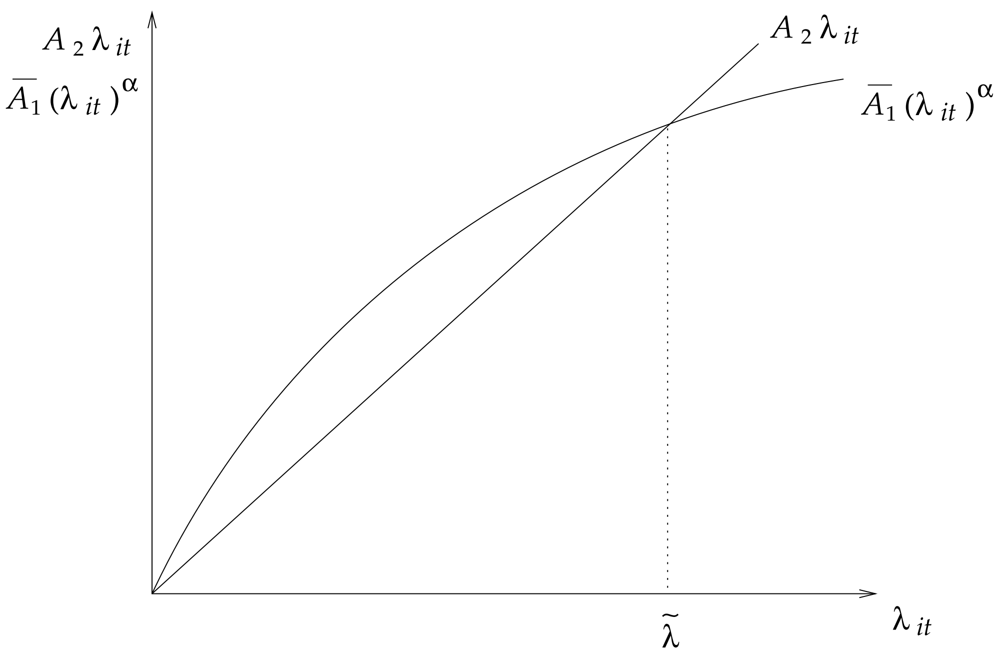

Figure 7: Sectoral income comparison given estate $n_{i(T-1)}$, with $\overline{A}_1 = A_1 n_{i(T-1)}$ and $\tilde{\lambda} = n_{i(T-1)} \left(\frac{A_1}{A_2}\right)^{1/(1-\alpha)}$.

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C Dynamics in Sector 1

It is easy to check that:

Remark 1
$h(1) \geq 1$ forces $\lambda^a(n_t)$ to be strictly higher than any possible stationary state, where $\lambda_{t+1} = \lambda_t$, since then $h(1)\lambda^a(n_t) + 1 > \lambda^a(n_t)$ is always true.

Remark 2
The line $h(1)\lambda_t + 1$ establishes an upper bound for all potential trajectories, i.e., no admissible trajectory crosses this line.

Proposition 9
If the trajectory is strictly convex in the area $[\lambda^S(n_t), \lambda^a(n_t)]$.

(a) *If $\lambda^S(n_t) > 1$ and $h(1) \geq 1$: There exists one unstable stationary state at a level $\lambda^*(n_t)$ and the locally stable poverty trap stationary state at $\lambda = 1$ with $1 < \lambda^S(n_t) < \lambda^*(n_t) < \lambda^a(n_t)$.*

(b) *If $\lambda^S(n_t) > 1$ and $h(1) < 1$: There are three possible scenarios:*

   (1) *If $h(1)\lambda^a(n_t)+1 > \lambda^a(n_t)$: There exists an unstable, middle stationary state at a level $\lambda^*(n_t)$, a second, locally stable, upper stationary state at a level $\lambda^{**}(n_t)$, and the locally stable poverty trap at $\lambda = 1$ with $1 < \lambda^S(n_t) < \lambda^*(n_t) < \lambda^a(n_t) < \lambda^{**}(n_t)$.*

   (2) *If $h(1)\lambda^a(n_t) + 1 = \lambda^a(n_t)$: There exists a stationary state at $\lambda^a(n_t)$ whose stability depends upon the starting point. Only if $\lambda_0 > \lambda^a(n_t)$ will λ converge to $\lambda^a(n_t)$. Furthermore there exists the locally stable poverty trap at $\lambda = 1$ with $1 < \lambda^S(n_t) < \lambda^a(n_t)$.*

   (3) *If $h(1)\lambda^a(n_t) + 1 < \lambda^a(n_t)$: There exists only the poverty trap as a stable stationary state.*

(c) *If $\lambda^S(n_t) = 1$ and $h(1) \geq 1$: There are two possible patterns:*

   (1) *If $\lim_{\lambda\to 1} \frac{d\lambda_{t+1}}{d\lambda_t} < 1$: There exists an unstable stationary state at a level $\lambda^*(n_t)$ and a locally stable poverty trap at $\lambda = 1$ with $\lambda^S(n_t) < \lambda^*(n_t) < \lambda^a(n_t)$.*

   (2) *If $\lim_{\lambda\to 1} \frac{d\lambda_{t+1}}{d\lambda_t} \geq 1$: There exists only an unstable stationary state at $\lambda = 1$.*

(d) *If $\lambda^S(n_t) = 1$ and $h(1) < 1$: There are four possible patterns:*

   (1) *If $\lim_{\lambda\to 1} \frac{d\lambda_{t+1}}{d\lambda_t} \geq 1$ and $h(1)\lambda^a(n_t) + 1 > \lambda^a(n_t)$: There exists a stable stationary state at a level $\lambda^*(n_t)$ and an unstable stationary state at $\lambda = 1$ with $\lambda^S(n_t) < \lambda^a(n_t) < \lambda^*(n_t)$.*

(2) *If* $\lim_{\lambda\to 1} \frac{d\,\lambda_{t+1}}{d\,\lambda_t} < 1$ *and* $h(1)\lambda^a(n_t) + 1 > \lambda^a(n_t)$*: There exist an unstable middle stationary state at a level* $\lambda^*(n_t)$*, a second, locally stable, upper stationary state at a level* $\lambda^{**}(n_t)$*, and a locally stable stationary state at* $\lambda = 1$ *establishing a poverty trap, with* $\lambda^S(n_t) < \lambda^*(n_t) < \lambda^a(n_t) < \lambda^{**}(n_t)$*.*

(3) *If* $\lim_{\lambda\to 1} \frac{d\,\lambda_{t+1}}{d\,\lambda_t} < 1$ *and* $h(1)\lambda^a(n_t)+1 < \lambda^a(n_t)$*: There exists only a globally stable poverty trap stationary state at* $\lambda = 1$*.*

(4) *If* $\lim_{\lambda\to 1} \frac{d\,\lambda_{t+1}}{d\,\lambda_t} < 1$ *and* $h(1)\lambda^a(n_t) + 1 = \lambda^a(n_t)$*: There exist one stationary state at* $\lambda^a(n_t)$ *whose stability again depends on the starting point, and a locally stable poverty trap state at* $\lambda = 1$*.*

(e) $\lambda^S(n_t)$ *does not exist (respectively, formally,* $\lambda^S(n_t) < 1$*),* $\lambda^a(n_t) > 1$*, and* $h(1) \geq 1$*. We have no lower threshold so that even at* $\lambda_t = 1$ *the resulting level of* λ_{t+1} *will be higher than unity but lower than* $h(1)+1$*. There are three possible cases:*

(1) *There exists no stationary state and even for* $\lambda_0 = 1$ *continuous, sustainable human capital growth occurs. If* $\lim_{\lambda\to 1} \frac{d\,\lambda_{t+1}}{d\,\lambda_t} \geq 1$ *this is always the case.*

(2) *Consider* $\lim_{\lambda\to 1} \frac{d\,\lambda_{t+1}}{d\,\lambda_t} < 1$*. There exists one point of tangency establishing a stationary state at some level* $\lambda^*(n_t)$ *where stability depends upon the starting point with* $\lambda^*(n_t) < \lambda^a(n_t)$*.*

(3) *Consider* $\lim_{\lambda\to 1} \frac{d\,\lambda_{t+1}}{d\,\lambda_t} < 1$*. There exists a lower, locally stable stationary state at a level* $\lambda^*(n_t)$ *and a second, unstable one at a level* $\lambda^{**}(n_t)$ *with* $\lambda^*(n_t) < \lambda^{**}(n_t) < \lambda^a(n_t)$*.*

(f) $\lambda^S(n_t)$ *does not exist (respectively, formally,* $\lambda^S(n_t) < 1$*),* $\lambda^a(n_t) > 1$*, and* $h(1) < 1$*. There are five potential patterns:*

(1) $h(1)\lambda^a(n_t) + 1 > \lambda^a(n_t)$ *and there exists only one stable stationary state at a level* $\lambda^*(n_t) > \lambda^a(n_t)$*. This case definitely occurs if* $\lim_{\lambda\to 1} \frac{d\,\lambda_{t+1}}{d\,\lambda_t} \geq 1$*.*

(2) $\lim_{\lambda\to 1} \frac{d\,\lambda_{t+1}}{d\,\lambda_t} < 1$*,* $h(1)\lambda^a(n_t) + 1 > \lambda^a(n_t)$ *and there exists one stationary state,* $\lambda^*(n_t)$*, established by a point of tangency whose stability depends on the starting point, and a second, locally stable one at a level* $\lambda^{**}(n_t)$ *with* $\lambda^*(n_t) < \lambda^a(n_t) < \lambda^{**}(n_t)$*.*

(3) $\lim_{\lambda\to 1} \frac{d\,\lambda_{t+1}}{d\,\lambda_t} < 1$*,* $h(1)\lambda^a(n_t) + 1 > \lambda^a(n_t)$ *and there exists a lower, locally stable stationary state at a level* $\lambda^*(n_t)$*, a second, unstable middle stationary state at* $\lambda^{**}(n_t)$*, and a third, locally stable upper one at* $\lambda^{***}(n_t)$ *with* $\lambda^*(n_t) < \lambda^{**}(n_t) < \lambda^a(n_t) < \lambda^{***}(n_t)$*.*

(4) *If* $h(1)\lambda^a(n_t) + 1 = \lambda^a(n_t)$*:*

1. *There exists a lower, locally stable stationary state at a* $\lambda^*(n_t)$*, and a second one at* $\lambda^a(n_t)$ *whose stability again depends on starting point.*
2. *There exists one stable steady state at* $\lambda^a(n_t)$*.*

(5) If $h(1)\lambda^a(n_t)+1<\lambda^a(n_t)$: There exists only one, stable stationary state at some $\lambda^*(n_t)<\lambda^a(n_t)$.

Proposition 10
If the trajectory is strictly concave in the area $[\lambda^S(n_t),\lambda^a(n_t)]$.

(a) If $\lambda^S(n_t)>1$ and $h(1)\geq 1$: There exists an unstable stationary state at $\lambda^*(n_t)$ and another locally stable one at $\lambda=1$ establishing a poverty trap with $\lambda^S(n_t)<\lambda^*(n_t)<\lambda^a(n_t)$.

(b) If $\lambda^S(n_t)>1$ and $h(1)<1$: There are three patterns to distinguish:

(1) If $h(1)\lambda^a(n_t)+1>\lambda^a(n_t)$: There exists a lower, instable stationary state at $\lambda^*(n_t)$, another, locally stable at $\lambda^{**}(n_t)$, and a poverty trap state at $\lambda=1$ with $\lambda^S(n_t)<\lambda^*(n_t)<\lambda^a(n_t)<\lambda^{**}(n_t)$.

(2) If $h(1)\lambda^a(n_t)+1=\lambda^a(n_t)$:

1. *There is a stationary state at $\lambda^a(n_t)$ whose stability depends on the starting point and the poverty trap at $\lambda=1$.*
2. *There is a lower, instable steady state at a $\lambda^*(n_t)$ and locally stable steady states at $\lambda^a(n_t)$ and $\lambda=1$ with $1<\lambda^*(n_t)<\lambda^a(n_t)$.*

(3) If $h(1)\lambda^a(n_t)+1<\lambda^a(n_t)$:

1. *There is only the poverty trap at $\lambda=1$.*
2. *There exists a lower, instable stationary state at $\lambda^*(n_t)$, another, locally stable at $\lambda^{**}(n_t)$, and a poverty trap state at $\lambda=1$ with $\lambda^S(n_t)<\lambda^*(n_t)<\lambda^{**}(n_t)<\lambda^a(n_t)$.*

(c) If $\lambda^S(n_t)=1$, and $h(1)\geq 1$: There exists only an instable stationary state at $\lambda=1$, since $\min\frac{\partial\lambda_{t+1}}{\partial\lambda_t}=h(1)\geq 1$.

(d) If $\lambda^S(n_t)=1$, and $h(1)<1$. There are three possibilities:

(1) If $h(1)\lambda^a(n_t)+1>\lambda^a(n_t)$: There is a locally stable stationary state at $\lambda^*(n_t)$ and another unstable one at $\lambda=1$ with $1<\lambda^a(n_t)<\lambda^*(n_t)$.

(2) If $\lim_{\lambda\to 1}\frac{d\lambda_{t+1}}{d\lambda_t}>1$, and $h(1)\lambda^a(n_t)+1\leq\lambda^a(n_t)$: There is a locally stable stationary state at $\lambda^*(n_t)\leq\lambda^a(n_t)$, and an instable one at $\lambda=1$.

(3) If $\lim_{\lambda\to 1}\frac{d\lambda_{t+1}}{d\lambda_t}\leq 1$: There is only the poverty trap at $\lambda=1$, which is stable.

(e) $\lambda^S(n_t)$ does not exist (respectively $\lambda^S(n_t)<1$), and $h(1)\geq 1$. No matter whether $\lambda^a(n_t)\leq 1$ or not, there exists no stationary state; sustainable growth of the household's human capital stock occurs.

(f) $\lambda^S(n_t)$ *does not exist (respectively* $\lambda^S(n_t) < 1$*), and* $h(1) < 1$*. No matter whether* $\lambda^a(n_t) \leq 1$ *or* $h(1)\lambda^a(n_t) + 1 \geq \lambda^a(n_t)$ *or not, there is a stable stationary state at a* $\lambda^*(n_t) > 1$*.*

Note that the cases Proposition 9 (d)(1), (f)(1), and Proposition 10 (d)(1), (d)(2), and (f) are similar in structure to the neoclassical growth model.[35] If $\lambda^a(n_t) < 1$, and thus does not exist, the trajectory is linear and there is no possibility of a poverty trap; if $h(1) \geq 1$ there is no steady state at all and if $h(1) < 1$ there exists a stable high level steady state.

Figure 1 illustrates Proposition 9 (a) (left curve), (c)(1) (middle curve), and (e)(1) (right curve); Figure 2 illustrates Proposition 9 (e)(2) and (e)(3), Figure 3 Proposition 10 (a), Figure 4 Proposition 10 (b)(3) 2., and Figure 5 Proposition 9 (e)(1) and Proposition 10 (e) for the special case where $\lambda^a \leq 1$, respectively.

[35] Not all cases are covered by propositions 9 and 10, since we have excluded oscillating trajectories.