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Trade, Development, and Poverty-Induced Comparative Advantage

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Abstract

This paper deals with the relation between trade and development when poverty affects individual decision making. We develop a two-sector model that links production and schooling decisions under poverty with standard neo-classical trade analyses. The decision to either work or acquire skills depends on households having reached subsistence levels of income, implying that the income level of a country becomes important in establishing comparative advantages and trade patterns. Trade liberalisation is always allocative efficient, but its timing is important for the speed by which countries industrialise as well as for global efficiency. Our analysis support the idea that there are instances that stalling trade liberalisation may serve poverty alleviation and global efficiency at the same time.

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1 Introduction

Ever since Adam Smith wrote his groundbreaking The Wealth of Nations, economists have debated the desirability of international trade. In this discussion, opponents have continuously brought in numerous specific cases in which free trade might not be desirable. Many of these convincing cases notwithstanding, this focus on exceptions has in a way only served to confirm the general rule that free trade is beneficial under 'normal' circumstances. With "the case for free trade (thus being) settled" in principle (Bhagwati et al., 1998), the economic debate has shifted towards specification of what circumstances could still count as normal.

A particularly persistent line of critique in this respect is that traditional trade theory has no attention for the specific problematic situation of developing societies. Being poor, lacking industrialisation and facing competition from economies in a much more advanced stage of development are not the normal circumstances for which the case for free trade has been settled. According to this argument, the poor need a special trade economics, as well as different policies than the liberal ones suggested by conventional trade theory. Such sentiments have fuelled protests at various WTO summits in recent years, and to some extent have contributed to the collapse of the current Doha-round. Theoretically, these dissent voices have been propped up by economic historians and development economists claiming that late-comer development requires industrialization under government protection and support, before subjecting economic sectors to the discipline of the market (e.g. Amsden 1989; Wade 1990).

Regardless of whether one is willing to subscribe to this argumentation to abandon free trade policies for poor societies, the pervasiveness of the critique warrants economics to confront the argument and address the impact of poverty upon trade patterns. This paper aims at doing so. We develop a framework in which poverty co-determines comparative advantage, and use it to verify the desirability of trade in relation to issues like allocative efficiency and development. In particular, we develop a two-sector model that links production and schooling decisions under poverty with standard neo-classical trade analysis. The decision to either work in agriculture or to acquire skills needed for manufacturing is modelled to depend on households having reached a certain minimum, subsistence level of income. Apart from the influence of nature-given comparative advantages, also the income level of countries is then important in establishing comparative advantage. Over time, reductions in poverty might shift trade patterns and the verdict on the desirability of trade becomes dependent on the timing of trade liberalisation as well as on the perspective taken. Our analysis suggests that whereas trade is always desirable if one focuses on short-term allocative efficiency, temporary protection might be preferred because of dynamic effects on industrialization and development.

The structure of our paper is as follows. Section 2 further motivates our set-up by discussing the potential impact of poverty on labour supply and production decisions on a micro-level, and trade and development on the macro-level. Section 3 subsequently constructs a formal model that takes these insights into account, which is used in Sections 4 and 5 to discuss the implications of including poverty over time for, respectively, the accumulation of training and comparative advantage. Section 6 discusses the desirability of trade in our poverty-ridden framework and Section 7 concludes.

2 Why Poverty matters

The critique on standard neo-classical models of international trade that they do not take into account the disadvantaged starting position of poor countries demands some clarification. Trade theory, and specifically comparative advantage models, in fact do address the consequences of differences between countries engaging in international trade. Indeed, such differences are the prime source of trade and welfare gains in these models. However, differences between countries considered only apply to endowments or technology, and are treated as 'givens' rather than as consequences of the level of development at a given time. The underlying assumption is that economic mechanisms apply universally, regardless of development level or context. In other words, comparative advantage models are not based upon micro-level analysis of specific consequences of making economic decision under conditions of poverty.

The sub-discipline of development economics, however, gives arguments why economies might operate differently under poverty than under relative affluence. The literature about efficiency wages provides a good example (e.g. Dasgupta 1997). The implications of such work for trade theory are serious. If decision making under poverty differs from decision making under affluence, economic actions will be dependent upon outcomes of previous actions, and thus to some extent endogenous[1]. Hence, the behavioural assumptions on which standard trade models are founded in that case are too static and too simplistic to be instrumental for analysing the welfare effects of trade.

In order to come up with an alternative, a micro-analysis of the circumstances under which the poor produce is warranted. A main characteristic of situations of poverty is that individuals are directly confronted not with one, as in usual neoclassical theory, but with two budget constraints. On the one hand, it is impossible to consume more than one earns. On the other hand, it is impossible to consume less than a certain minimum needed for survival. This simple fact has important consequences for the labour supply decision of the individual, which are depicted in Figure 1.

[insert Figure 1 about here]

The figure depicts the decision of an individual confronted with the choice between work, resulting in income in the present, and training, resulting in higher wages in future. The U-curves represent iso-utility curves depicting all possible combinations of training and current income that yield the labourer the same level of utility. The slope of the curve in each point gives the marginal rate of substitution of current income and training in utility: the steeper the slope, the more the labourer values an additional unit of training.

[1] For example, efficiency wage theory shows that self-reinforcing income differences may occur between initially identical individuals (Dasgupta, 1997). A similar idea is endorsed by Sen who regards development as an increase in freedoms or entitlements (Sen, 1999). The corollary of this idea is that lack of development means a lack of freedoms and capabilities, which will make decision making qualitatively different.

She weighs this against the opportunity cost of training, which is the wage to be earned on the labour market. In the figure, this is represented by the slope of the budget lines $w_z L_{max}$, for $z = A, B, C$. These budget lines give, for each level of training that is physically possible ($L \leq L_{max}$), the income level attainable at the prevailing wage rate. Normally, the optimising labourer will choose a 'consumption' basket of training and income such that the marginal costs of training equal the marginal benefits, that is: where the budget line is tangent to the highest indifference curve possible. Point B and C indicate such points. Below the wage associated with point B, however, optimisation means to work until income reaches the level of consumption minimally required to sustain the household (the horizontal line E_{min}), while spending the rest of time on training. The low wage prevents the labourer from choosing the desired combination of training and work, resulting in a lower than desired rate of training. For instance, for wage w_A, the optimum choice would be A$'$, yet the labourer must choose A to stay at a subsistence level of income. In the presence of poverty, therefore, the training expansion path is depicted by the bold solid line in the figure. Up until point B, any rise in the wage rate will increase the possibilities for training, and, thereby the level of it. It is the room for training that determines how much labourers train, not their preferences. At wages above w_B, however, they are not longer constrained by the need to survive and the level of training is determined by the normal marginal cost-benefit analysis. Under such conditions, the optimal level of training will be lower than upon subsistence, though at wage levels high enough training may increase again. This leads to the 'bend' in the training expansion path.[2]

The relevance of this analysis is that for an individual constrained by poverty, it will be rational to limit labour supply once earnings go up, since more room is created to invest in training. This implies that, ironically

[2]That is, we implicitly assume that the wages just above subsistence are not high enough to lead to a situation in which higher wages lead to a lowering of the number of hours worked. The latter phenomenon is a well-known possibility in the literature on labour markets, where it leads to the backward bending part of the individual labour supply curve. Our assumption seems reasonable in light of the fact that backward bending supply curves are usually considered to occur in situations of relative affluence.

enough, the individuals earning the highest wages when supplying untrained labour will be the ones deciding to work least and train most. In other words, if training would yield the same higher income for all individuals, those with the least incentive to train will decide to train most. This only changes when wages rise above subsistence levels. Then standard neoclassical trade-off decisions apply, giving rise to a negative relation between (current) wages and time devoted to training.

On a macro-level, this has important implications for the development of societies. If we take the development of society as a process of industrialisation coupled with increasing labour productivity, the level of training becomes central to the pace of economic growth. Training is required for untrained labour to engage in manufacturing and to become more productive. Therefore, a society in which more people devote more of their time to training instead of earning direct income will develop faster. If the amount of time devoted to training relates positively to current income, it follows that relatively affluent societies will develop a vaster stock of trained labour, fostering industrialisation. If such a country subsequently engages in trade with a poorer country that assigned less time to training, it will have developed a comparative advantage in manufacturing goods and export these goods accordingly.

The interesting aspect of this is that the comparative advantage in manufactured goods arises precisely because the richer country was more productive in the goods for which untrained labour was required. It follows because the inclusion of poverty in the analysis establishes a positive link between training levels and productivity and higher wages in agricultural sectors. Development and industrialisation are constrained by productivity in the agricultural sector, yielding fertile regions comparative advantages in manufactured goods and less fertile regions in agricultural goods. Accordingly, trade patterns that occur are only indirectly based on nature-given circumstances. Poverty matters, for trade patterns and development.[3]

[3] This pattern also has clear historical antecedents. Industrial and commercial centres typically emerged either at locations where the soil was fertile enough to boost large populations not directly engaged in food production, or where particularly favorable water routes made it possible to import food from other regions, such as the cases of Venice, the

3 A Formal Model of Poverty and Training

To verify the consequences of poverty-based training decisions at the household level on aggregate variables in a more formal manner, we model the economy of a potentially poor country as producing two goods by means of the production factors land and labour. The quantity and quality of land is fixed throughout the analysis. Labour, in contrast, is not homogeneous but consists of two qualities: trained and untrained labour. Initially, all labour is of the untrained quality but this can change over time as individuals might become trained. Untrained labour is an input to the production of a homogeneous, agricultural product F (from Food), which also takes land as an input. Trained labour is the sole production factor for producing a variety of manufactured goods M. Food is characterised by decreasing returns to scale (as the quantity of land is fixed over time, whereas the quantity of untrained labour is not). For the production of manufactured goods we assume increasing returns to scale at the firm level.

To formalise training decisions, we start by assuming that per period each individual has a certain amount of time available for working and/or training and we normalise this to one. This time is devoted to working (for trained individuals) or for working and/or training (for untrained individuals). Next we assume that the decision how much to train is based on a comparison between current wages foregone and the net present value of the increment in wages that result from being trained, *except* when such amount of training would yield a wage income below subsistence. Then the time devoted to training is such that it allows individuals to survive, leaving them a subsistence level of income. Consequently, above subsistence the decision to become trained labour is based upon the desire for training. 'At subsistence' it is the room for training that determines time allotted to training. Finally, we must aggregate individual training levels. In our analysis being a trained or untrained individual is a dichotomous affair: one works either in the untrained agricultural sector or in the trained manufacturing sector. For aggregation, this would imply — given an initially homogeneous labour force

Black Sea and Holland (Cipolla 1980, 75-6).

— that all labourers would devote the same time to training, simultaneously becoming trained enough to enter the manufacturing sector. This is not a very plausible way of aggregating individual decisions. Therefore, we first aggregate individual training activities and use that to determine how many trained individuals arise. One way to view this is that training efforts can be pooled within the agricultural sector, so that all individual training inputs combined result in a certain level of transformation. Untrained individuals see the importance of people becoming trained and are willing to sacrifice income in order for others to become trained. The amount of time devoted to training is thus actually what each individual decides to 'chip in' for the common good of getting a trained labour force.

This set-up is made explicit by the following set of equations. The time individuals devote to training is governed by:

$$T = \frac{r - w}{\rho w} \qquad \text{(above subsistence)} \tag{1}$$

$$T^S = (w - E_{\min})/w \qquad \text{(at subsistence)} \tag{2}$$

where T denotes the share of time per period devoted to training, while w and r denote wage rates for untrained and trained labour, respectively.[4] The superscript 'S' is used to distinguish training levels at subsistence. The parameter $0 < \rho \leq 1$ denotes the individual's time preference and $E_{\min}$ is the minimum subsistence level of expenditures. There are no tuition fees.

By choice of units, we set the total number of individuals in society equal to one. Denoting untrained individuals with L and trained individuals with H, this implies that at any point of time:

$$H + L = 1. \tag{3}$$

The transformation of individual training activities into trained individuals

[4]The expression features nominal wage rates, where real wage rates would be due. However, in (1), the price index drops out.

is governed by:

$$\begin{aligned} \dot{H}_t &= C \cdot T \cdot L \qquad \text{(above subsistence)} \\ \dot{H}_t &= C \cdot T^S \cdot L \qquad \text{(at subsistence)} \end{aligned} \tag{4}$$

That is, the total amount of time trained in society $(T^{(S)} \cdot L)$ translates directly into trained individuals, while taking into account a training efficiency parameter $C \geq 0$. An increase in the efficiency parameter C implies that the training system becomes more efficient: a given input of hours training yields a higher 'output' of trained individuals.

Essentially, (1) is the outcome of a cost-benefit calculation made by the untrained labourer, where she weighs the net present value of a persistent difference in wages $(r-w)/\rho$ against the costs of current wage income foregone due to (also) being engaged in training wT (which therefore cannot be used to work). It is relevant when individuals have a choice to optimally determine their training-work decision. In terms of Figure 1: when the curved part of the training expansion path applies.[5] By contrast, (2) determines training levels such that the wage income that remains is just equal to the minimum level of expenditures required to survive: $w(1 - T^S) = E_{\min}$. It is the room for training that determines how much individuals train, as on the flat part of the training expansion curve in Figure 1. Which of the two decision rules applies is determined by the model, as it will depend on the wage income untrained labour earns.

Since part of the untrained labourer's time is devoted to training, the amount of labour available for directly productive activities in the food sector is $\pounds \equiv \zeta(T) \cdot L < L$, with $0 < \zeta(T) < 1$ a declining function of the time devoted to training. We depict the amount by which training reduces effective labour input as a general function because training-while-working may affect labour input disproportianally. For instance, given that the untrained

[5] The above subsistence training decision implies that individuals are myopic, perceiving current wage differentials to persist forever. It can be shown, however, that (1) is also consistent with static forward-looking expectations (see Baldwin et al., 2003, Section 2.B.4). Moreover, it is intuitively plausible: untrained labour bases its decision to become trained or not on the profitability of doing so.

labourer learns, this could positively affect the efficacy of labour input (even though the training does not directly apply to food production). By contrast, training may require more effort and energy than the hours devoted to it, decreasing labour input by more than the time it takes. In any case, we assume that the individual takes the value of ζ as given, while in our analysis we will typically apply $\zeta = 1 - T$ as a plausible benchmark. Once trained, individuals fully engage in directly productive activities, implying that H also denotes the amount of trained labour available for the manufacturing sector.

Wages of untrained labour are determined in de food sector. Food is produced by land and untrained labour and since the pile of arable land is given and fixed, its production entails decreasing returns. Specifically, we assume

$$F = A\pounds^{\beta} \tag{5}$$

with $0 < \beta < 1$ indicating decreasing returns to scale and where A is a positive constant denoting fertility of land. Since food is a homogeneous product, we choose it as numeraire setting its price to one throughout the analysis ($p_F = 1$). The wage income of untrained individuals is then equal to their marginal productivity:

$$w = \beta A\pounds^{\beta-1}. \tag{6}$$

Trained labour is the sole production factor of manufactures. The manufacturing sector is monopolistically competitive and faces increasing returns to scale.[6] Specifically, the production of a variety of the manufactured good requires f units of trained labour to organise production —this is the fixed cost— and a_m units of trained labour for each unit of output produced — the marginal cost of production. Hence, the labour requirement of any manufacturing variety is: $H_x = f + a_m x$.[7] The costs of producing x units of a variety

[6] In modelling the manufacturing sector and the demand side of the economy, we follow standard practice in international trade modelling and modelling in the new economic geography literature. See e.g. Brakman et al. (2001) and Baldwin et al. (2003).

[7] We ignore subscripts to distinguish between varieties as each variety enters consumer demand symmetrically. Hence, equilibrium output, price and labour requirements will be

thus equals $r(f + a_m x)$. Profit maximisation by manufacturing producers then implies that the price each producer charges is a fixed mark-up over marginal cost:

$$p = \frac{a_m r}{1 - 1/\sigma} \tag{7}$$

Assuming free entry and exit in the manufacturing sector implies that profits will be driven to zero, so that, in equilibrium $x = f(\sigma - 1)/a_m$ and $H_x = \sigma f$. Since trained labour is only used in manufacturing, this implies that the total number of varieties in the economy is implicit in the full employment condition for trained labour:

$$H = NH_x = N\sigma f \tag{8}$$

Consumption is divided over food and the composite of manufactured goods in a Cobb-Douglas way, while the demand for varieties entails standard Dixit-Stiglitz love of variety. Denoting the total number of varieties available by N, we get:

$$U = C_M^{\mu} C_F^{1-\mu} \tag{9}$$

$$C_M \equiv \left(\int_{i=0}^{N} c_i^{1-1/\sigma} di \right)^{1/(1-1/\sigma)} \tag{10}$$

where $0 < \mu < 1$ denotes the expenditure share on manufactured goods and where $\sigma > 1$ is the constant elasticity of substitution between varieties as well as the price elasticity of demand. C_M and C_F denote, respectively, the consumption of the manufacturing composite and food. Utility maximisation implies that a share μ of the individual's income is spent on manufactured goods and a share $1 - \mu$ on food.

All individuals divide their income over food and manufactures in the same way, irrespective of training and income levels.[8] Accordingly, we can

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the same across varieties.

[8]That is, we assume identical and homothetic preferences. Though perhaps unfitting for an analysis that centers around poverty as key determinant for decision making, we

depict consumption levels as a function of aggregate income I as follows:

$$C_F = (1-\mu)I \text{ and } C_M = \mu I \tag{11}$$

Total income in the economy consists of what is earned in manufacturing and food production. Recalling that there are zero profits in manufacturing and assuming that rents (due to the presence of decreasing returns to scale in agriculture) are redistributed among the entire population[9], we get:

$$I = rH + w\pounds/\beta$$

All income is spent on food and manufactures. Wages foregone due to training are implicit in $\pounds$, while there are also no tuition fees.

In autarky, the ratio of total earnings in manufacturing and agriculture must equal the ratio of expenditure shares. Hence, equilibrium requires that:

$$\frac{r(f + a_m x)N}{A\pounds^\beta} = \frac{\mu}{1-\mu} \tag{12}$$

where we used (11) to determine C_M/C_F. Substituting the equilibrium firm size in this equation and rearranging gives the wage rate for trained labour as a function of H:

$$r = \frac{\mu}{(1-\mu)} \frac{A\pounds^\beta}{H} \tag{13}$$

We are now in the position to determine the amount of training when the income of untrained labour is above subsistence. Substituting (6) and (13)

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apply it to maintain focus on the relation between poverty, training decisions and comparative advantage. Moreover, it keeps results tractable, for which reason homothetic preferences is also the standard assumption in trade theory. See, however, Matsuyama (2000) and Stibora and de Vaal (2007) for a treatment of nonhomothetic preferences in a trade theoretic framework.

[9] The land rents are equal to food production minus what is paid to untrained labour, hence $(1-\beta)w\pounds/\beta$. Our assumption that land rents are redistributed to the whole population implies that initially, when all individuals are untrained, each untrained labourer is also owner of land and that this does not change when individuals become trained.

in (1) yields,

$$T = \frac{1}{\rho}\left[\frac{\mu}{(1-\mu)}\frac{\zeta(T)}{\beta}\frac{(1-H)}{H} - 1\right] \tag{14}$$

In other words, above subsistence the amount an individual trains is a declining function of the amount of labour that has already been trained ($\partial T/\partial H < 0$, taking ζ as given). A rise in the share of trained labour[10] will cause a fall in the relative reward of trained labour. If untrained labour is removed, wages of untrained labour will rise due to decreasing returns to scale in agriculture. Furthermore, a higher share of trained labour means more manufacturing varieties, increasing competition and entailing a lower wage for trained labour. If the relative reward for trained labour falls, so does the desirability of undergoing training, and transformation slows down ($\partial^2 T/\partial H^2 > 0$). The amount of H beyond which training is zero is given by $\bar{H} \equiv \frac{\zeta\mu}{[(1-\mu)\beta+\mu\zeta]}$. For any $\bar{H} < H < 1$ the wage premium of getting trained does not compensate for the loss of wage income foregone. We note that $\bar{H}$ is independent of A. The reason is that a higher fertility of land constitutes an exogenous boost of total incomes and expenditures in the economy, which are distributed over the economy according to relative expenditure shares on goods. Although agricultural incomes are higher because of higher quality land, manufacturing wages are also higher and the difference between the two remains the same.

At subsistence, it is the room for training that determines how much an individual trains, as given by (2). Applying the equilibrium wage rate for untrained labour, the amount of training is:

$$T^S = \left[\beta A \pounds^{\beta-1} - E_{\min}\right] / \beta A \pounds^{\beta-1} \tag{15}$$

At subsistence, therefore, the time individuals devote to training increases with the share of trained labour in society, at an increasing rate ($\partial T^S/\partial H > 0, \partial^2 T^S/\partial H^2 > 0$ for given ζ). As transformation is based on the possibilities for training, training increases when the income of untrained labour rises, which is the case as more labour becomes trained. When the wage rate is

[10] By (3), H is also the share of trained labour in society.

equal to the subsistence level of expenditures, the room for training is zero and individuals devote all their time to earn wage income. This is the case for any value of $H \leq \underline{H} \equiv 1 - (1/\zeta) \cdot (E_{\min}/\beta A)^{1/(\beta-1)}$. A positive level of training in the initial situation, when all labour is untrained and $H = 0$, requires $\underline{H} < 0$ and hence $(E_{\min}/\beta A)^{1/(\beta-1)} > \zeta$. For the remainder of the analysis we assume that this is the case, so that also at $H = 0$ we have nonnegative training levels.[11]

Figure 2 shows for either function the evolution of T as a function of H (the dashed curves). The exact position of the curves of course depends on the particular parameter values. For instance, the subsistence curve cuts the vertical axis at $\left[1 - E_{\min}/\beta A\zeta^{\beta-1}\right]$, which is nonnegative by assumption. The above subsistence curve always cuts the horizontal axis for $H < 1$, as drawn. The true function of T of course depends on which decision rule applies, to which we turn next.

[insert Figure 2 about here]

4 Training as time goes by

When the amount of trained labour in the economy increases, our model indicates that individual training levels increase when the economy is at subsistence, while training levels decrease when the economy is above subsistence. Which situation applies is most easily determined by comparing the outcomes of training decisions under either regime. If $T^S \geq (<)\ T$, then untrained labour is apparently above (at) subsistence as the room for training is equal or higher (lower) than the desired levels of training. In terms of Figure 2, the true function of T would therefore be indicated by the bold curve.

The value of $\tilde{H}$ for which the regime switch occurs is implicit in:

$$(1+\rho)(1-\tilde{H})^{\beta-1} = \frac{\rho E_{\min}}{\beta A \zeta^{\beta-1}} + \frac{\mu}{1-\mu}\frac{\zeta(.)}{\beta}\frac{(1-\tilde{H})^{\beta}}{\tilde{H}} \tag{16}$$

[11]Though technically feasible, it makes no sense to allow for $w = E_{\min}$ at positive levels of H as then positive H could never have been reached.

It can be shown that $\tilde{H}$ is unique and that it always lies between zero and one.[12] By applying the implicit function theorem it is easy to see that $d\tilde{H}/dA < 0$ and $d\tilde{H}/dE_{\min} > 0$. If land is more fertile or when subsistence levels of expenditure are lower, there is more room for training and the economy reaches its above subsistence state faster. The extent by which training reduces effective labour supply in agriculture also has an impact. If ζ goes up, it takes longer before the economy reaches the above subsistence state ($d\tilde{H}/d\zeta > 0$). A higher ζ means that effective labour supply in food production goes up, implying a lower wage level for the untrained individual and less room for training.

The important point to be noted, however, is that the transition from one state to another is not as smooth as indicated in Figure 2. Individuals are myopic in the sense that they do not realise that their individual training decisions influence their wage rates. But since all individual behave alike, their individual decisions of course have macro implications. This is not problematic as long as training levels increase when H goes up, as is the case when the economy is at subsistence. Higher training levels imply that the marginal productivity in agriculture goes up, which is reinforced by a lower number of untrained labourers. This increases the room for training, wages rise, et cetera. When the economy is above subsistence, however, training levels decrease sharply in H (see Figure 2) and wages will drop even though H increases. This implies that when the economy moves from the 'at subsistence' to the 'above subsistence' state, the wage drop may be such that the economy immediately switches back to 'at subsistence' again. With the room for training once more determining training levels, wages rise and another regime switch occurs, et cetera, et cetera.

To see the macro implications of individual training decisions more clearly, we depict the true path of training as a function of H in Figure 3 (solid curve), along with the T^s and T curves (dashed). The figure is based on numerical calculations that are based on the following parameter values: $A = 4$, $E_{\min} =$

[12]The left-hand-side of (16) is a positive function of H, ranging from $(1+\rho)$ at $H = 0$ to infinite at $H = 1$. The right-hand-side of the equation is a negative function of H and ranges from infinite at $H = 0$ to $\rho E_{\min}/\beta A\zeta^{\beta-1} > 0$ at $H = 1$.Hence, both functions intersect at $\tilde{H} < 1$.

1.75, $\mu = \beta = 0.6$, $\rho = 0.9$, $C = 0.1$, $a_m = 0.5$ and $f = 1$, increasing H from zero and one with 0.01 increments.[13] Moreover, we set $\zeta(T)$ equal to $1 - T$. To operationalise myopic behaviour, we assume that optimal training levels for a certain value of H depend on the wages of the previous value of H. Indeed, since H accumulates over time and we do not allow for distraining — once untrained labour is trained there is no way back — lower values of H indicate earlier moments in time. Hence, in the figure $T_t = \left[(r/w)_{t-1} - 1\right]/\rho$ and $T^S = 1 - E_{\min}/w_{t-1}$.

[insert Figure 3 about here]

The figure clearly shows oscillations around the switching point, which dampen when H increases. The dampening occurs because the trend in desired training levels is going down when H increases, to eventually become zero. At the same time, the room for training eventually goes up again, implying that from some point onwards desired levels determine training levels. The figure also shows that the first part of the subsistence curve increases rapidly at low levels of H, returning to a steady slope thereafter (disregarding the oscillations). This is simply a 'beginning of time' effect. At time zero, training levels increase from zero to a positive but finite level, increasing wages considerably. This continues for a while, until the changes in training levels and wages over time normalise.

The oscillations could be easily avoided by assuming that individuals do not change training levels over time that lightly. If, for instance, we would assume that the *change* in training levels depends on past wages through:

$$T_t = T_{t-1} + \delta \left[\left(\frac{r - w}{w} \right)_{t-1} - T_{t-1}) \right] \tag{17}$$

and if we would choose $0 \leq \delta \leq 1$ low enough, the oscillations disappear and the figure becomes smooth as depicted in Figure 2. The plausibility of such a procedure depends on how one interprets a time period. In our

[13]The basic form of the figure is invariant to alterations in any of these parameters, provided of course that training levels are positive at $H = 0$.

set-up trained individuals arise as the result of pooled individual training decisions. In that case it seems plausible to see each period as a moment in time when a new generation of individuals decides how much to set aside for training. Training in each period then concerns different individuals and large swings in training levels across periods are not unlikely. We will pursue this interpretation henceforth.

The accumulation of H over time is based on an aggregation of individual training levels. Using (4), we get

$$\dot{H}_t = \begin{cases} C \cdot L_t \cdot T_t & = \frac{C}{\rho}(1-H_t)\left[\frac{\mu}{(1-\mu)}\frac{\zeta(.)(1-H_t)}{\beta H_t} - 1\right] \quad \text{(above subsistence)} \\ C \cdot L_t \cdot T_t^S & = \dfrac{C\left[\beta A\zeta(.)^{\beta-1}(1-H_t)^{\beta} - (1-H_t)E_{\min}\right]}{\beta A\zeta(.)^{\beta-1}(1-H_t)^{\beta-1}} \quad \text{(at subsistence)} \end{cases} \tag{18}$$

with a dot denoting a time derivative. The subscript t is added to signify that training decisions depend on the amount of trained individuals at a particular moment in time. The particular curvatures of both curves are as follows (omitting time subscripts):

At subsistence

$$d\dot{H}/dH \qquad C[(2-\beta)E_{min} - w]/w \gtrless 0$$
$$d^2\dot{H}/dH^2 \qquad (2-\beta)CE_{\min}(\beta-1)/w(1-H) < 0$$

Above subsistence

$$d\dot{H}/dH \qquad -C\left(T + \frac{T}{H} + \frac{1}{\rho}\frac{1}{H}\right) < 0 \text{ if } T > 0$$
$$d^2\dot{H}/dH^2 \qquad C\left[T + \frac{1}{\rho}\left(1 + \frac{\mu\zeta(.)}{\beta(1-\mu)}(1+\frac{1}{H})\right)\right]/H^2 > 0 \text{ if } T > 0$$

Above subsistence, trained labour accumulates over time as long as the level of training is positive, that is when $H < \bar{H}$. The rate of accumulation decreases when time proceeds. At subsistence, the accumulation of trained labour increases over time as long as $w < (2-\beta)E_{\min}$. Hence, whereas T^S increases in H, aggregate training levels might decrease in H. This is a logical outcome of aggregation. While the room for training increases, the number of individuals it applies to reduces.

Ultimately the accumulation of trained labour stops, which we will refer to as the economy's steady state. Since untrained labour always gets above subsistence at some level of $H < 1$ —if $H \rightarrow 1$, w goes to infinity— it follows that the steady state level of H is determined by setting $C \cdot (1 - H_t) \cdot T_t = 0$. By (18) we calculate that the economy reaches a steady state at:[14]

$$H = \frac{\mu\zeta(T)}{(1-\mu)\beta + \mu\zeta(T)} \tag{19}$$

which indeed coincides with the threshold level $\bar{H}$ beyond which individual training levels are zero. We note that the steady state level of H is independent of A, the fertility of land.

The oscillation patterns that affected individual training levels when H progressed also influence the accumulation of trained labour. Figure 4 depicts the development of $\dot{H}$ over time for the parameter constellation we used before, for alternative values of β and A.[15] For low values of β the accumulation of H increases at first, then decreases and ultimately becomes zero. For higher values of β, the decline sets in much faster. Changes in the value of A affect the position of the $\dot{H}$-curve, but not its pattern. Also the time it takes before the continuous regime switches end does not change. Higher fertility of land implies that the curves shift upwards, while rotating counterclockwise. Initial training levels are higher and subsistence levels of income are reached at an earlier stage. The oscillations would disappear once changes in T are smoothened over time, as in (17) and provided the adjustment rate is low enough.[16] The fact that $\dot{H}$ ultimately reaches zero is consistent with

[14] We note that a second steady state equilibrium exists, which occurs when even at $H = 0$ wages are at subsistence. Then $w - E_{\min} = 0$ also implies a positive steady state level of H. It is however immediately clear that this is a theoretical possibility only, as supposedly any economy has started at some point in time without any amount of trained labour (hence positive H could never have been reached). The limiting case when $w - E_{\min} = 0$ at $H = 0$ is possible though, but highly unstable. Any rise in H leads to an upward spiral until income is above subsistence level and, subsequently, the stable steady state equilibrium is reached.

[15] In contrast to Figure 3 the horizontal axis exhibits constant increments in time and not in H. All values of $\dot{H}$ were calculated by using the actual amount of H in the previous period.

[16] The smoothness of $\dot{H}$ also disappears if the effectivity C by which training transforms

the constant steady state level of H.

[insert Figure 4 about here]

5 Poverty-induced Comparative Advantage

In this section we uses our model to verify the implications of poverty on comparative advantage. We assume that the world consists of two regions, North and South, that are initially exactly similar, except that North has more fertile land at its disposal than South. Using asterisks to denote southern variables, $A > A^*$ throughout the analysis.

In our model, comparative advantage is given by the relative price of manufactures over food. With food being numeraire, the relative price of manufactured goods is given by (7). Using (13) to substitute for r, we get:

$$p = \frac{a_m A\mu}{(1-\mu)} \frac{\sigma}{\sigma - 1} \frac{\zeta(T)^\beta (1-H)^\beta}{H} \tag{20}$$

as the relative price of manufactures in North. The relative price of manufactures increases when the share of manufacturing in total expenditures increases (μ), when the marginal labour costs of manufacturing production goes up (a_m) and when the monopoly power of manufacturing producers increases (as implied by a lower price elasticity of demand σ). The relative price of manufactures also increases when the fertility of land A goes up. Likewise, (20) implies that the relative price of manufactures goes down when H increases ($dp/dH < 0$) and when the effective labour input into food production goes down ($\zeta(T)$ down).

For the South an isomorphic equation applies for p^*. The comparative advantage of both countries is given by p/p^*. If $p/p^* > (<) 1$, we say that North has a comparative advantage in food (manufactures). If the two countries

individuals into trained labour appraoches one. The reduction in untrained labour as well as the reduction in desirability of getting trained during the first period is so large that the economy immediately swithches to the above subsistence state and remains there forever.

are completely identical, except for the fertility of land, we get:

$$\frac{p}{p^*} = \frac{A}{A^*}\frac{H^*}{H}\left[\frac{\zeta(T)\cdot(1-H)}{\zeta(T^*)\cdot(1-H^*)}\right]^{\beta} \tag{21}$$

where we have implemented $\mu = \mu^*$, $\sigma = \sigma^*$ and $a_m = a_m^*$. For equal training levels and trained labour stocks, South's comparative advantage lies in manufacturing. The less fertile soil in South puts it at a disadvantage in producing food compared to the North. This will be for instance the case when neither of the countries has trained labour, as in the initial situation. However, differences in soil fertility also imply that South and North face different time paths for the accumulation of trained labour. In terms of Figure 4: the upper (lower) curve would be North's (South's). With H and T increasing more rapidly in North than in South, p/p^* increases and comparative advantage shifts. More specifically, when $A\pounds^{\beta}/H < A^*\pounds^{*\beta}/H^*$, the South acquires a comparative advantage in food instead of manufacturing. Note that in our framework average food production (per unit of trained labour) indicates (revealed) comparative advantage of nations.

Due to poverty and its effects on training decisions, an initial comparative advantage in manufacturing becomes a disadvantage, setting nations behind in their transformation from mainly agriculture based societies to industrialised societies. This clearly contrasts to standard treatments of comparative advantage, where comparative advantage is typically taken as given. Also in comparison to the dynamic comparative advantage literature[17], the mechanism we offer is completely different. As of yet, comparative advantage has not been linked to decision making under poverty at all.

To see more clearly how poverty determines comparative advantage, we verify the conditions under which comparative advantage shifts when countries start at equal, initial amounts of trained labour ($H = H^*$) and concomi-

[17] The literature on endogenous comparative advantage tries to explain how comparative advantages evolve when there are no inherent differences between agents, see Yang and Ng (1998) for an overview. In addition, the relation between exogenous comparative advantage and endogenous comparative advantage has received attention, for instance by establishing conditions under which initial exogenous comparative advantages may change. An early and seminal contribution is Yang (1994).

tant individual training levels (so that $\zeta(T) = \zeta(T^*)$). If countries are both above subsistence level, then also the accumulation of trained labour is the same. Above subsistence, training decisions are independent of A, see (14). H and H^* follow identical paths over time, leaving comparative advantage unchanged. If, however, both countries are at subsistence, things change dramatically. When the initial amount of trained labour is equal, say close to zero, the room for training is higher in the North. Accumulation of trained labour goes faster in the North than in the South, declining North's relative price of manufactures. In fact, it can be shown that comparative advantage will shift in the first period that training occurs (so in period one).[18] Having more fertile land implies a comparative advantage in manufactures at the beginning of the first period after which training could occur.

We illustrate the development of comparative advantage over time for two different values of β in Figure 5, again using our benchmark parameter constellation. As expected, comparative advantage shifts right away, to eventually return to its nature given ordering. The reasoning is as before. In the initial situation, where both countries have zero trained labour, the room for training is higher in the North. H accumulates faster than H^*, shifting initial comparative advantages. North however also reaches the point where income gets above subsistence faster, declining the incentive for training (while in the South the room for training still increases). Consequently, from that point onward p/p^* will go up again. This continues when South surpasses its subsistence level of income. In both countries the price of manufactures falls, but as South is further away from steady state, prices in South fall more rapidly than in the North. As both countries reach the same steady state —$\bar{H}$ is independent of A — eventually comparative advantage retains its initial ordering again.

The overall picture is invariant to the value β. A lower value of β shifts the

[18]During period 1 training levels are $[1 - E_{\min}/\beta A]$ for North and $[1 - E_{\min}/\beta A^*]$ for South, amounting to $H = C[1 - E_{\min}/\beta A]$ and $H^* = C[1 - E_{\min}/\beta A^*]$ at the beginning of period 2. Using this in (21) and assuming $\zeta(T) = 1 - T$ and $\zeta(T^*) = 1 - T^*$, shows that the relative price of manufactures in period 2 is smaller than A/A^* (which was the initial relative price). Taking the derivative of the relative price with respect to A and evaluating it for $A = A^*$, yields $d(p/p^*)/dA < 0$. Hence, during period 1, p/p^* falls and becomes lower than one.

curve downward and prolongs the time it takes for South to retain its nature given comparative advantage in manufactures. The reason is simple and in line with our earlier results. A lower value of β implies higher decreasing returns in food production, which amplifies the positive impact of training on wages. With training levels at subsistence higher in North, the wage difference between North and South increases and so does H accumulation over time (cf. Figure 4). This also explains the difference in amplitude of the oscillations that appear in the figure. With lower decreasing returns, the time paths of trained labour accumulation converge and oscillation periods overlap. The wage and price shocks that occur in both countries therefore either reinforce or counter each other, affecting the amplitude of the swings in comparative advantage accordingly.

[insert Figure 5 about here]

The overall picture is also invariant to allowing for depreciation of trained labour. Arguably, skills acquired during training may wear out over time, implying that trained labour may become unsuitable for producing manufactures after a while. However, allowing for this possibility in our framework, for instance by assuming that each period a certain percentage of the total trained labour force becomes untrained again, does not affect the analysis whatsoever. This is different when we allow for other increases in the untrained labour force, for instance exogenous population growth. Provided the (exogenous) untrained labour force growth exceeds the (endogenous) outflow into trained labour, a country may remain at subsistence forever. The reason is of course that since the number of people working in agriculture does not decline, wages for untrained labour are depressed, which mitigates the room for training and depresses wages even further.[19] In our analysis it is more likely that the less fertile country remains at subsistence – the pressure on

[19] In the end this must imply that the room for training becomes negative, so that untrained labour gets *under* subsistence. This opens the door to endogenous population growth —some people will starve to death— but we will not consider this option.

wages in agriculture is initially highest there. In that case also its comparative advantage will remain in agricultural produce forever. In terms of Figure 5: the upward sloping part disappears.[20]

6 Trade, poverty and development

In this section we discuss the consequences of our framework on the desirability of trade liberalisation in the wake of poverty. As shown, poverty affects the development of countries, affecting their comparative advantages over time. The effects of trade liberalisation therefore depend on the time it takes place. We start with discussing the impact of trade development

Starting with allocative efficiency, it is clear that trade is beneficial for both countries: the overall gains from trade are invariant to the reason for comparative advantage. However, it might be that global efficiency is served by preventing poverty to affect comparative advantage and trade patterns. To see this, we note that the switch away from nature-given comparative advantage is not efficient compared to a world where this switch had not occurred. A conceivable alternative world in which the infertile country develops a larger industrial base and the fertile country specializes in agriculture, clearly would be able to achieve higher global output in both agricultural and manufactured goods. Food production taking place in fertile regions means that the world is able to harbor a higher share of trained workers, so that the number of manufacturing companies increase, bringing down costs of manufactures. In other words, *given* the circumstances there are advantages in terms of allocative efficiency, but opening up to trade also affects the circumstances. Whether this is for the good depends on the timing of trade liberalization. Trade could help creating an alternative distribution of endowments that is more efficient, but it is also possible that trade delays or prevents reaching the most efficient distribution of endowments. How

[20] This holds when the population growth rates in both countries are not too far apart. Only when the more fertile North also reaches steady state at subsistence levels of income, while having a population growth rate exceeding that of South considerably, will the upward sloping part reappear.

this works will become clear after discussing how trade affects comparative advantage and how this depends on the timing of trade liberalisation.

Comparative advantage changes with the development phase of a country. Initially, North has a comparative advantage in agricultural products, which is in line with its nature-given comparative advantage. Due to North's faster industrialisation, however, its comparative advantage immediately shifts into manufacturing once training enters the analysis. In steady state though, North's comparative advantage is in food again. Qualitatively, trade does not affect this development pattern. Regardless of whether trade does or does not take place, the steady state, in which no more labour is trained, is always the same, determined by internal factors only.[21] In the (very) long run, therefore, trade has no impact upon development and, for that matter, the endowment distribution.

However, this does by no means imply that trade is irrelevant. Trade affects the income distribution and, by that, influences the speed of development of countries. How exactly depends on the moment that trade liberalisation occurs. It turns out that the important distinction for developing an industrial base is between (1) liberalisation occurring before the southern region has achieved subsistence levels of income, (2) liberalisation occurring after the southern region has achieved subsistence levels of income, but with still a comparative advantage in agricultural goods, and (3) liberalisation occurring after the southern region has achieved subsistence levels of income and has returned to its nature-given comparative advantage in manufactured goods.

If trade occurs before the southern region has achieved subsistence levels of income (phase 1), it will tend to speed up the industrialisation processes sketched in the previous section. For this to take place it does not matter when exactly during phase 1 trade is liberalised. Suppose, for instance, that there is free trade right from the start. Then North will start exporting agricultural products and import industrial goods (and opposite for South)[22].

[21] Specifically, the relative consumption shares of agricultural and manufactures products and the degree of economies of scale in the agricultural sector.

[22] To be precise, both countries are either a net importer or net exporter of manufactures,

However, comparative advantages will immediately shift and North acquires a comparative advantage in manufacturing. If trade remains liberalised, South's comparative advantage in agriculture implies that that sector starts to gain from trade. This accelerates training and South starts to catch up. If this takes place before South has reached the subsistence threshold, trade thus increases the rate of industrialisation in South. By contrast, in North it will lower the rate of industrialisation, as long as North is still at subsistence. During phase 1, therefore, trade counters poverty-induced specialisation patterns and supports the restoration of nature-given comparative advantages.

Once both countries reach subsistence levels of income, the impact of trade becomes different. Now, the desirability rather than the room for training governs training decisions. Were South still to have a comparative advantage in agricultural goods (phase 2), then trade tends to augment southern incomes in this sector, while depressing incomes in manufacturing. As a result training becomes less attractive. In North the opposite occurs: training is supported as trade boosts (lowers) incomes in manufacturing (agriculture). The overall effect is that trade supports poverty-induced specialisation patterns, delaying the shift back to nature-given comparative advantages. North reaches its steady state earlier because of trade, while for South it takes longer.[23]

However, the opposite occurs when trade is liberalised when both countries are above subsistence, yet comparative advantages are in line with their nature-given positions (phase 3). Now North, confronted with lower manufacturing and higher agricultural wages because of trade, will experience a decrease in the rate of training. In South, on the other hand, the manufacturing sector benefits from trade so that training becomes more attractive, speeding up industrialisation. In other words, trade supports specialisation in line with nature-given comparative advantages.[24]

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as trade in manufactures will be of the intra-industry type. Hence, when we speak of specialization in production, we actually mean relative specialization.

[23]Note that due to differences in fertility, comparative advantage will shift before the process of catching up is completed.

[24]This also holds true for the situation where North is above subsistence and South at subsistence levels of income, while South has a comparative advantage in agriculture. In that case, trade liberalisation increases training levels in both countries, boosting devel-

For the desirability of trade liberalisation, this has important implications. First, we note that ultimate outcomes of development are not affected by trade, so that these do not enter the evaluation of trade liberalisation. In other words, there are no strict 'lock-in' effects. Even if we would allow for exogenous population growth, with South's comparative advantage remaining in agriculture forever, trade is not the reason for lock-in effects.[25] What trade can do, however, is to affect the moment these ultimate, steady-state outcomes are achieved, either delaying it or advancing it. Second, we note that the analysis lends some to the idea that global efficiency might be served by stalling trade liberalisation. Returning to our earlier point on allocative efficiency: while efficient in terms of allocation of production and consumption, trade may not be efficient regarding the distribution of endowments. Stalling trade during intermediate phase 2 would have the benefit that it brings the world closer to the situation where nature-given comparative advantages rather than poverty determine specialisation and trade patterns.[26]

The implications of trade liberalisation on industrial development are summarised in Table 1. Consider the southern, less fertile region, then trade is certainly supportive of industrialisation in phase 1. Boosting agricultural incomes, trade increases the room for training and industrialisation can occur at a higher pace. Trade negatively affects industrialisation objectives, however, once South has reached subsistence levels of income but still has a poverty-induced comparative advantage in agricultural goods. It is only after comparative advantages have shifted back to their nature-given positions that trade becomes supportive of industrialisation again. For North the implications are exactly opposite.

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opment in North and South.

[25]In fact, with population growth, trade may help South to escape subsistence levels of income, as it increases the room for training.

[26]This seems to ignore any costs that could be involved in shifting from the poverty-induced to the nature-given state. As it can be argued that individuals would weigh these costs against the benefits of structural transformation in their training decisions, including such costs would render the argument favouring temporary protection null and void. However, price-taking individuals do not take into account the effects of training that occur via changed global endowment distributions and specialization pattern. Individuals not taking into account these effects train less than the optimal amount from a social perspective.

Table 1: Effects of trade on the pace of industrial development

	North	*South*
Phase 1: at subsistence	negative	positive
Phase 2: above subsistence; poverty induced comparative advantage	positive	negative
Phase 3: above subsistence; nature-given comparative advantage	negative	positive

From the point of view of industrialisation and endowment distribution, therefore, our analysis implies that trade is beneficial to the poorest countries, but might be forgone by middle-income countries in the process of catching-up. Choosing not to open up to trade could accelerate development for these countries.[27] However, what is also clear from Table 1 is that when industrialisation is at stake, trade liberalisation tends to be a zero-sum game, at least until steady states have been achieved. Whenever North benefits from trade, South does not and vice versa. The only exception occurs in the intermediate phase that is not exhibited in the table, when North has reached subsistence levels, while South has not. In that case, trade is temporarily positive for both countries (see footnote 24).

7 Conclusion

This paper has argued that poverty is a crucial factor in assessing the desirability of trade liberalisation for development. The basic argument we have

[27] We only use trade policy as intervention option for illustrative purposes. Other forms of intervention might of course be preferable to trade policy, but it is beyond the scope of this paper to assess which policy constitutes a first- or second-best intervention to the problems we perceive.

put forward is that poverty limits people in their economic choices. Confronted with a wage that is hardly sufficient to survive, people are forced to supply all the labour time necessary for reaching a subsistence income. In this sense, deciding on one's labour inputs on basis of their preferences about various alternative uses of available time is a luxury that poor people cannot afford.

The main effect of this observation is that in a context of poverty, higher wages will tend to limit labour supply and boost alternative uses of time, such as schooling. It follows that countries whose population enjoys higher agricultural incomes will be able to invest more in training, and therefore develop faster. These aspects of poverty have been analysed in a formal set-up that takes heed of these non-standard decision processes. It has been shown that countries enjoying a nature-given comparative advantage in agriculture, for instance because of higher fertility of land, will develop a poverty-induced comparative advantage in manufacturing. Over time, however, as incomes rise and industrialisation takes hold in less advantaged regions as well, this pattern of comparative advantage will shift back again to its nature-given position.

Trade has no qualitative effect on these processes, but may either prolong or compress the period of poverty-induced comparative advantages. Dependent on the specific phase of relative development of a country, it might be desirable to pass by on trade if one's goal is to industrialise as soon as possible. Our paper therefore supports the critique that poverty disqualifies the standard reasoning (in economics) that free trade is typically good. Poverty has been shown to matter, for both development and the resultant emergence of trade patterns. Dependent on the importance one attaches to dynamic income effects, a temporary phase of protection might therefore be desirable for developing countries. Such temporary protectionist measures are however not benefiting the poorest countries. Opposition to free trade is principally in the interest of middle-income countries in the process of catching-up. This puts the collapse of trade talks in Cancun in a rather different light, since the opposing block of developing nations was led by precisely such middle-income countries. In terms of poverty alleviation, then, free trade is still optimal.

In the end, of course, the income effects of various policy alternatives need to be compared to assess the relevance and desirability of policy intervention. We have not addressed this issue explicitly, but note that whereas industrialisation raises incomes in the long(er) run, trade always brings direct beneficial effects, in terms of increased static allocative efficiency. In other words, the decision whether to open up to trade or not for a middle-income country while catching-up hinges on its particular trade-off between direct income effects and the desired speed of industrialisation. If a country puts a stronger emphasis on current income, trade is always beneficial. If, by contrast, a country is willing to sacrifice current gains from trade to achieve higher levels of income in future sooner, stalling free trade could be optimal. For instance when trade liberalisation would prolong the state where poverty-induced comparative advantage pattern governs trade patterns. Because of poverty, countries seeking fast industrialisation and a rapid dissemination of dynamic income effects may want to temporarily stall the free movement of goods until comparative advantage has resumed its nature-given order.

If other countries have the same objective, conflicts of interest are likely to emerge. One might suspect that trade liberalisation becomes a very difficult exercise for this reason. On the other hand, also global efficiency may be served by stalling free trade. Global income levels will be highest when natural endowments determine comparative advantage and not poverty. In a world where poverty matters, our analysis shows that there are instances where postponing trade liberalisation may serve poverty alleviation and global efficiency at the same time.

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Figure 1: The training decision of untrained labour

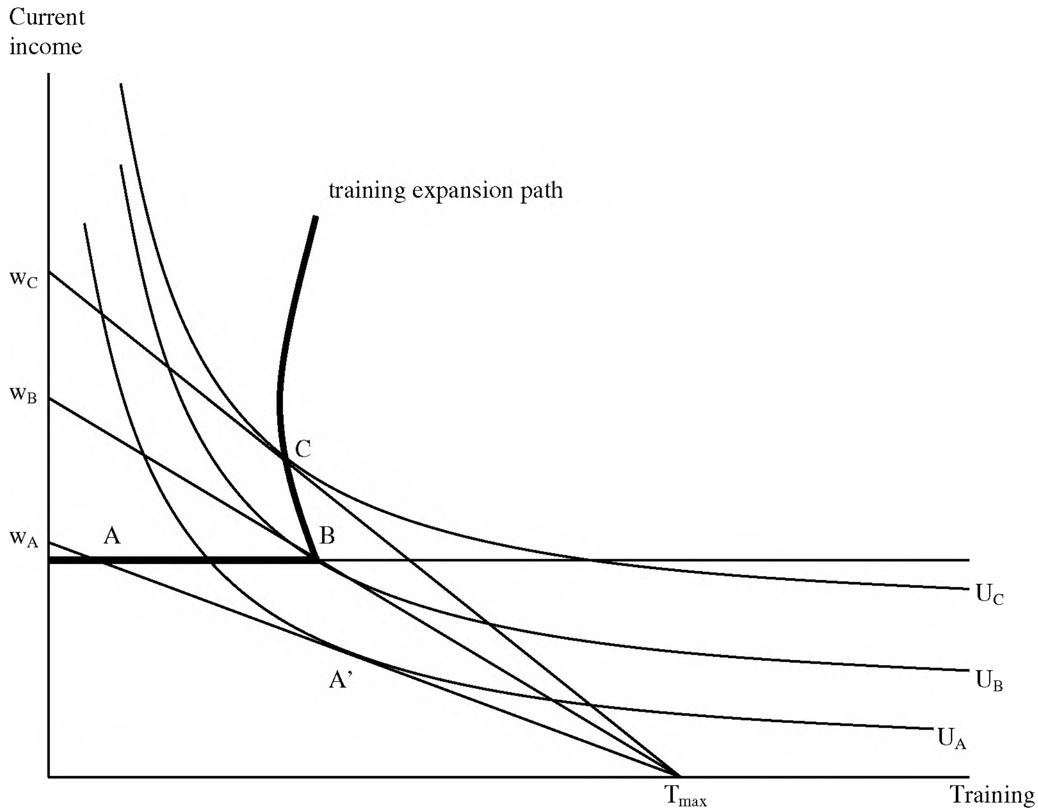


Figure 2: Development of training as a function of H

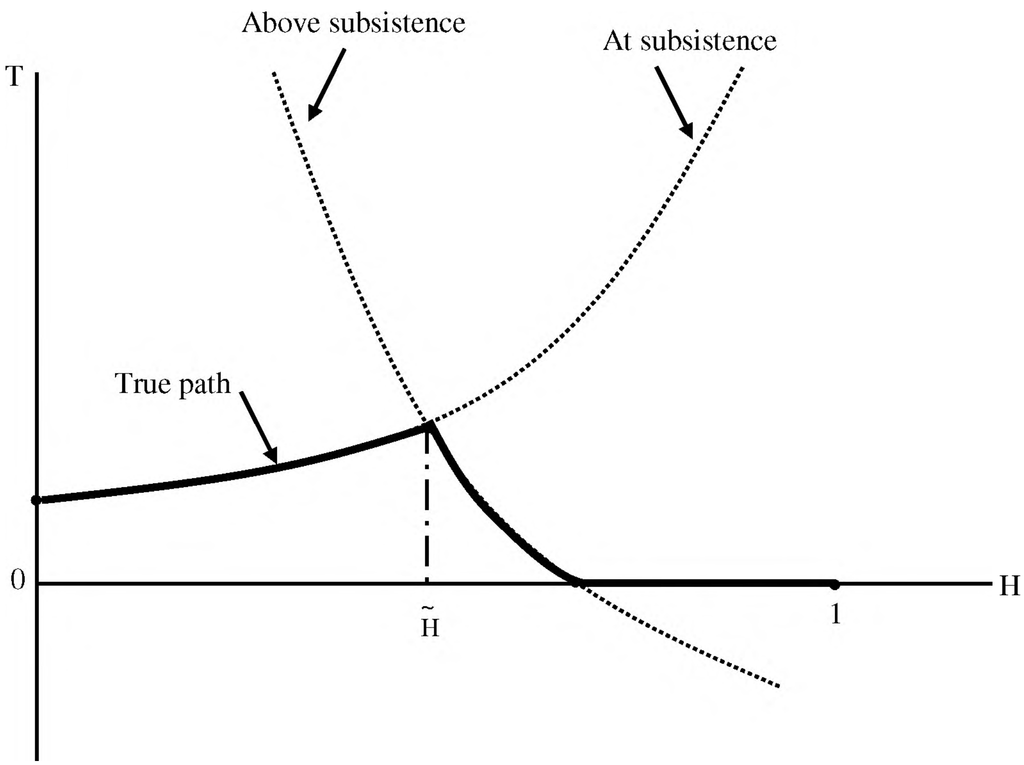


Figure 3: Individual training decisions over time (T, T^S)

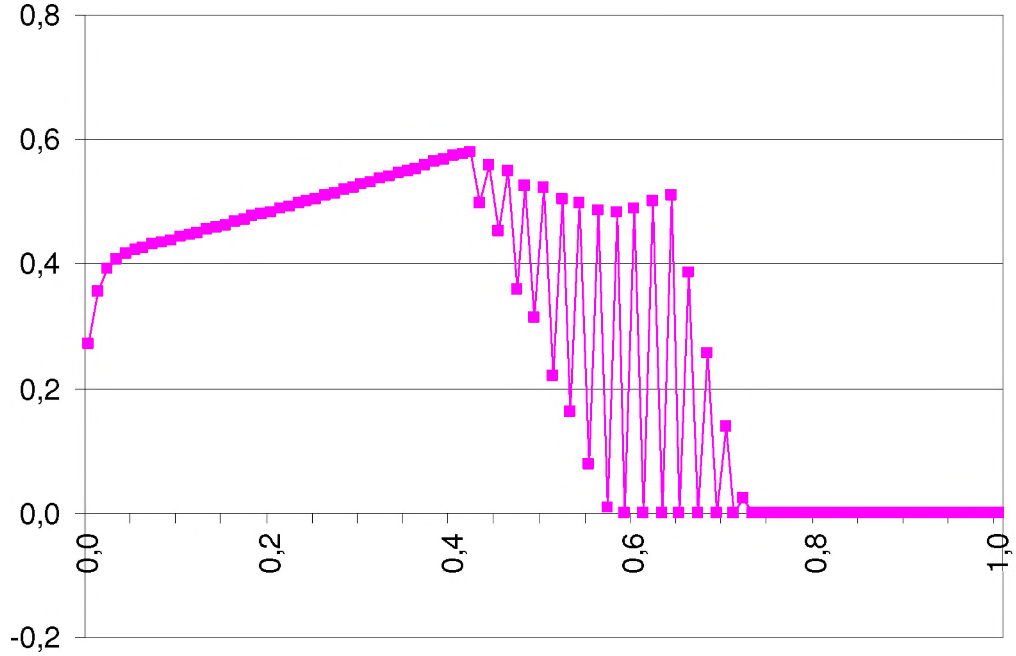
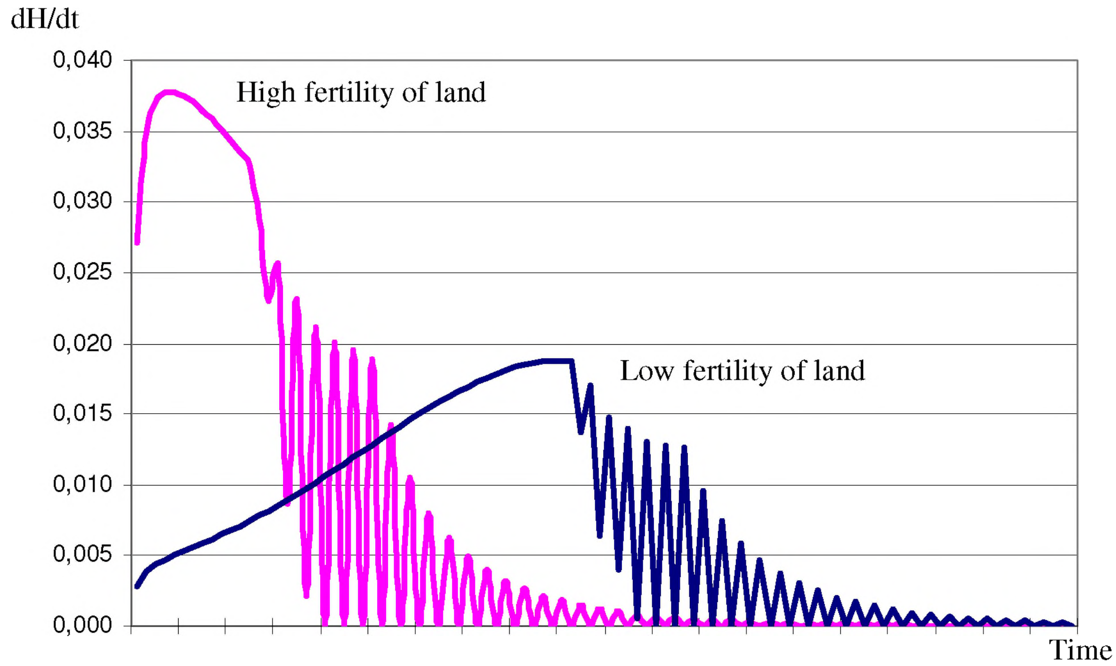


Figure 4: Accumulation of trained labour over time

Panel A: Low value of β



Panel B: High value of β

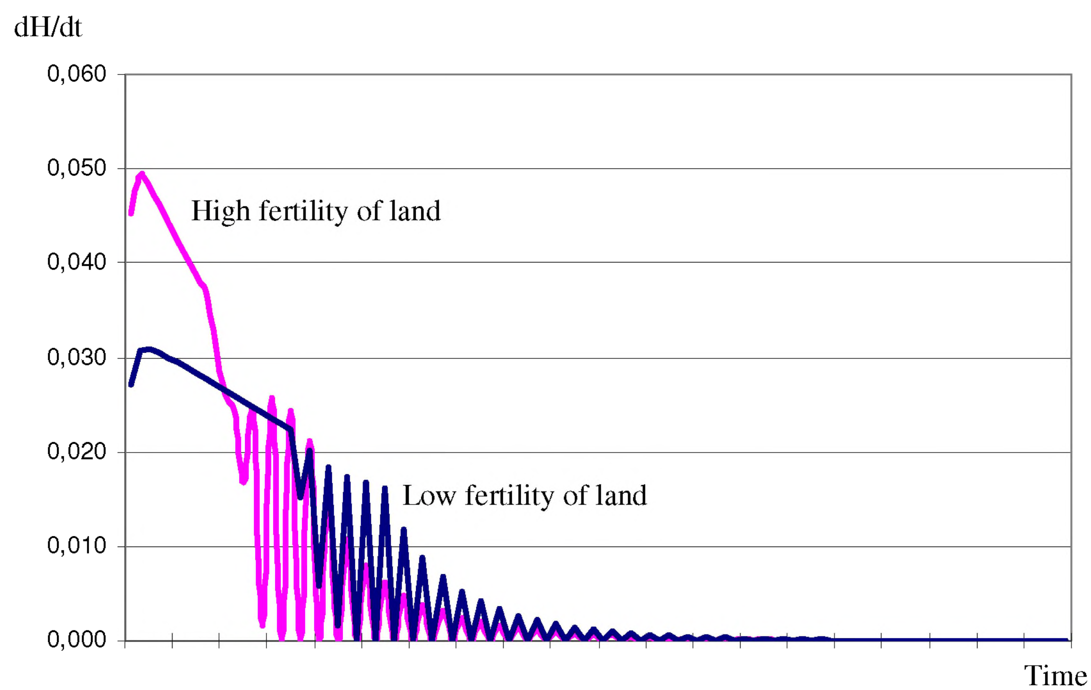


Figure 5: Comparative advantage over time