CONVERGENCE CLUBS AND
SUBSISTENCE ECONOMIES

Dan Ben-David

Working Paper **6267**

CONVERGENCE CLUBS AND
SUBSISTENCE ECONOMIES

Dan Ben-David

Convergence Clubs and Subsistence Economies
Dan Ben-David
NBER Working Paper No. 6267
November 1997
JEL Nos. E1, E2, O4

ABSTRACT

This paper focuses on one possible explanation for the empirical evidence of (a) income convergence among the world's poorest countries and among its wealthiest countries, and (b) income divergence among most of the remaining countries. The model incorporates the assumption of subsistence consumption into the neoclassical exogenous growth model – yielding outcomes that are consistent with the convergence-divergence empirical evidence. While subsistence consumption can lead to negative saving and disaccumulation of capital, it can also coincide with positive saving and accumulation of capital. The model predicts that the poorer the country, the lower its saving rate, a result that also appears to be borne out by the evidence provided here.

Dan Ben-David
Berglas School of Economics
Tel Aviv University
Ramat Aviv, Tel Aviv 69978
ISRAEL
and NBER
BenDavid@econ.tau.ac.il

NON-TECHNICAL SUMMARY

As many empirical studies in recent years have pointed out, income gaps between most countries do not appear to be falling over time. In fact, the evidence suggests that income differentials between many countries may even be rising.

If countries are arrayed along a spectrum of per capita incomes, there appear to be only two segments of the income spectrum where the likelihood of finding income convergence is no less than the likelihood of finding income divergence among countries. These are the segment comprising the world's wealthiest countries and the segment comprising the world's very poorest countries.

In particular, if one randomly groups together countries chosen from the subset of the world's wealthiest countries, then the probability of finding convergence within the random groupings – while not particularly high – is not negligible. Where the convergence appears to be the most prevalent however, is among the poorest countries.

In other work that I have done, I have explored the convergence issue to see if it might be possible to isolate a common thread that ties together the non-poor converging countries from those non-poor non-converging countries. The focus in those studies was on the contribution of international trade which, it turns out, appears to be quite closely linked to the incidence of income convergence.

But high-end convergence and low-end convergence appear to manifest themselves quite differently. While convergence at the higher end of the income spectrum is the result of catching-up by the poorer countries within the respective groups, convergence at the lower end of the income spectrum is due to a convergence downward. This paper concentrates on the low-

i

end convergence and its goal is to provide a simple theoretical explanation that is consistent with the empirical evidence.

The per capita income spectrum is very wide. The average American's 1985 income was over 5,500% greater than the average Ethiopian's income of $300 that year (using purchasing power parities). In the 1940's, George Stigler determined the least cost diet needed to keep a person alive for one year. Surprisingly − or not − it turns out that the very low end of the income spectrum scrapes bottom at the current value of Stigler's least cost subsistence dietary requirement.

This paper takes the idea that there is a minimum level of consumption necessary to sustain life and imposes this constraint on the neoclassical growth model. The model shows that, while not all countries consuming at the subsistence level are necessarily disinvesting and experiencing declines in output, above-optimal consumption in the poorer countries leads to slower transitional growth that may lead to eventual disinvestment, or alternatively, to an eventual convergence to the optimal consumption path.

One implication of the model, a positive relationship between developmental levels and investment shares of output, is shown here to have strong empirical corroboration. Another implication of the model is that the poorest of the subsistence economies will converge downwards.

I. INTRODUCTION

The empirical issue of income convergence has been explored quite extensively during the past decade, with most studies concluding that there appears to be unconditional convergence among the wealthier countries of the world and little evidence of convergence anywhere else. Once different factors are controlled for, the evidence then points to the existence of conditional convergence.

More recently, Quah (1993) and Ben-David (1995) have shown that unconditional income convergence is not a trait that characterizes just the wealthiest countries. It is a phenomenon that is also apparent among the very poorest countries. In fact, as Ben-David (1995) shows, convergence among the very poorest countries is considerably more prevalent than among the wealthier countries. In addition, while the convergence at the top is one of "catching-up", Ben-David (1995) shows that the convergence at the bottom is downward, with the top seven countries out of the bottom 14 exhibiting negative average real per capita income growth between 1960 and 1985.

The primary emphasis of this paper is to provide a possible explanation for the convergence at the lower end of the income spectrum – an explanation that is, at the same time, consistent with the income convergence among the wealthier countries of the world and the divergence among nearly all of the other countries.

How would it be possible to explain the existence of the poorer club? The "poverty trap" case was modeled by Nelson (1956). In his classic paper from the same year, Solow showed that two steady states are possible if the saving rate (s) is an increasing function of the capital-labor ratio (k) and $s < 0$ for very small k. More recently, Rebelo (1992), Azariadis and Drazen

1

(1990), and Becker, Murphy and Tamura (1990) developed endogenous growth models that use varying formulations for the accumulation of human capital to explain how countries may be drawn into poverty traps.[1]

The theoretical framework adopted in this paper is a bit different. Since the poorer convergence clubs include countries that are the poorest of the poor, there exists the possibility that people in these areas are surviving on subsistence levels alone. If so, then how might the incorporation of subsistence affect our expectations of global convergence in the neoclassical growth model?

This issue is examined below by allowing for subsistence consumption under conditions of exogenous growth. While neither one of these concepts alone is new, the contribution here is in the merging of the two and a comparison of the predictions with recent empirical evidence. In the model, countries consuming at the subsistence level exhibit divergence from the other countries and, in most cases, also from one another — a state of affairs that can last for a considerable period of time and appears to be quite consistent with the empirical evidence provided in Ben-David (1995). Also in the model, the very poorest countries exhibit downward convergence. However, subsistence consumption does not imply that a country is inevitably destined to remain impoverished forever, nor does it even imply that the country necessarily has negative savings. As will be shown below, there still exists the possibility that the country will break out of the poverty cycle and move to the same long-run steady state path as the other, wealthier, countries.

---

[1] Among the other theoretical explanations for convergence-divergence behavior, see also Brezis, Krugman, and Tsiddon (1993) and Goodfriend and McDermott (1994).

Is it reasonable to assume the existence of technical progress in conjunction with subsistence level economies? The rationale here is not that countries on the verge of starvation devote resources towards technological advancement but rather that such advancement is occurring in other, more developed, countries and that this technology becomes available to all. In the case of the poorest countries, this could include higher-yield grains, new irrigation techniques, and so on.

Section two provides some motivation for the theoretical framework that follows in section three. Section four details the model's implications and a simple numerical example is provided out in section five. Section six concludes.

II. MOTIVATION

Much of the recent work in growth theory utilizes endogenous growth models that produce multiple steady states. Models such as those in Rebelo (1992) and Azariadis and Drazen (1990) which incorporate the concept of human capital thresholds are particularly useful in providing an explanation for the existence of a steady state at poverty trap levels. However, it is not mandatory to use endogenous growth models to attain multiple steady states. Other plausible outcomes are possible within an exogenous growth framework as well. One such variant of the neoclassical growth model with exogenous growth is shown here.

If one wants to examine the behavior among the poorest of the poor, then the issue of subsistence consumption might be considered a more relevant argument than decisions pertaining to the accumulation of human capital. Here, the assumption is that desperate people will draw down their existing capital just to survive (for example the slaughter of a family's entire stock of animals for food, the complete deforestation and dismantling of anything that burns to survive

3

winter cold, etc.). Diminishing capital stocks will have a detrimental effect on output production, trapping the affected countries into a "club" characterized by non-existent, or even declining growth.

Suppose then, that there is a minimum amount of consumption required for sustaining life. How appropriate, or relevant, is this assumption? There are clearly other heavy burdens that handicap these countries which might be modeled in endogenous growth frameworks. Poor and deteriorating infrastructure and the lack of coordination in the supply of goods and services are just a few of the major impediments that can inhibit growth. However, the relevance of subsistence consumption might be in the premise that, if a large enough segment of the population is concerned with nothing else than just staying alive, then these other issues that are of such importance to most other countries will be minimally addressed, if at all, in the very poorest nations.

If the existence of subsistence consumption can lead to different behavior in the afflicted countries, then how applicable is this status? Are there any countries that are really that poor? If not, then this whole discussion is purely academic (no pun intended).

Stigler (1945) showed that the least cost requirement for sustaining an individual's minimum dietary needs (e.g. flour, evaporated milk, beans, etc.) is approximately $300 a year (in 1980 dollars).[2] As Becker (1993) points out, this entails just the very basics and would certainly leave much to be desired as far as taste and variety are concerned.

---

[2] Stigler calculates two alternative diets. The annual cost of the two diets in 1944 prices was $60 and $68, respectively. While relative prices are clearly not the same today as then, and while Stigler himself notes that different cultures and different dieticians may prescribe different minimum diets, Stigler's calculation does provide a ballpark estimate for the cost of basic nutritional necessities.

The World Development Report (1990) on poverty concludes that there were 1.1 billion people living below the poverty line in developing countries in 1985. Of these, 633 million were classified as extremely poor. These findings are supported by a United Nations (1992) study on nutrition which finds that approximately one-third of the children living in developing countries suffer from malnutrition. One of the most prevalent symptoms of malnutrition is low height for a given age. The World Development Report (1993) finds that approximately 40% of all two-year olds in developing countries are short for their age.

In 1960, the first year of the empirical analysis in Ben-David (1995), the United States had a real per capita income of $7,130 (in what Summers and Heston (1988) refer to as 1980 international dollars, which are rough equivalents of U.S. dollars). In the same year, 1960, there were 6 countries with real per capita incomes below $300, 10 with incomes below $400, and 24 countries with incomes below $500. Hence, if there is such a thing as a minimum subsistence level, then there do appear to be countries for which application of this concept would not seem to be too far-fetched.

III. THE MODEL

Consider a closed economy with identical consumers in a model that incorporates exogenous technical progress with the productivity parameter $A(t)$ growing at a constant rate μ. Lower case variables will represent aggregates divided by units of effective labor, $A(t)L(t)$, while aggregate quantities will be denoted by capital letters. Assume that the technology exhibits constant returns to scale in capital and effective labor. Preferences, which are represented by a concave utility function of the consumption stream, are denoted by

(1)
$$\int_0^\infty e^{-\rho t} u\,[c(t)]\,\mathrm{d}t$$

where ρ is the constant rate of time preference. The economy produces a single good that may be consumed or saved. Capital accumulates according to the following time path:

(2)
$$\dot{k}(t) = f(k(t)) - (\delta+n+\mu)k(t) - c(t) \qquad \forall\ t \geq o$$

where δ equals the exogenous rate of depreciation and n equals labor's constant rate of growth.

Each period's consumption is bounded from below by $\bar{c}$, the subsistence level in terms of effective labor, and from above by the country's output level $f(k(t))$, *i.e.* $\bar{c}(t) \leq c(t) \leq f(k(t))$. The time subscript in $\bar{c}(t)$ is inserted to indicate that, while subsistence consumption in per capita terms is constant, the increases in $A(t)$ lead to a reduction in the subsistence level when it is denoted in terms of effective labor.

Individuals choose a time path for consumption. Their consumption decisions, taken together with the economy's initial capital stock $k(0)$ and its technology, imply a time path for the capital-labor ratio. These optimal paths are derived by maximizing H, the current value Hamiltonian which is defined as follows (the time subscripts are dropped for notational clarity):

(3)
$$H(k,\theta,c,t) = u(c) + \theta[f(k) - (\delta+n+\mu)k - c] \qquad .$$

The shadow price, θ, must satisfy

(4)
$$\dot{\theta} = -[f'(k) - (\delta+n+\mu+\rho)]\theta$$

where $\dot{\theta} = 0$ defines the balanced growth capital stock k^* since $f'(k^*) = \delta+n+\mu+\rho$.

The first order condition for an interior maximum is

(5)
$$\frac{\partial H}{\partial c} = u'(c) - \theta = 0$$

Letting θ^* be the balanced growth level of θ , then $u'(c) = \theta^*$ yields the optimal level c^*. In the event that $u'(c) > \theta^*$, then $c(t) = f(k(t))$. Alternatively, if $u'(c) < \theta^*$, then H is maximized when $c = \bar{c}$, the subsistence level of consumption.

From equation 2, $\dot{k} = 0$ implies that $c = f(k) - (\delta+n+\mu)k$. Therefore,

(6)
$$\bar{c} = f(k_L) - (\delta+n+\mu)k_L$$
$$= f(k_H) - (\delta+n+\mu)k_H$$

where $\bar{c}$ determines the lower and upper boundary levels k_L and k_H . When k is between these boundaries and c is below the $\dot{k}=0$ curve, then $\dot{k}>0$. Conversely, $\dot{k}$ will be negative when k is outside of the two boundaries. Similarly, since $c=\bar{c}$ when $k<k_L$ and $k>k_H$, then $\dot{c}<0$ in those regions as well. Figures 1 and 2 illustrate how the inclusion of subsistence consumption will lead to two possible steady states, the first of which is the standard steady state combination of k^* and c^* .

Note that the decline in $\bar{c}$ implies that k_L is also falling over time, while k_H
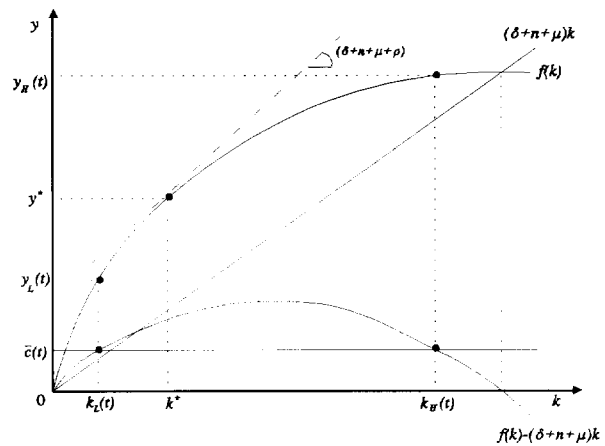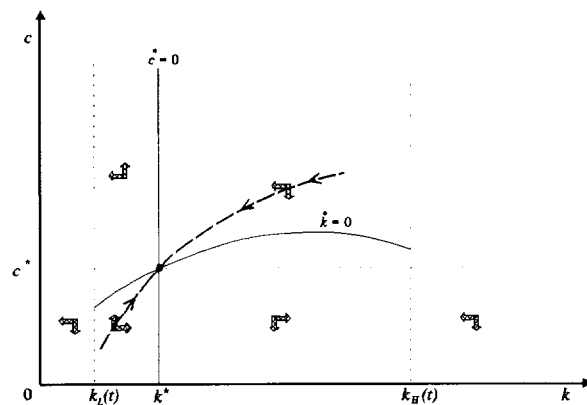

Figure 1

Figure 2

7

is rising. If the initial level $k(0)$ is greater than k^*, then stability requires that $c > c^*$. Alternatively, when $k_L < k(0) < k^*$ then stability requires $c < c^*$. If $k(0) < k_L$, then $c(t) = \bar{c}$ and $\dot{k}, \dot{c} < 0$.

However, since $\dot{k}_L < 0$ as well, there remains the question of whether k_L is falling at a faster rate than k. If $k(0) < k_L$ and $\dot{k}_L < \dot{k} < 0$, then it is possible that while k will fall in the short-run, it can later increase to k^* after it is overtaken by the falling k_L. The question then, is whether it is possible that $\dot{k}_L < \dot{k} < 0$.

Since $\bar{c}$ falls at the rate μ, then a total differentiation of the top part of equation 6 yields

$$(7) \qquad \frac{\dot{k}_L}{k_L} = -\mu \left(\frac{\dfrac{f(k_L)}{k_L} - (\delta + n + \mu)}{f'(k_L) - (\delta + n + \mu)} \right) \; .$$

Thus, assuming that $f(k)$ exhibits constant returns to scale in capital and effective labor, then k_L's rate of decline is lower for smaller values of k_L since $f(k_L)/k_L > f'(k_L)$. In other words, $\dot{k}_L$ becomes less negative as k_L falls.

Because $\dot{k} = 0$ at every k_L, then $\dot{k}$ is just slightly below 0 for some very small ϵ below k_L and the rate of decline increases to negative 100 percent as k falls to 0. Hence, if $k(0) < k_L$, then there must exist some critical value $0 < k_c < k_L$ above which $\dot{k}_L < \dot{k} < 0$ and the falling k will be overtaken by the falling k_L. If $k(0)$ is below this critical value, then $\dot{k} < \dot{k}_L < 0$ and k will continue to fall.

IV. IMPLICATIONS

The convergence to the steady states may be seen in figure 3. When countries begin with

very low levels of income that are

accompanied by subsistence

consumption, for example

$$y(0) = f(k(0)) < f(k_c(0)) = y_c(0) ,$$

then the result will be negative

saving, and a further reduction in

incomes. However, subsistence

consumption does not imply that a

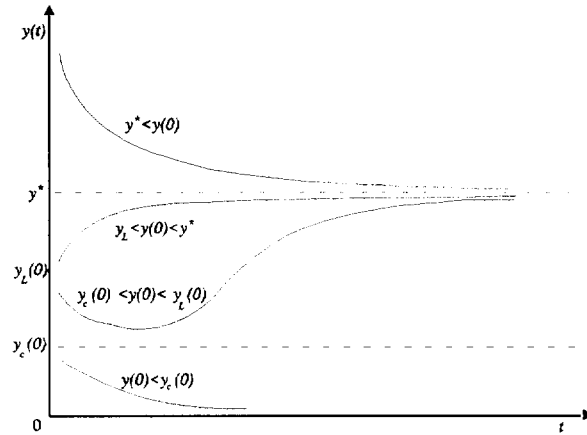country will necessarily converge

downward forever. Countries with

Figure 3

incomes above y_c will eventually be able to consume beyond what is required for subsistence

and they should converge to the higher steady state level of income, y^*.

In fact, consumption at the subsistence level does not necessarily imply that a country is

disinvesting and experiencing declines in output. Take the example of the hypothetical country

depicted in figure 4. Suppose that it starts at $t=0$ with an initial level of capital that is below

k_L, *i.e.* $k(0) < k_L(0)$. Thus, minimum consumption will be $\bar{c}(0)$ and the economy will begin

at point E_0 — meaning that both k and k_L are initially declining.

Now assume that at $t=1$, the drop in k_L exceeds the drop in k so that $k(1) > k_L(1)$. The

level $k_L(1)$ implies that the new level of minimum consumption will be at $\bar{c}(1)$ — which is

greater than $\hat{c}(1)$, the optimal level of consumption (on the stable manifold) at $k(1)$. Hence,
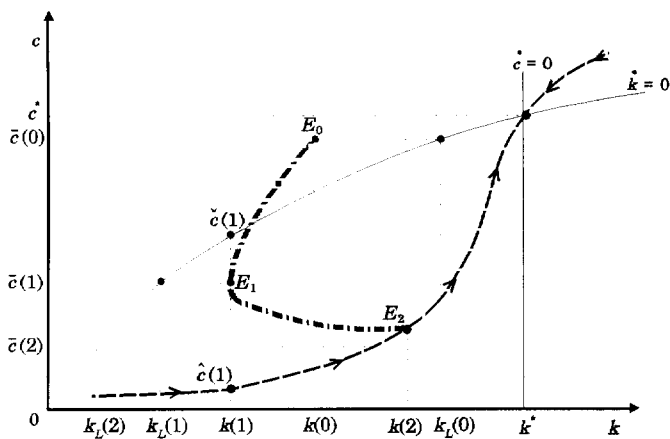
9

Figure 4

consumption will remain at the subsistence level (the economy will be at E_1), though k now starts to accumulate since $\bar{c}(1) < \check{c}(1)$. This process continues (along the thick dotted line), with $\bar{c}$ falling and k rising, until the stable manifold is reached, at E_2. From that point, the economy moves from subsistence consumption to the optimal level of consumption and continues along the stable manifold until it reaches k^*.

Do countries at different levels of development really exhibit different saving rates – and is it even conceivable that the poorest countries actually disinvest? The addition of utility maximization in the model endogenizes the savings rate, yielding a positive relationship between saving rates and income levels. Saving rates, which in this model are assumed to equal the share of investment in output, $\dot{K}/Y$, can be rewritten as

$$(8) \qquad \frac{\dot{K}}{Y} = (\gamma_k + \delta + n + \mu)\frac{k}{y}$$

where $\gamma_k = \dot{k}/k$. Thus, according to the model, wealthier countries will have higher capital-output ratios (as is evident in figure 1) and hence, higher investment ratios.[3] How closely is this prediction matched by the empirical evidence?

---

[3] This is true providing that cross-country differences in the capital-output ratios across countries exceed the cumulative discrepancies in the terms within the parentheses.

Ben-David (1995) ranks 112 countries according to their per capita incomes in 1960 and then partitions these countries into 8 equally-sized groups with 14 countries in each. The 14 poorest countries are in Group 1, the next 14 countries are in Group 2, and so on until the 14 wealthiest countries which are in Group 8. F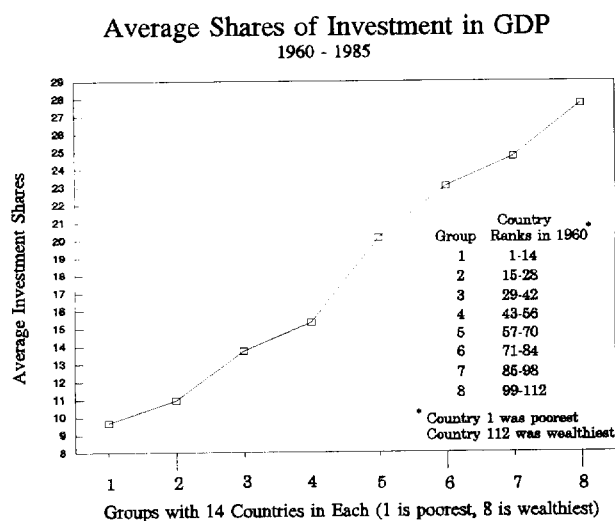igure 5 plots the average ratios of investment to GDP for each group between 1960 and 1985.[4] As is evident from the figure, there appears to be a positive relationship between investments and incomes — which would seem to corroborate the implications of the model.[5] Countries that invest less exhibit lower levels of development.

Average Shares of Investment in GDP
1960 - 1985

Group	Country Ranks in 1960
1	1-14
2	15-28
3	29-42
4	43-56
5	57-70
6	71-84
7	85-98
8	99-112

* Country 1 was poorest
Country 112 was wealthiest

Groups with 14 Countries in Each (1 is poorest, 8 is wealthiest)

Figure 5

Since net investment will be below the values depicted in figure 5, then this would be reflected in a new schedule that would lie below the gross investment plot. Whether or not this is negative for the poorest countries can only be conjectured in lieu of accurate data on net investments in these countries. However, to the extent that this is negative for those countries that are bordering the subsistence income definition (e.g. the countries in Group 1), then the outcome of downward convergence exhibited by these countries would be an expected outcome of the model.

---

[4] Data source: Summers and Heston.

[5] Romer (1994) also reports a positive relationship between investments and incomes.

When $k(0) < k_c(0)$, the capital stock is eventually depleted and the population either starves or begins to kill one another for control of the remaining resources.[6] The abrupt fall in L, possibly coupled with — or preferably, prevented by — an inflow of international aid, will cause k to jump upward (figure 6). If this jump is to a level of $k(t) > k_c(t)$, then the economy should be able to avoid future crises of this magnitude (barring unforeseen disasters such as droughts, floods and man-made calamities) and should eventually converge to the upper steady state (curve A).
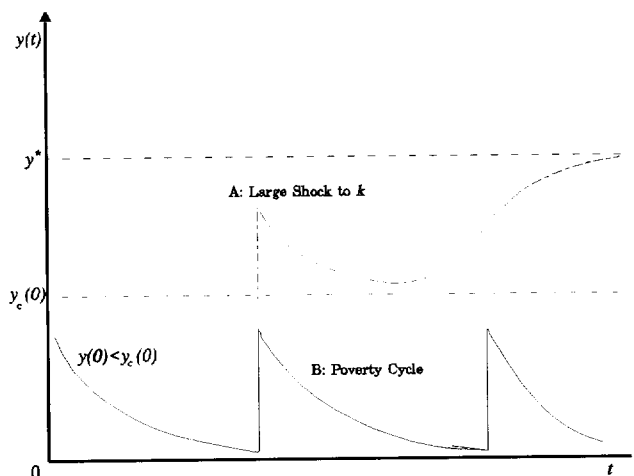
Figure 6

However, if the jump in k only brings temporary "relief" (curve B), then the country will find itself again experiencing the poverty cycle. Thus, the lower steady state is not stable in the sense that the higher steady state is.

While admittedly simplistic, this model provides a framework for explaining the stylized facts described in Ben-David (1995). The prediction of convergence to two steady state paths, one high and the other the poverty trap, appears to be consistent with the empirical evidence.

---

[6] The Malthusian outcome is described from a different perspective in Tamura (1995), which focuses on human capital accumulation and spillovers and their subsequent impact on the development process. Ehrlich and Lui (1991) and Tamura (1994) analyze how countries can extricate themselves from such poverty traps through reductions in fertility rates.

The divergence outcomes of the countries in between the two convergence clubs are also explained here.

Note that the values in figure 3 are denoted in output per effective labor, hence a decline in these values does not necessarily imply that *per capita* output will exhibit negative growth. Figure 7 reflects the figure 3 dynamics, this time in terms of log per capita output (represented here by $\tilde{y}$) for countries with $\tilde{y}_c(0) < \tilde{y}(0)$. As is shown in the figure, divergence in per capita terms can occur even when all countries experience non-negative growth.
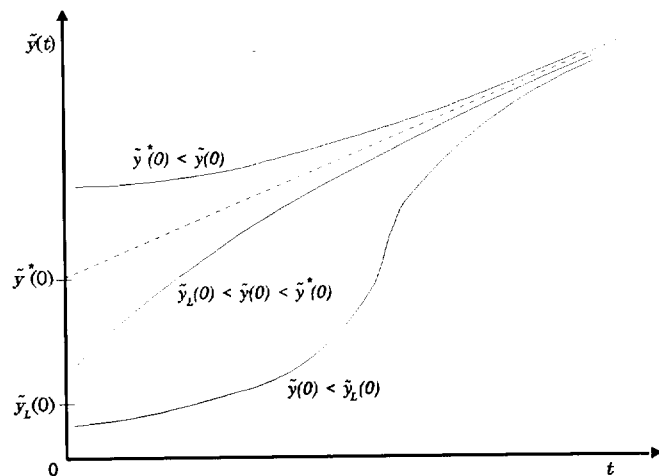

Figure 7

This kind of behavior is consistent with Fogel (1994) who finds that low food intake by the inhabitants of poor countries effectively limits their participation in the work force and impairs the productivity of those who do participate, leading to slower rates of economic growth by the affected countries.

The implications of the model however, as shown in figure 7, indicate that the divergent paths of countries beginning with incomes between $\tilde{y}_c(0)$ and $\tilde{y}^*(0)$ may not be a long-term phenomenon. Much of the slow growth exhibited by the subsistence level countries may eventually revert to faster growth and long-run convergence towards the upper steady state path.

This too is consistent with Fogel's long-term findings for several of today's industrialized countries that had exhibited many of the symptoms of current Third World countries including widespread malnutrition and stunted growth. As these conditions receded over the past two centuries, Fogel shows that the per capita growth rates of these countries increased.

V. AN EXAMPLE

A simple numerical example using log preferences [$u(c)=\ln c$] and Cobb-Douglas production [$y=k^{\alpha}$] can be used to illustrate the behavior of countries in the model. Following Coe, Helpman, Hoffmaister (1995), α will be set at 0.4.

Continuing with the Ben-David (1995) ranking of 112 countries by their 1960 real per capita incomes, this numerical example will concentrate on the lower half, or 56 countries, of the sample. Let the top 18 of these countries (in terms of per capita income) be included in group A, the next 19 in group B, and the last 19 in group C. The example will focus on 3 imaginary countries, each representing one of the 3 groups. Average population growth rates in each of the groups over the 25 year sample period are quite similar: 2.61%, 2.61%, and 2.69%, respectively. Hence, n will be set at 2.6%. To round out the other parameters, let $\delta=0.1$, $\rho=0.01$, and $\mu=0.01$.

The choice of these numbers does not qualitatively affect the general outcomes detailed below. One could, for example argue that μ, the rate of technological progress is higher. On the other hand, a counter-argument could be made that the technologies in the economies in question differ from those in the more developed countries and a lower μ might be a more appropriate characterization. Even in this instance however, it is more than likely that μ is still positive, given the continuing advances in the development of high-yield crops, fertilizers,

14

irrigation techniques, etc., which are available to the countries — whether or not they are actually adopted at any particular point in time.

The use of higher μ's for the wealthier countries and lower μ's for the poorer countries would lead to different steady states, a result that would still be consistent with the empirical stylized facts. Under these circumstances however, the interpretation of divergence among most countries would be that each is heading towards its own unique steady state path.

But why should countries have differences in technologies? Technology is transferable. So, we would expect that over time, all countries should converge to the same technology. The point of the model developed here is that one need not assume different technologies in order to provide an explanation for the empirical regularities. To the extent that technologies do differ however, incorporation of different μ's into the model is certainly possible.

Average annual real income levels for the three groups comprising the poorer 56 countries are \$847, \$555, and \$356.[7] Suppose that subsistence consumption is \$500, or 90% of the middle group's income. The middle group's initial income is used as the numeraire for this example and the other two group's initial incomes are scaled appropriately. Using the above assumptions, it is possible to calculate the steady state level, k^*, by substituting the appropriate parameter values into

$$(9) \qquad\qquad k^* = \left(\frac{\alpha}{\delta + n + \mu + \rho} \right)^{\frac{1}{1-\alpha}} .$$

The related steady state values y^*, c^*, and θ^* can then be determined as well.

The next step is to approximate the stable manifold. Since, by definition, $\dot{k} = 0$ and $\dot{\theta} = 0$ in the steady state, reducing k by a minuscule amount makes it possible to calculate the related

---

[7] This is compared with \$5,225, \$2,406, and \$1,306 for the three divisions of the top 56 countries.

values of $\dot{k}$ and $\dot{\theta}$ – which can then be used to determine new values of k (and hence, y) and θ. The latter, in turn, can be used to calculate c using equation 5. By working backward in this manner, it is possible to calculate the stable manifold for this exercise. The path of $\bar{c}$ and the related k_L's (using equation 6) are also calculated backward starting from $\bar{c}(0)$.

It now becomes possible to examine the growth paths of A, B, and C. In the case of A, its initial $k^A(0)$ exceeds $k_L(0)$ – implying that it is accumulating k – but the optimal level of consumption along the stable manifold at $k^A(0)$ is still below the minimum subsistence level, $\bar{c}(0)$, in the initial period. Therefore, although A consumes at the subsistence level at first, it nonetheless begins to accumulate capital, albeit at sub-optimal levels. As $\bar{c}$ falls and k rises (similar to the movement from E_1 to E_2 in figure 4), A moves to the stable manifold within a half dozen periods. The growth path of output for A may be seen in figure 8.

In the case of the two other groups, $k^C(0) < k^B(0) < k_L(0)$, hence the subsistence consumption constraint leads to negative savings. World Bank (1994) data on net transfers indicates that the countries in these groups are net recipients of aid from the rest of the world. Suppose then, that B receives a small amount of aid at a level that is 0.5% of its initial income level. Assume further that this amount of aid is maintained at the same level, in real per capita terms, as long as the country is consuming at the subsistence level.[8] The time path of output for B is depicted in figure 8.

Output per effective worker is declining for the first 34 periods while $k^B(t) < k_L(t)$. At $t=35$, k_L falls below k^B though the optimal level of consumption is still below subsistence. Hence, the economy continues to consume at the subsistence level for an additional 10 periods, though k^B begins to rise. As is clear from the figure, the gap between A and B is widening for

---

[8] Note that in terms of effective labor, the implication is that the level of aid is actually declining over time.
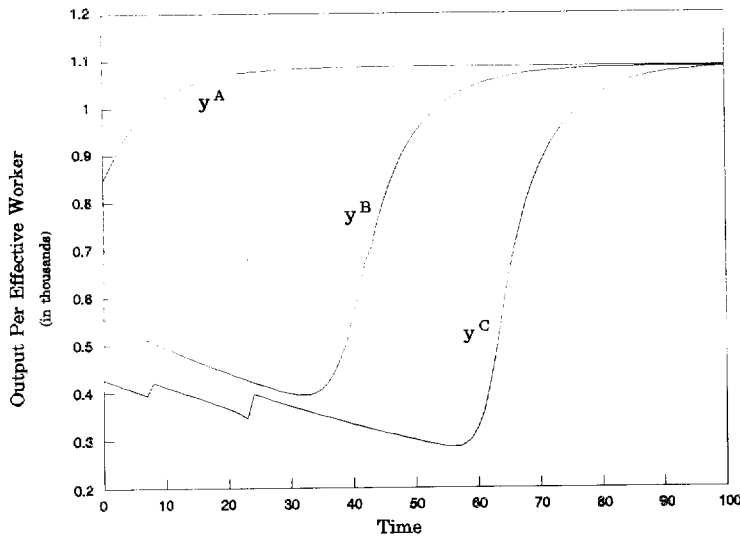
Figure 8

much of the time span since $t=0$. After 44 periods however, the economy reverts to its stable manifold and the groups converge to the same long run target.

Suppose that the poorest group, C, also receives aid from the rest of the world at a level that is initially 24% of its income level during the first period. However, this amount of aid is not enough to prevent the country from heading towards economic collapse. Hence, after 8 periods, it is in need of a large aid package — say 35% of its income that year — in order to prevent total collapse by period 9.[9] Aid from $t=9$ drops to 16% of per capita income and remains at that level until the next crisis materializes.

To keep things in perspective, it might be useful to note that large one-time transfers to the poorest countries are not uncommon. Somalia received net transfers averaging 29% of its income between 1981 and 1991.[10] In 1985 alone, net transfers totalled 45% of Somalia's GDP. Aid to other countries, such as Gambia, Mauritania, Mali, and Tanzania, reached peaks of 28%, 25%, 22%, and 38% of their outputs.

---

[9] Although it is not obvious in the figure, had economy C continued an additional period without the aid package, it would have collapsed the following period.

[10] Data source: World Bank *World Tables* (1994).

17

By period 23, the economy of C is about to collapse again and another infusion of aid is provided, this time equaling 41% of output. The massive amount of aid is high enough so that even if aid levels the following year and onward are lowered to 5% of output, the economy will eventually be able to converge with the other economies to the same long run steady state path. Incidently, when these outcomes are converted into per capita outputs rather than per effective worker, then output for each of the groups is either relatively flat, or it is rising, during the entire sample period.

One last note regarding this example. Suppose that the first large aid package to C was at roughly the level of the second large transfer. More specifically, suppose that the first transfer totaled 45% of output (rather than 35%) and that aid from that point fell to
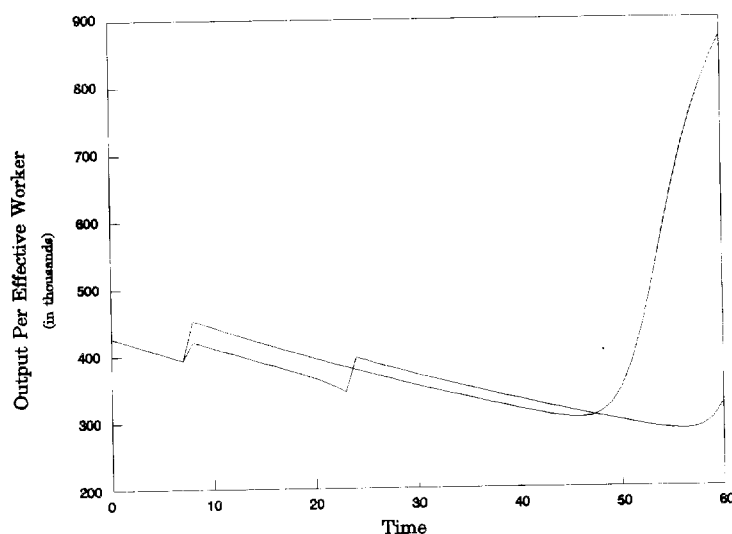

Figure 9

9% of output. As is evident from figure 9, this will be sufficient to raise output beyond the critical level so that eventually, after 54 periods (compared with 63 before), C will move from subsistence consumption to the stable manifold.[11]

---

[11] As in the instances above, output starts to rise while C is still consuming at the subsistence level since consumption, while not yet at the optimal level, is nonetheless smaller than net output. Hence, positive accumulation of capital is possible.

VI. CONCLUSION

The main goal of this paper was to describe a framework that could account for the downward convergence that exists among the poorest countries and, in conjunction with this, would also be consistent with (a) the evidence of divergence among most of the other countries in the world as well as (b) convergence among the wealthiest countries. The neo-classical model with labor-augmenting technological progress is not new, and the concept of subsistence consumption is certainly not novel. However, when these two ideas are merged and their subsequent ramifications are compared with the empirical evidence in Ben-David (1995), the model seems to provide results that are consistent with the evidence, producing "convergence clubs" at both ends of the income spectrum as well as a positive relationship between saving rates and levels of development. In the case of the poorest countries, it would appear that those countries that are sufficiently poorly endowed and whose inhabitants survive by depleting their capital stock will experience negative growth and face the prospect of involuntary membership in an unwanted club.

REFERENCES

Azariadis, Costas and Alan Drazen (1990), "Threshold Externalities in Economic Development," *Quarterly Journal of Economics, 105,* 501-526.

Becker, Gary S. (1993), "George Joseph Stigler: January 17, 1911-December 1, 1991," *Journal of Political Economy, 101,* 761-767.

Becker, Gary S., Kevin M. Murphy, and Robert R. Tamura (1990), "Human Capital, Fertility, and Economic Growth," *Journal of Political Economy, 98,* S12-S37.

Ben-David, Dan (1995), "Convergence Clubs and Diverging Economies," Foerder Institute working paper 40-95.

Brezis, Elise S., Paul R. Krugman, and Daniel Tsiddon (1993), "Leapfrogging in International Competition: A Theory of Cycles in Technological Leadership," *American Economic Review, 83,* 1211-19.

Coe, David T., Elhanan Helpman, and Alexander W. Hoffmaister (1995), "North-South R&D Spillovers," NBER Working Paper No. 5048.

Ehrlich, Isaac and Francis Lui (1991), "Intergenerational Trade, Longetivity, and Economic Growth," *Journal of Political Economy, 99,* 1029-1059.

Fogel, Robert W. (1994), "The Relevance of Malthus For the Study of Mortality Today: Long-Run Influences of Health, Mortality, Labor Force Participation, and Population Growth," NBER historical working paper 54.

Goodfriend, Marvin and John McDermott (1994), "A Theory of Convergence, Divergence, and Overtaking," unpublished working paper.

Nelson, Richard R. (1956), "A Theory of the Low-Level Equilibrium Trap in Underdeveloped Economies," *American Economic Review, 46,* 894-908.

Quah, Danny (1993), "Empirical Cross-Section Dynamics in Economic Growth," *European Economic Review, 37,* 426-434.

Rebelo, Sergio (1992), "Growth in Open Economies," *Carnegie-Rochester Conference Series on Public Policy, 36,* 5-46.

Romer, Paul M. (1994), "The Origins of Endogenous Growth," *Journal of Economic Perspectives, 8,* 3-22.

Stigler, George S. (1945), "The Cost of Subsistence," *Journal of Farm Economics, 27,* 303-314.

Summers, Robert and Alan Heston (1988), "A New Set of International Comparisons of Real Product and Price Levels Estimates for 130 Countries, 1950-1985," *Review of Income and Wealth, 34*, 1-25.

Tamura, Robert (1994), "Fertility, Human Capital and the Wealth of Families," *Economic Theory, 4*, 593-603.

Tamura, Robert (1995), "From Decay to Growth: A Demographic Transition to Economic Growth," forthcoming in *Journal of Economic Dynamics and Control*.

United Nations (1992), *Second Report on the World Nutrition Situation: Global and Regional Results*, Geneva.

World Bank (1990), *World Development Report: Poverty*, New York: Oxford University Press.

World Bank (1993), *World Development Report: Investing in Health*, New York: Oxford University Press.

World Bank (1994), *World Tables*, CD-ROM.