ISSN 0265-8003

CONVERGENCE CLUBS AND DIVERGING ECONOMIES

Dan Ben-David

Discussion Paper No. 922
February 1994

Centre for Economic Policy Research
25-28 Old Burlington Street
London W1X 1LB
Tel: (44 71) 734 9110

CEPR Discussion Paper No. 922

February 1994

ABSTRACT

Convergence Clubs and Diverging Economies*

This paper focuses on the question of income convergence among countries. While the methodology used to determine convergence differs from the common cross-sectional approach, it corroborates Baumol's finding of a convergence club among the world's wealthiest countries. It also shows that there is strong evidence in support of a second convergence club, however. This one is among the world's very poorest countries. These clubs exhibit different forms of convergence. The group of wealthy countries is characterized by what may be referred to as *upward convergence*, where the poorer group members catch up with the richer countries. The group of extremely poor countries exhibits *downward convergence*, or a reduction in income disparity brought about by nearly zero, or even negative, growth by the group's 'wealthier' members. One of the attributes that sets these countries at the bottom apart is that they are very close to what Stigler once calculated as the least cost subsistence diet. Inserting this constraint into the neoclassical growth model produces two steady states, with divergence in between. An example of such a model is developed here.

JEL classification: O1, O4, O5, E1
Keywords: economic growth, income convergence, subsistence consumption

Dan Ben-David
Department of Economics
Ben-Gurion University
PO Box 653
Beer-Sheva 84105
ISRAEL
Tel: (972 7) 472 298

*This paper is produced as part of a CEPR research programme on *Market Integration, Regionalism, and the Global Economy*, supported by a grant from the Ford Foundation (no. 920-1265). I would like to thank W Davis Dechert, Peter R Hartley, Dan Levin, Michael M Loewy, Michael G Palumbo, David H Papell, Thomas H Mayor and seminar participants at the University of Houston – Rice University Macroeconomics Workshop for their very helpful comments. This research was supported by a grant from the Centre for Economic Policy Research, under its research programme *Market Integration, Regionalism and the Global Economy*.

Submitted 24 January 1994

NON-TECHNICAL SUMMARY

This paper focuses on the question of income convergence among countries. Do levels of income across countries converge over time? Do the disparities between countries decline over time, or do they grow?

Assuming that countries have similar technologies and preferences, the traditional neoclassical growth model predicts that incomes per capita should converge to the same steady-state growth path. Incomes per capita in the long run will converge to similar levels and similar rates of growth across all countries. More recent models of economic growth, which endogenize the growth process, offer the possibility that there may be more than one steady-state path.

The empirical evidence is not clear. Some studies suggest that countries are converging over time, others point to just the opposite.

If not all countries are converging to the same steady-state path, are there sub-groupings of countries that exhibit convergence to different paths? By examining a cross-section of countries, William Baumol found that there does appear to be income convergence among the world's wealthier countries. This 'convergence club', as Baumol referred to the group, was not very large. Baumol also reported much weaker convergence among middle- income countries, while growing income gaps seem to describe the long-run behaviour between the remaining countries.

This paper shows that the country groupings in these studies are very sensitive to the inclusion, or exclusion, of specific countries. Slight changes in group membership can sometimes cause major changes in the convergence/divergence findings.

Furthermore, there has been some criticism of the methodology commonly used for determining convergence. Convergence tests are usually conducted on a cross-section of countries between two arbitrary points in time. Rates of growth are regressed on initial levels of income, with or without additional explanatory variables. Since convergence implies that poorer countries must grow faster than wealthier countries, a negative coefficient on the initial incomes is interpreted as indicating convergence. One of the main drawbacks of the cross-sectional test is that it is not very practical for obtaining an accurate assessment of convergence/divergence within small groups of countries (since the power of the tests will be quite low).

This paper defines income convergence as a reduction in the annual disparity among countries. The estimate for the average income differentials among group members (the standard deviation of log per capita incomes within each group of

countries) is calculated annually and then analysed over a period of 25 years to determine whether these differentials show evidence of declining (income convergence), increasing (income divergence), or remaining steady over time. This methodology facilitates sensitivity checks of convergence/divergence outcomes by enabling the inclusion or exclusion of one, two, or more countries from any given group.

The world is partitioned into groups of equal size. The behaviour of the income differentials within each group is explored by creating every possible sub-grouping of countries within the larger group and testing for convergence/divergence within each sub-group. The world is repartitioned several times and the experiment with the sub-groups is repeated for each of the partitions. This paper supports Baumol's finding of a convergence club among the world's wealthier countries. While the income gap between the majority of the remaining countries has been increasing, however, an unexpected by-product of this methodology is the finding of very significant income convergence among the world's poorest countries.

Though there is convergence at both ends of the income spectrum, the two forms of convergence are qualitatively different. Within the wealthier group, convergence comes about as the poorer group members catch up with the wealthiest countries. In the less developed group, convergence occurs because income levels of the top members of the group decline towards those of the members in the bottom half.

As these findings of two steady states appear to be fairly robust, can they be reconciled within the neoclassical framework that predicts only one steady-state path (the endogenous growth models already provide for multiple steady states)?

One of the attributes that sets the countries at the bottom apart is that they are very close to what George Stigler once calculated as the least cost subsistence diet of approximately $300 in 1980 US dollars. If nothing other than diet is considered, this amount could be viewed as a minimum requirement for sustaining life. In 1960, the first year of the empirical analysis, there were 6 countries with average real incomes per capita below $300, 10 countries had sub-$400 incomes, while 24 countries had per capita incomes below $500.

If the neoclassical growth model is altered to account for this minimum subsistence level of consumption, the model produces two steady states, with divergence in between. An example of such a model is developed in this paper. In this framework the poor countries will initially be consuming at the subsistence level. Of these, the poorest will not be able to escape this 'poverty trap'. Countries that are sufficiently poorly endowed and whose inhabitants survive by depleting their capital stock will experience negative growth and may face the prospect of involuntary membership in an unwanted club.

I. INTRODUCTION

Do levels of income across countries converge over time? Do multiple equilibria represent a more accurate reflection of the data than the standard neoclassical growth model's prediction of global convergence? These are the issues that are the focus of this paper.

The empirical evidence has been mixed. Using a combination of cross-sectional and time-series data, Rostow (1980) concludes that countries do converge. He states that "the widely held notion that the rich typically get richer, the poor relatively poorer, is supported neither by evidence from the contemporary scene nor by that from the longer past" (pg. 259).

Kristensen (1982), focusing on the cross-section alone, grouped countries by their 1974 income levels and found a hump-shaped relationship between group's 1970-79 growth rates and their income levels, with the middle-income groups enjoying higher rates of growth than the wealthier and the poorer groups. This finding of divergence among the poorer countries and convergence among the relatively wealthier ones is supported by Chenery and Syrquin (1986), who combine time-series and cross-sectional data for several countries and find a similar hump-shaped development curve.

By testing for a negative relationship between average annual rates of growth and initial levels of income, Baumol (1986) concluded that industrial countries appear to belong to one convergence club, middle income countries to a separate, only moderately converging club, and that low income countries actually diverged over time. He went on to note that these groups also exhibited very little convergence with one another. De Long (1988) commented that the strong convergence findings in the top group were primarily the result of an ex post selection of wealthy countries rather than an ex ante selection.

Other studies have raised doubts about the plausibility of global convergence altogether. In his examination of 115 countries, Romer (1987 and 1989) used a scatterplot that horizontally measured the 1960 per capita incomes of each country and vertically measured their average annual growth rates between 1960 and 1981. Global convergence requires a negative relationship between the points on the plot. But Romer (1989) found that "in the cross-section, the mean growth rate shows no variation with the level of per capita income" (pg. 55). One drawback to this type of a plot is that average growth rates could be susceptible to the possibility that 1960 or 1981 may be outlier years.

An alternative would be to horizontally plot each of the annual incomes for each of the 113 market economies in the Summers and Heston (1988) data set in each of the years between 1960 and 1985 together with a vertical plot of the subsequent rate of growth experienced by each country for the following year. Ben-David (1994) shows that these 2825 observations are arrayed in a mean-preserving wedge that is very similar to the Romer plot. The lower the incomes, the greater the number of observations, and the larger the variance in growth rates. However, as figure 1 indicates, there does not appear to be much fluctuation in the means.

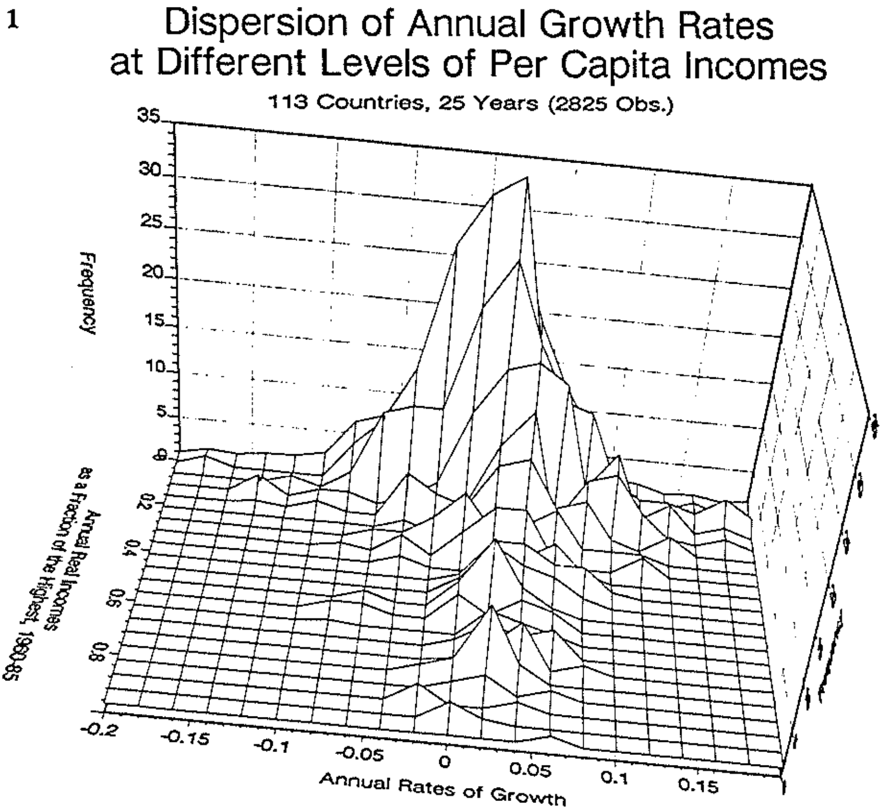
The absence of evidence on global convergence was a major influence behind the seminal papers by Romer (1986) and Lucas (1988). These were followed by a large number of "New Growth" models that endogenized technological progress and predicted very different outcomes concerning the behavior of income differentials over time. One characteristic of many such models is the prediction that countries will converge to multiple equilibria rather than to a single target.

While there exists a broad consensus in the more recent literature suggesting an absence of convergence to a single steady state, newer studies that control for various differing characteristics across countries point to the existence of conditional convergence (see for example: Mankiw, Romer and Weil, 1992; Barro, 1991; and Levine and Renelt, 1992).[1]

---

[1] As Durlauf and Johnson (1991) point out, such a negative correlation need not infer global convergence. In the event of misspecification, this could be an indication of multiple steady states. They test for the existence of multiple steady states by segmenting the world according to literacy levels and initial levels of income (by up to three partitions for each control variable) and find evidence of localized convergence within groups. Further evidence of localized convergence is provided by Ben-David (1993 and 1994). These studies control for trade liberalization within various trade groups such as the European Economic Community and find significant convergence occurring after the onset of liberalization.

Figure 1



Dispersion of Annual Growth Rates
at Different Levels of Per Capita Incomes
113 Countries, 25 Years (2825 Obs.)
Frequency
35
30
25
20
15
10
5
0
Annual Real Incomes
as a Fraction of the Highest, 1960-85
0.2
0.4
0.6
0.8
-0.2
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
Annual Rates of Growth

The thread that ties most of the above empirical literature on convergence is the cross-sectional nature of the majority of the tests. Friedman (1992) and Quah (1990) have raised questions about the advisability of using such tests to indicate the existence of convergence. Their primary concern focuses on regression to the mean arguments that would bias these tests. Friedman echoes Hotelling's (1933) view that convergence is best measured by an examination of the behavior of cross-country income differentials over time. This concept is adopted here for determining convergence and divergence.

Baumol's finding of convergence (he used cross-sectional evidence) among the wealthier countries is supported by the methodology employed in this study. However, there appears to be an additional convergence club as well. This one is situated at the very bottom of the income ladder. The difference between these two "clubs" is the difference between what one might describe as *upward convergence* versus *downward convergence*. While upward convergence may be defined as a case of poorer club members catching up to wealthier members, downward convergence is characterized by very low (and even negative) growth among the top club members.

How would it be possible to explain the existence of the poorer club? The "poverty trap" case was first modeled by Nelson (1956). More recently, Rebelo (1992), Azariadis and Drazen (1990), and Becker, Murphy and Tamura (1990) have developed endogenous growth models that use varying formulations for the accumulation of human capital to explain how countries may be drawn into poverty traps.

The theoretical framework adopted here is a bit different. Since the poorer convergence club includes 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, how might this affect our expectations of global convergence in the neoclassical growth model?

The model developed here examines this issue by allowing for subsistence consumption under conditions of exogenous growth. Such a model predicts convergence to two steady state paths, and as the empirical evidence provided below indicates, this appears to be a fairly good description of the behavior among countries since 1960.

Section 2 provides the empirical evidence while section 3 outlines a model that provides an explanation for these results. Section 4 concludes.

II. EMPIRICAL EVIDENCE

Lorenz curves for the years 1960 and 1985 point to an increasing degree of disparity among the 113 market economies in the Summers and Heston (1988) sample (figure 2). The curves appear to indicate that most of this rise in inequality was due primarily to a growing discrepancy among the world's relatively poorer nations.

The question is, what constitutes "wealthy", "poor", and other subgroupings? Each of the studies mentioned in section 1 grouped countries differently, and each came up with different results.

Kristensen's (1982) results for the 1970-79 period depict convergence among the top four of his seven income groupings. In his study for the years 1950-80, Baumol (1986) grouped nations into three groups and found very little convergence between the groups. On the other hand, he concluded that countries within the wealthiest group exhibited income convergence among themselves, thus constituting what Baumol calls, a "convergence club". Among the middle income group, Baumol found much less convergence, while the poorest group displayed diverging economies.

In each of these instances, convergence was inferred by an examination of the relationship between the starting level of per capita income and the countries' average rates of growth over the ensuing period. Whether this was representative of what happened in the interim is not always obvious. Furthermore, since the world was partitioned into only a limited

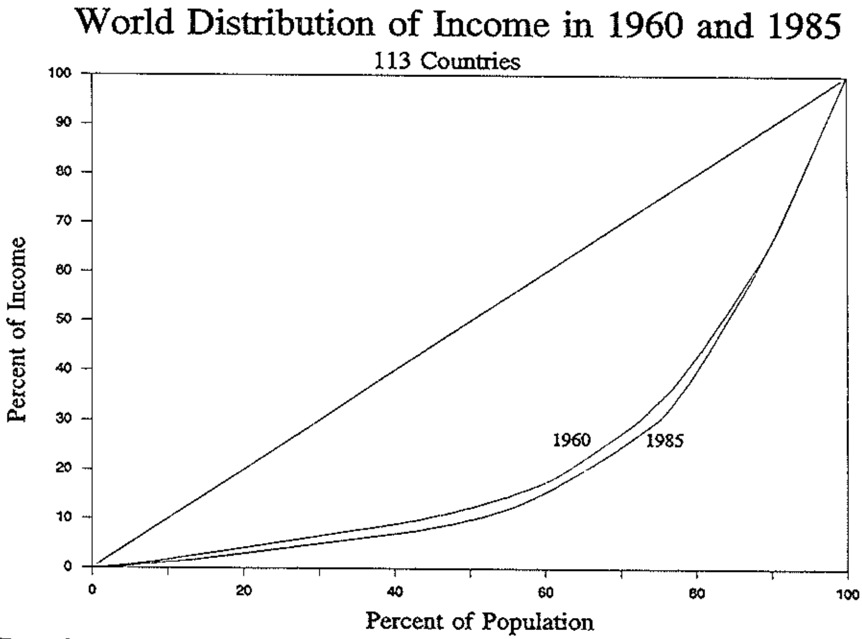

World Distribution of Income in 1960 and 1985
113 Countries
100
90
80
70
60
50
40
30
20
10
0
Percent of Income
1960
1985
0
20
40
60
80
100
Percent of Population

Figure 2

number of country groupings, this raises the question of how sensitive the results are to group membership.

Take for example, an analysis of the 1960-85 period, with a different grouping of countries than in either of the above studies. Based on rankings of real per capita incomes in 1960, it is possible to divide up the market economies of the world into 3 income groups: wealthy, middle-income and poor. Let the wealthy group be defined as those countries that maintained, as a group, the same proportions of the world's total product and total population in 1985 that they had in 1960. The line dividing the middle income group from the low-income group is drawn at the per capita income level of $2000 where there is a relatively sizeable gap between the countries producing more than that amount and the countries producing less.

Sixteen countries comprise the top group and their incomes range from 60 to 100 percent of the top country's (the United States) income in 1960. The middle group consists of 15 countries with incomes ranging from 25 to 60 percent of the U.S. income. The poorest group consists of the remaining 82 countries.

In 1960, the degree of inequality within groups (measured by the annual standard deviation of the log per capita incomes) appeared to be positively related to the group's average level of income (figure 3). Furthermore, the disparity among the poorest countries rose steadily from year to year. Income differentials among the middle income countries also increased over time, while only the wealthiest countries appeared to maintain any semblance of preserving the status quo, and even this was accomplished only after the exclusion of Venezuela (which was an outlier in the group).

The impact of one country, Venezuela, on the entire group, highlights the point raised above. How robust are all these results to changes in the composition of the various groups? Suppose that, rather than using the above criteria for partitioning the world, the segmentation into groups is arbitrary.

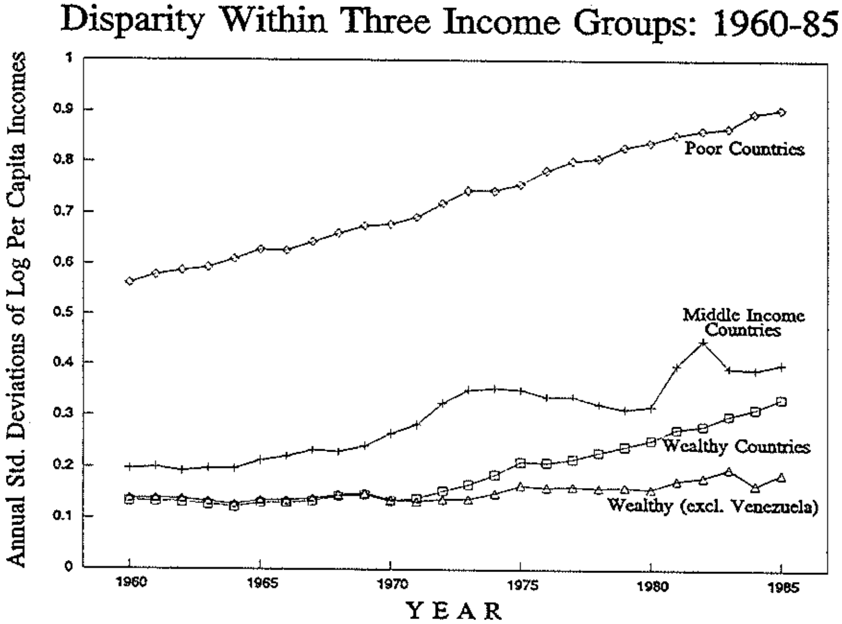

Disparity Within Three Income Groups: 1960-85
Annual Std. Deviations of Log Per Capita Incomes
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Poor Countries
Middle Income Countries
Wealthy Countries
Wealthy (excl. Venezuela)
1960
1965
1970
1975
1980
1985
YEAR

Figure 3

For example, let the cutoff points between groups be set at 20 percent intervals of the 1960 U.S. level of income. In this case, the world is partitioned into 5 groups where the first group comprises the four wealthiest countries with incomes between 80 to 100 percent of the U.S. income. Incomes in group two range between 60 and 80 percent of the U.S. income in 1960. There are 12 countries in this group, 7 in the third group (40-60%), 18 in the fourth group (20-40%), and 72 in the fifth and final group (0-20%).

The only group exhibiting no divergence at all is group one, the wealthiest group (figure 4). The countries within each of the remaining groups displayed income divergence, with the degree of inequality tending to be higher, the poorer the group. Both figures provide support for Baumol's argument that disparity is higher among poorer countries, though these figures fail to provide much visual support for the existence of a convergence club among the wealthier countries. On the other hand, two sample segmentations of the world do not provide enough evidence for determining the existence of one or more convergence clubs. The remainder of this section centers on exactly this point.

Examination of disparity on an annual basis has an advantage over the conventional method of determining convergence (which is to regress rates of growth on initial incomes) in that information on the behavior of income differentials for the years *between* the period's initial and terminal years is also utilized. The conventional method of determining convergence is further handicapped by the relatively low power of the test when the analysis covers only a small group of countries.

Since the objectives of this paper are to examine the sensitivity of convergence outcomes with respect to (a) group membership - i.e. the relative wealth of the countries in the group - and (b) group size, a different methodology for testing convergence is needed which utilizes the annual information on the degree of income disparity within a group. Let $y_{i,t}$ equal the log of country i's per capita income in year t. Then income disparity may be defined as the difference between country i's income and $\bar{y}_t$, the group's average per capita income in year t.

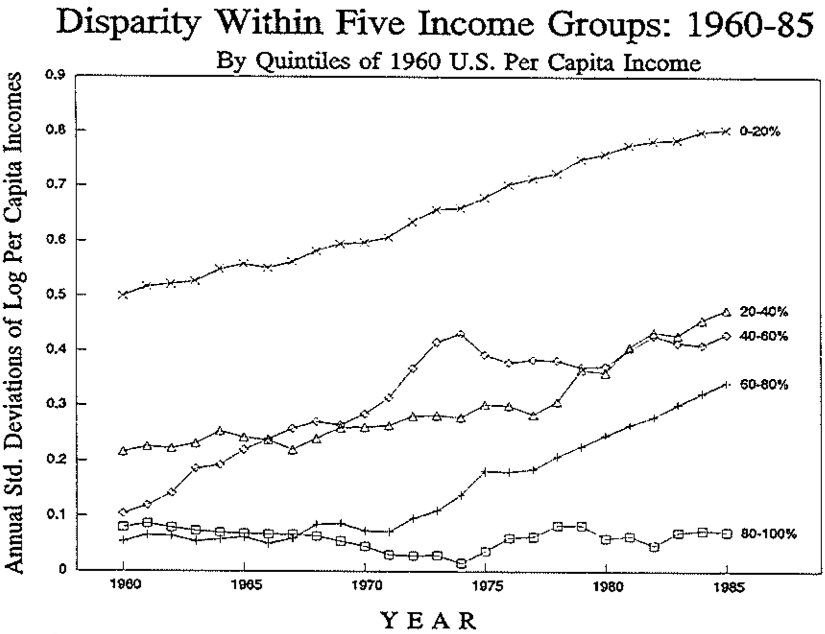

Disparity Within Five Income Groups: 1960-85
By Quintiles of 1960 U.S. Per Capita Income
Annual Std. Deviations of Log Per Capita Incomes
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1960
1965
1970
1975
1980
1985
YEAR
0-20%
20-40%
40-60%
60-80%
80-100%

Figure 4

It is possible to test for convergence by pooling each country's annual discrepancy from the group average and estimating the following equation.

(1) $$(y_{i,t} - \bar{y}_t) = \phi(y_{i,t-1} - \bar{y}_{t-1})$$

The parameter ϕ may be considered a convergence coefficient, as it represents the rate of convergence within the group when its value falls below unity. An outcome of $\phi > 1$ indicates income divergence among the group members. This coefficient may be used to calculate the number of years required by the group to halve its average disparity (when $\phi < 1$) by dividing the log of 0.5 by the log of ϕ (see Ben-David, 1993). In the event of diverging economies, the number of years that it will take for the average discrepancy to double is log 2 divided by the log of ϕ. A rough estimate of the average *annual* rate of convergence may be calculated by dividing one-half the log of ϕ by the log of 0.5.[2]

Estimation of equation 1 for 113 market economies during the 1960 to 1985 period yields an estimated ϕ of 1.0073 (Table 1), indicating divergence. When the world is divided in half, the poorer half exhibits significant divergence over time, with the average disparity increasing at a rate that would double the income differentials in 46 years. The wealthier half of the world displayed no significant tendency in either direction.

When the world is partitioned into three country ranges of equal size, only the range of countries with the highest incomes fails to exhibit significant divergence. However, further partitioning reduces the size of the wealthiest country range, and its convergence coefficient becomes significantly greater than unity.

---

[2] Let H denote the number of years that it takes to reduce the first year's average discrepancy (D) in half. Therefore, the average fall per year for the duration of the half life will be $0.5D/H$, or as a percent of the first year's discrepancy, income differentials will decline at a rate of $0.5/H$, or $0.5\text{Ln}(\phi)/\text{Ln}(.5)$ when the equation for the half-life is substituted in.

Table 1

Convergence Coefficients By Range

Country Range First	Country Range Last	$\hat{\phi}$	NOBS	R^2	t-statistic (H_0: $\phi=1$)	Half/Double Life*
1	113	1.00725	2825	0.997	6.847	95.9
1	57	0.99986	1425	0.992	-0.058	-4941.9
58	113	1.01536	1400	0.988	5.177	45.5
1	38	0.99814	950	0.986	-0.486	-371.5
39	75	1.02812	925	0.982	6.195	25.0
76	112	1.01050	925	0.974	1.920	66.3
1	29	1.00699	725	0.981	1.329	99.6
30	57	1.02518	700	0.976	4.121	27.9
58	85	1.03057	700	0.982	5.720	23.0
86	113	1.01070	700	0.971	1.627	65.1
1	23	1.01775	575	0.984	3.245	39.4
24	45	1.01939	550	0.962	2.247	36.1
46	67	1.02750	550	0.971	3.611	25.5
68	89	1.03421	550	0.979	5.272	20.6
90	111	1.01306	550	0.970	1.719	53.4
1	19	1.01790	475	0.975	2.370	39.1
20	37	0.99711	450	0.957	-0.291	-239.6
38	55	1.03100	450	0.961	3.177	22.7
56	73	1.03555	450	0.976	4.661	19.8
74	91	1.04703	450	0.977	6.151	15.1
92	109	1.00110	450	0.959	0.113	628.7
1	17	1.02714	425	0.974	3.316	25.9
18	33	1.00063	400	0.963	0.064	1108.5
34	49	1.04640	400	0.974	5.379	15.3
50	65	1.02463	400	0.968	2.646	28.5
66	81	1.04168	400	0.986	6.735	17.0
82	97	1.04275	400	0.968	4.487	16.6
98	113	0.99494	400	0.962	-0.510	-136.7
1	15	1.03205	375	0.974	3.698	22.0
16	29	1.01016	350	0.967	1.013	68.5
30	43	1.04128	350	0.965	3.873	17.1
44	57	1.02349	350	0.957	2.018	29.9
58	71	1.03688	350	0.979	4.581	19.1
72	85	1.03951	350	0.968	3.917	17.9
86	99	1.04640	350	0.963	4.249	15.3
100	113	0.97450	350	0.943	-1.997	-26.8

* The half-lives are denoted by negative numbers.

These results differ from those of other studies in that not only do the wealthiest countries fail to converge, but the countries whose income differentials exhibit the smallest increases over time (and in some cases they even appear to decline) are the very poorest countries.

One of the first questions that comes to mind here is the sensitivity of these results to the inclusion/exclusion of individual countries. This is best illustrated by the distortion that may be caused by an outlier country such as Venezuela, a country that ranked among the ten wealthiest in 1960, but which displayed negative average annual growth over the next quarter century.

Exclusion of Venezuela from the wealthiest category (table 2) reduces the convergence coefficient to below unity in nearly every case, though it is still insignificantly below unity in most cases. Figure 5 plots the convergence coefficients for each of 8 country ranges (comprising 14 countries apiece). The only non-divergent behavior is found at both ends of the spectrum.

The country sensitivity issue may be taken one step further by examining how random draws of country groupings may affect the relationship between income levels and income convergence. In other words, how much of a restriction does inclusion of all countries within a given range pose on the representative convergence coefficient for that range?

Within each range of countries, smaller groups were formed and their convergence coefficients calculated.[3] Continuing with the above example, if the world is divided into eight ranges of equal sizes, each range will comprise fourteen countries. Within each range it is possible to create smaller groupings of countries and examine whether these smaller groups behave similarly to the range as a whole.

For example, suppose that from each range of 14 countries, groups comprising 6 countries are drawn and their ϕ's are calculated. There are 3003 different possible draws within

[3] For the remainder of the paper, Venezuela is excluded from the data.

Table 2

Sensitivity of Convergence Coefficients to Inclusion of Venezuela

Country Range		With Venezuela			Without Venezuela		
First	Last	$\hat{\phi}$	t-statistic (H_0: $\phi=1$)	HL/DL*	$\hat{\phi}$	t-statistic (H_0: $\phi=1$)	HL/DL*
1	113	1.00725	6.847	95.9	1.00769	7.208	90.5
1	57	0.99986	-0.058	-4941.9	1.00041	0.168	1698.5
1	38	0.99814	-0.486	-371.5	0.99780	-0.570	-314.7
1	29	1.00699	1.329	99.6	1.00465	0.871	149.4
1	23	1.01775	3.245	39.4	1.01048	1.859	66.5
1	19	1.01790	2.370	39.1	0.97947	-2.346	-33.4
1	17	1.02714	3.316	25.9	0.98479	-1.507	-45.2
1	15	1.03205	3.698	22.0	0.99049	-0.872	-72.5
1	13	1.03822	4.327	18.5	0.99639	-0.316	-191.7
1	12	1.04514	6.395	15.7	0.99475	-0.568	-131.8
1	11	1.04867	6.654	14.6	0.99251	-0.730	-92.2
1	10	1.04853	6.594	14.6	0.99221	-0.752	-88.7
1	9	1.05011	6.738	14.2	0.99563	-0.412	-158.1

* The half-lives are denoted by negative numbers.

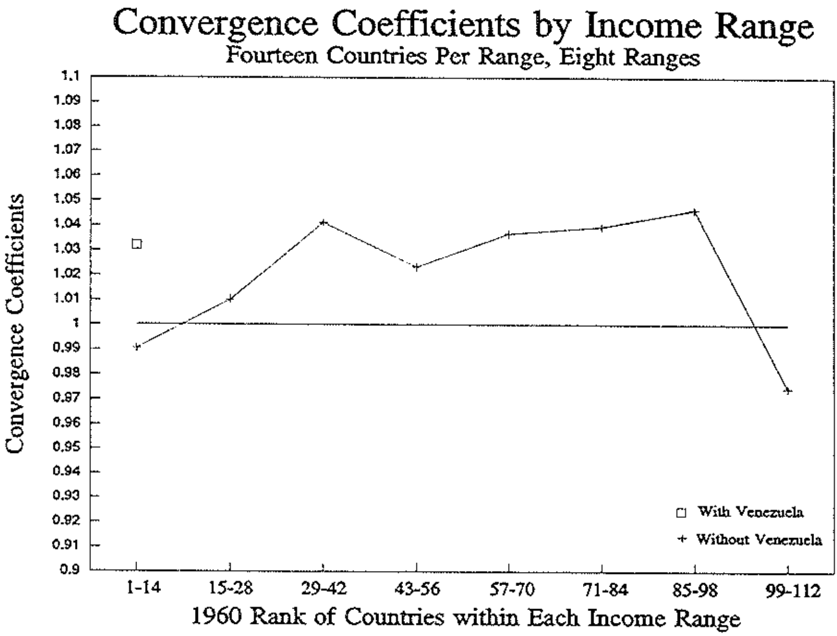


Figure 5

each range.[4] The cumulative distributions for the ranges appear in figure 6. In only the wealthiest and poorest ranges are the majority of ϕ's below unity. In each of the six remaining country ranges, the likelihood of finding a ϕ above unity exceeds 80 percent.

How much of this result is dependent on group size? Groups comprising four, five, seven and eight countries were also created for each range and their convergence coefficients are compared in figure 7. Here too, only the very wealthiest and the very poorest ranges had the majority of their groups exhibit an estimated ϕ below unity. Groups with eight members displayed the highest likelihood of convergence, while groups with four members were somewhat less likely to converge. Among the wealthiest countries, a random grouping of four countries had a 70.1% probability of converging while a grouping of eight countries had a probability of 88.1%. The poorest countries exhibited an even stronger prevalence of convergence, with the likelihood of finding convergence ranging from 87.1% for groups of four, to 99.8% for groups of eight countries.

For the remaining countries in the intermediate ranges, non-convergence was the prominent feature of the country groupings, with the possibility of finding convergence never exceeding one third of the possible outcomes. It is interesting to note that the larger the group size, the stronger the results: be they convergence in the top and bottom ranges, or strong evidence of non-convergence in the remaining ranges. While this example was performed on eight ranges with fourteen countries in each, the results are robust for other partitions of the world as well. Most of the convergence appears to be concentrated among the wealthiest countries and among the poorest.

While there appear to be two convergence clubs, one at each end of the income spectrum, they exhibit quite different convergence characteristics. The distinction between the upward convergence exhibited by the top group, and the downward convergence displayed by the bottom

---

[4] In a range with n countries, it is possible to draw a maximum of $n!/(k!(n-k)!)$ different groups with k members. In other words, out of each range with 14 countries, 3003 groups with six countries were drawn, 3432 with seven, etc.

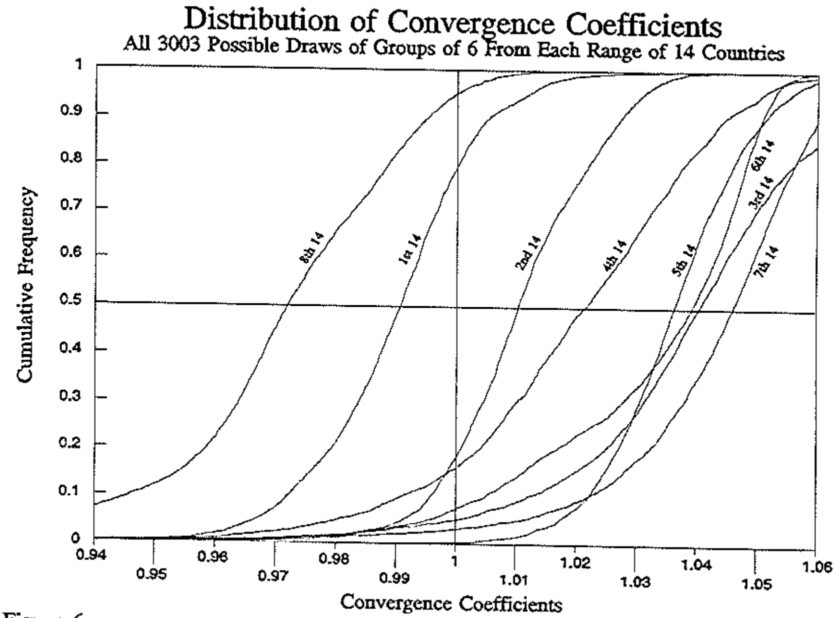


Figure 6

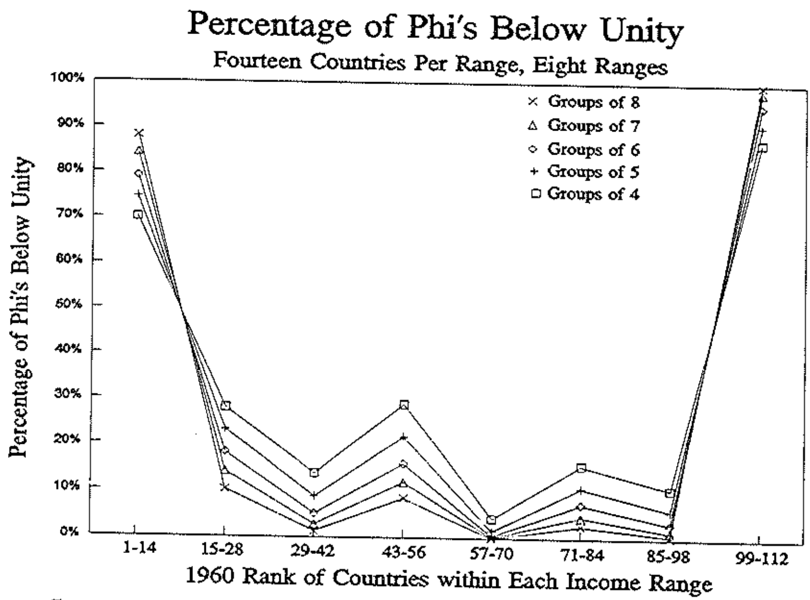


Figure 7

group can be seen in the following example. The 7 countries comprising the upper half of the top group grew at an average rate of 2.30 percent between 1960 and 1985. This compares with an average growth rate of -0.04 for the top 7 countries of the bottom group.

III. A THEORETICAL EXPLANATION

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. These outcomes are possible within an exogenous growth framework as well.

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 winter cold, etc.). 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. Poor and deteriorating infrastructure, and the lack of coordination in the supply of goods and services, are just a few of the major difficulties that can inhibit growth. But the relevance of subsistence consumption under these circumstances 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).[5] 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. The Stigler calculations are quite close to current World Bank measures of poverty (World Bank, 1990).

In 1960, the first year of the empirical analysis above, 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 six countries with real per capita incomes below \$300, 10 with incomes below \$400, and 24 countries with incomes below \$500. The use of actual exchange rates rather than the purchasing power parities developed by Summers and Heston paints an even grimmer picture. 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.

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. Preferences, which are represented by a concave Stone-Geary utility function of the stream of real per capita consumption, $C(t)/L(t)$ (for $t \geq 0$), are denoted by

---

[5] Stigler calculates two alternative diets. The annual cost of the two diets in 1944 prices was \$60 and \$68, respectively. While he 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.

(2) $$\int_0^\infty e^{-\rho t} u[A(t)c(t) - \hat{c}]dt$$

where ρ is the constant rate of time preference and $\hat{c}$ is the subsistence level of per capita consumption. The economy produces a single good that may be consumed or saved. Capital accumulates according to the following time path:

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

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

(4) $$H(k,\theta,c,t) = u(Ac-\hat{c}) + \theta[f(k) - (\delta+n+\mu)k - c]$$

The first order condition for an interior maximum is

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

Defining $\bar{c} = \frac{\hat{c}}{A}$, then as A increases over time, $\bar{c}$ (the subsistence level of consumption in terms of effective labor) will decline. The shadow price θ must satisfy

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

Thus $\dot{\theta} = 0$ defines k^* since $f'(k^*) = \delta+n+\mu+\rho$. From equation 3, $\dot{k} = 0$ implies that $c = f(k) - (\delta+n+\mu)k$, with $\bar{c}$ determining the levels k_L and k_U . Figures 8 and 9 illustrate how the inclusion of subsistence consumption may lead to two possible steady states. Note that the decline in $\bar{c}$ implies that k_L is also falling over time, while k_U is increasing.

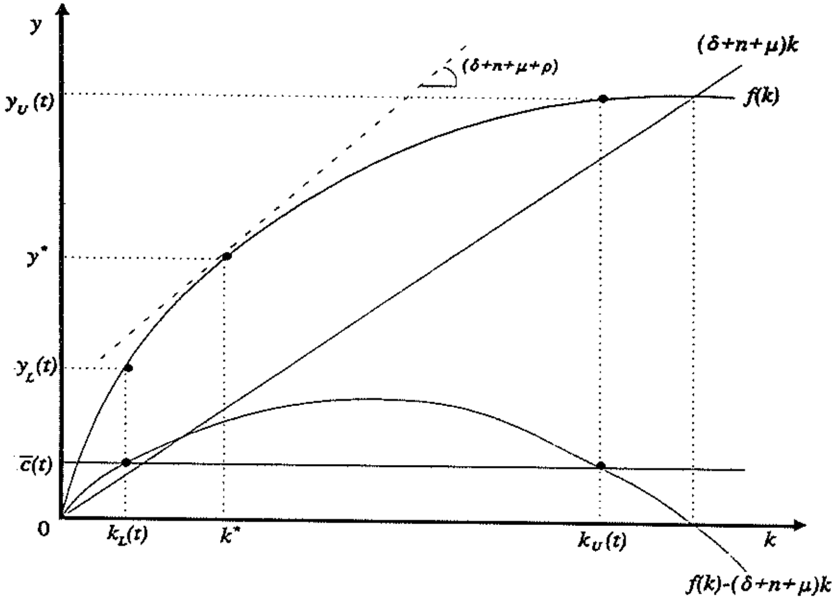


Figure 8

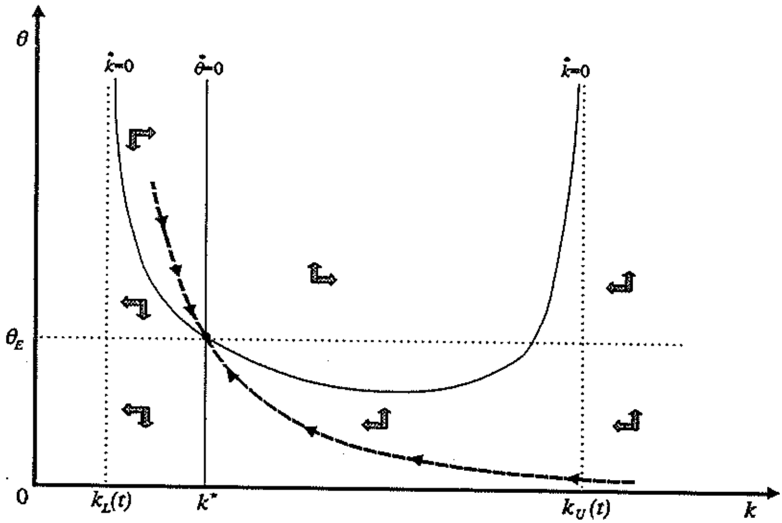


Figure 9

If $k^* < k(0)$, then stability requires that $\theta < \theta_E$, while $k_L < k(0) < k^*$ means that stability requires $\theta_E < \theta$. If $k(0) < k_L$, then $c(t) = \bar{c}$ and $\dot{k}$, $\dot{\theta} < 0$. However, since $\dot{k}_L < 0$ as well, there remains the question of whether k is falling at a faster rate than k_L . If so, then the steady state equilibrium for the least endowed countries will be

$$\lim_{t \to \infty} k(t) = 0$$

$$\lim_{t \to \infty} y(t) = 0$$

However, if $\dot{k}_L < \dot{k} < 0$, 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 $\dot{k}_L < \dot{k} < 0$.

At every k_L , it must be true that $\dot{k} = 0$. That is

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

Since $\bar{c}$ falls at the rate μ, then differentiating equation 7 yields

(8) $$\frac{\dot{k}_L}{k_L} = -\mu\left(\frac{\frac{f(k_L)}{k_L}-(\delta+n+\mu)}{f'(k_L)-(\delta+n+\mu)}\right)$$

Thus, assuming that $f(k)$ exhibits constant returns to scale, then k_L's rate of decline is lower for smaller values of k_L since $f(k_L)/k_L > f'(k_L)$.

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 approaches $-\infty$ as k approaches 0. Hence, if $k(0) < k_L$ and θ is high enough, 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 forever.

Those parts of both the $\dot{k} = 0$ line and the stable manifold that are to the left of k^* and above θ_E will rotate counter-clockwise as k_L declines over time. This occurs as a result of the increase in $A(t)$, which is held constant along each of these lines in figure 9.

The convergence to the steady states may be seen in figure 10. When countries begin with very low levels of income that are accompanied by subsistence consumption, for example

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

then the result will be negative saving, and a further reduction in incomes that asymptotically approaches zero. However, subsistence consumption does not imply that a country will necessarily converge downwards. Countries with 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^*.

While admittedly simplistic, this model provides a framework for explaining the stylized facts from the previous section. 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. The divergence outcomes of the countries in between the two convergence clubs are also explained here. Note that while the values in figure 10 are denoted in output per effective labor, a decline in these values does not necessarily imply that *per capita* output will exhibit negative growth. Hence divergence in per capita terms can occur even when all countries experience non-negative growth, as long as the wealthier countries are growing faster. In figure 10, the divergent paths of countries that begin between y_c and y^* implies that much of the divergence exhibited by the remaining countries may be a phenomenon that will eventually revert to a long-run convergence towards the upper steady state path.

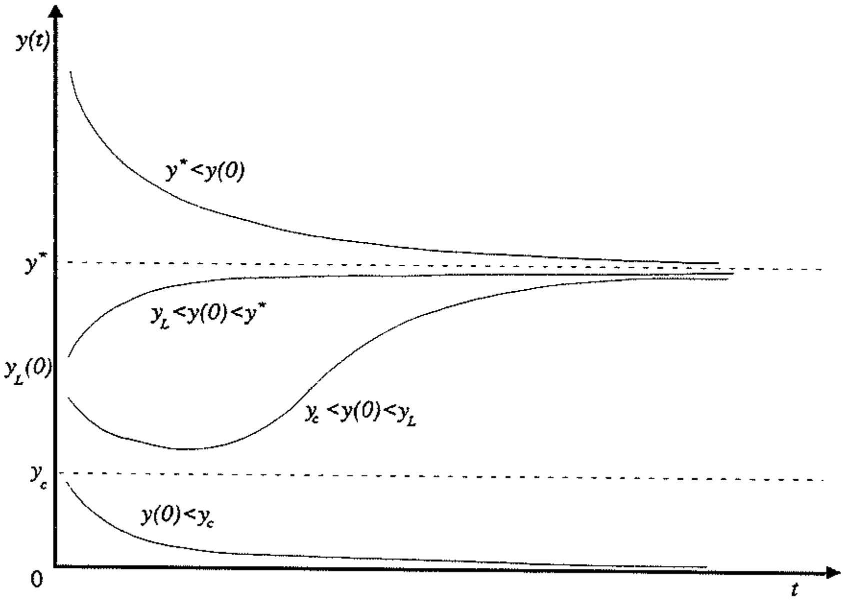


Figure 10

IV. Conclusion

The purpose of this paper was to establish a stylized fact regarding the issue of income convergence across countries. The methodology employed here differs from the conventional cross-sectional approach and it adopts the Hotelling/Friedman view that convergence is best represented as a decline in income differentials over time. In addition to avoiding the problems raised by Friedman (1992) and Quah (1990), this methodology enables a utilization of all the information available for the entire period rather than just the two end points. It also makes it possible to examine convergence within a small group of countries, something that is not so advisable under the cross-sectional approach.

The main finding of this paper is that there exist two "convergence clubs", one at each end of the income spectrum. These two clubs are characterized by different forms of convergence. The wealthy club exhibits upward convergence, where the poorer members essentially catch-up with the richest members. The poverty trap case provides an example of downward convergence, where the decline in income disparity is brought about by very low growth among the club's better off members.

A growth model that incorporates the concept of subsistence consumption provides a theoretical basis for the existence of these two steady states. Countries that are sufficiently poorly endowed and whose inhabitants survive by depleting their capital stock will experience negative growth and may 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.

Barro, Robert J. (1991), "Economic Growth in a Cross-Section of Countries," *Quarterly Journal of Economics*, *106*, 407-443.

Baumol, William J. (1986), "Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show," *American Economic Review*, *76*, 1072-85.

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 (1994), "Income Disparity Among Countries and the Effects of Freer Trade," *Economic Growth and the Structure of Long Run Development*, in Luigi L. Pasinetti and Robert M. Solow (eds), International Economic Association, London: Macmillan, forthcoming.

Ben-David, Dan (1993), "Equalizing Exchange: Trade Liberalization and Income Convergence," *Quarterly Journal of Economics*, *108*, 653-79.

Chenery, Hollis and Moshe Syrquin (1986), "Typical Patterns of Transformation," in Hollis Chenery, Sherman Robinson and Moshe Syrquin, eds., *Industrialization and Growth: A Comparative Study*, Oxford: Oxford University Press.

De Long, J. Bradford (1988), "Productivity Growth, Convergence, and Welfare: Comment," *American Economic Review*, *78*, 1138-54.

Durlauf, Steven N. and Paul A. Johnson (1991), "Local Versus Global Convergence Across National Economies," Unpublished Working Paper.

Friedman, Milton (1992), "Do Old Fallacies Ever Die?" *Journal of Economic Literature*, *30*, 2129-2132.

Hotelling, Harold (1933), "Review of *The Triumph of Mediocrity in Business*, by Horace Secrist," *Journal of the American Statistical Association*, *28*(184), 463-65.

Kristensen, Thorkil (1982), *Development in Rich and Poor Countries*, New York: Praeger.

Levine, Ross and David Renelt (1992), "A Sensitivity Analysis of Cross-Country Growth Regressions," *American Economic Review*, *82*, 942-63.

Lucas, Robert E. Jr. (1988), "On the Mechanics of Economic Development," *Journal of Monetary Economics*, *22*, 3-42.

Mankiw, N. Gregory, David Romer and David N. Weil (1992), "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics*, *107*.

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

Quah, Danny (1990), "Galton's Fallacy and Tests of the Convergence Hypothesis," Unpublished Working Paper.

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

Romer, Paul M. (1989), "Capital Accumulation in the Theory of Long Run Growth," in Robert Barro (ed.), *Modern Business Cycle Theory*, Cambridge: Harvard University Press.

Romer, Paul M. (1987), "Crazy Explanations for the Productivity Slowdown," NBER Macroeconomics Annual, 163-210.

Romer, Paul M. (1986), "Increasing Returns and Long Run Growth," *Journal of Political Economy*, *94*, 1002-38.

Rostow, Walt W. (1980), *Why the Poor Get Richer and the Rich Slow Down*, Austin, TX: University of Texas Press.

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.

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