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'Examining the Evidence Concerning the Relationship of the Rate of Growth to the Level of Development'

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by Charles L. Wright*

Development literature contains the hypotheses that countries pass through successive stages of slow growth, accelerating growth and finally decelerating growth, and that middle income countries grow faster than other countries. Hagen and Hawrylyshyn in 1969 found the hypotheses unsupported by empirical evidence, while Horvat in 1974 "confirmed" the hypotheses and concluded that income disparities among countries are decreasing. This paper examines the debate in light of data for the 1960 decade, and with regard to the nature of the hypotheses themselves, finding Horvat's position unsupported by the evidence.

INTRODUCTION

The literature on the disputed relationship between the rate of growth and the level of development has been concisely reviewed by Horvat [1974: 382-3]. There are three questions involved, namely

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the existence, nature and cause of such a relationship. Horvat states that prior to his article scholars refuting the existence of such a relationship seemed to have more impressive evidence. Hagen and Hawrylyshyn in particular found no support for the hypothesis of fastest growth in middle income countries, while the alleged relationship of income growth to per capita income was weak or non-existent [1969: 49; 88-9]. Horvat contests these findings with data from the overlapping subperiods 1953-1963 and 1958-1968. Using regression analysis, he claims to confirm the hypotheses at the 0.1% level [pp. 382-94]. Horvat then concludes that there exists a "self-correcting mechanism of the world economic development process ... except for those in the initial phase of development, all other countries are catching up with the most advanced pioneers" [p. 392].

The present research attempts to resolve the apparent empirical contradictions in these studies and investigates the logical difficulties inherent in such analyses.

THE HYPOTHESES

Initially, it is necessary to point out that there are two distinct hypotheses involved: (1) fastest income growth will be found in middle-income countries (hereafter, the "cross-sectional hypothesis"); and (2) countries pass through three successive stages of growth: slow, accelerating and decelerating (hereafter, the "historical hypothesis"). They are superficially similar and Horvat makes no distinction between them. However, the first hypothesis refers to international comparisons for specific

time periods and may be tested with cross-sectional data for any given time period(s). The conclusions would apply only for the period or periods examined. The second hypothesis refers to a secular historical process for given countries over time and cannot be tested with cross-sectional data.[1] The only data which may be used to test this hypothesis are the historical growth rates and income figures for currently developed countries. Since statistical tests cannot be applied to the individual experiences, and the results could not in any case be extrapolated for other countries, no attempt is made in the present research to test the historical hypothesis.[2]

The cross-sectional hypothesis, on the other hand, may be readily tested with available data and is the subject of the following analysis.

DATA

The selection and treatment of observations in the present research is similar to that used by Horvat, with exceptions for differences in exclusion of observations and in methodology which will be mentioned as they occur. The data comes from the same source, the U.N. Statistical Yearbook, in my case the 1974 edition [pp. 634-42; 650-2]. The 51 countries in my sample were listed in some part of Horvat's study and met his a priori criteria of data for a reasonably long growth period and "critical mass" of 1 million population and half a billion dollars of income. The period considered is the 1960 decade or a subset of years within the same decade.[3] A few countries are eliminated due to lack of data on relevant variables.

These include the Eastern European countries with centrally planned economies, since they do not calculate GDP per capita and their exchange rates for conversion to U.S. dollars are even more arbitrary than for market economies.

TESTING THE ALLEGED RELATIONSHIPS

There are several methods which might be used for statistical tests of the cross-sectional hypothesis. Horvat states, "It is assumed that the relationship exists between the growth of total (not per capita) GDP and the logarithm of per capita GDP" [p. 385]. Horvat thus defines the dependent variable as:

g = percentage rate of growth of GDP per annum,

rather than:

g' = percentage rate of growth of per capita GDP per annum.

The independent variable is to be expressed as a logarithm of

Y = GDP per capita (in U.S. dollars).

Horvat reasons that a faster rate of growth among the middle income countries may be tested by dividing the observations into "low" and "high" income groups and examining regression estimates for evidence of an upward-sloping curve for the low income group and a downward-sloping curve for the high income group, such as the curves in Figure 1 (a) and (b).

There are several drawbacks to Horvat's procedure. It is unclear why the dependent variable should be expressed as g (growth of GDP) rather than g' (growth of per capita GDP). It is equally unclear why

such a social phenomenon as cross-sectional growth rates should best be described as a logarithmic function. In both cases, examination and comparison would seem preferable to assumption. Finally, the division into high and low income groups is arbitrary, and Horvat makes the division by "inspection" of the data, using different dividing points for the two groups for the subperiods he considers [p. 386].

I have chosen to eliminate arbitrary and subjective division of the sample observations by choosing what seems to be the simplest and least arbitrary method of representing the hypothesized relationship: a parabolic-type function such as that shown in Figure 1 (c). Two mathematical expressions are used:

(1) $g = a + bY + cY^2$

(2) $g = a + b(\log Y) + c(\log Y)^2$

The symbols g and Y are defined as before, and in each equation it is necessary to test if the coefficient "b" is statistically significantly greater than zero and if "c" is less than zero at (say) the 5% level of significance. The first equation is probably the most straightforward manner of representing a parabola and is used as an alternative to Horvat's assumption of a logarithmic relationship as expressed in equation (2). The dependent variable g may similarly be replaced in the above equations by g' as an alternative to assuming that the relationship is between income and total growth rather than per capita growth. The results of the least-squares regressions are given by equations (3) - (6), with "t" values in parentheses.

$$(3)\quad g = \underset{(11.87)}{5.3} - \underset{(0.14)}{0.0001Y} - \underset{(0.08)}{0.00000002Y^2} \qquad \bar{R}^2 = -0.032$$

$$(4)\quad g = \underset{(0.68)}{-5.7} + \underset{(1.33)}{8.32\log Y} - \underset{(1.36)}{1.55(\log Y)^2} \qquad \bar{R}^2 = -0.001$$

$$(5)\quad g' = \underset{(4.59)}{2.0} + \underset{(3.13)}{0.0025Y} - \underset{(2.57)}{0.0000007Y^2} \qquad \bar{R}^2 = 0.157$$

$$(6)\quad g' = \underset{(1.43)}{-12.0} + \underset{(1.57)}{9.74\log Y} - \underset{(1.32)}{1.49(\log Y)^2} \qquad \bar{R}^2 = 0.166$$

Equations (3) and (4) may be regarded as tests that a relationship exists between the rate of growth of GDP and level of GDP per capita, as stated by Horvat. The adjusted coefficients of determination are negative and the "t" tests are non-significant at the 5% level. Thus there is no evidence in support of Horvat's arguments.

Equations (5) and (6) show that if any relationship exists at all in the cross-sectional observations, it is between GDP per capita and the per capita rate of growth. The quadratic function (5) rather than the logarithmic relationship assumed by Horvat is the only one with "t" values significant at the 5% level. Moreover, the tests in equation (5) cannot be accepted without question as definitive proof of the relationship. The "explanatory power" of this regression is very low, while the correlation between independent variables is

very high: 0.948 for Y and Y^2 (for log Y and its square, the simple correlation is almost unity: 0.997). This high correlation can bias the regression coefficients (the numerators of the "t" tests) in opposite directions when combined with low explanatory power, possible specification problems and the inevitable errors in macro-economic data [Johnston, 1972: 160-9].

In summary, a very weak relationship may exist between the per capita measures of growth and income. The relationship between total growth and per capita income assumed by Horvat is completely unsupported by the data, as is the assumption regarding the logarithmic specification. The question naturally arises as to the differences between my results (confirming Hagen and Hawrylshyn's findings) and those of Horvat. Actually, the contrast occurs only because of Horvat's post hoc elimination of two groups of observations. The first group is dismissed for "political instability" or "too great a burden of traditions" and includes: Morroco, Uruguay, Argentina, United Kingdom, Ireland, Chile, Bolivia and Ghana. Horvat presents no justification for considering political instability as the cause of low growth rates rather than vice-versa. (economic difficulties in Uruguay, for example, clearly preceeded its political collapse into military rule). There is also no explanation as to why some traditional or politically unstable countries manage to obtain respectable growth rates, or how the United Kingdom can be classified with Morroco and Bolivia under any reasonable definition of "traditional" or "politically unstable".

Horvat's elimination of a second group of countries is equally unacceptable with the exception of Iran and Saudia Arabia (due to excessive oil rents). The remaining countries in the group are: Thailand, UAR, Taiwan, Zambia, Syria and South Korea.

The only common trait among the countries in either group is that they are off Horvat's assumed regression lines (the first group considerably below, the second group above). Their elimination naturally resulted in "significant" regression coefficients and somewhat higher R^2 values. When Horvat used all the observations not eliminated by the a priori criteria (minimum growth period and critical mass), his results are consistent with mine: an R^2 of about 0.2 for the low income group and non-significant regression coefficients for the high income group [Horvat, 1974: 391].

A NOTE ON CAUSALITY

Questions of causality may seem superfluous when dealing with weak or non-existent relationships. Some developed countries, however, may prove to have secular growth patterns similar to that suggested by the historical hypothesis (which has not been tested here). There may also be some researchers who will regard my equation (5) as evidence supporting a modified cross-sectional hypothesis. In each case, explanations are required. This points out a crucial logical difficulty with the literature on the subject: the hypotheses do not discriminate among alternative causal factors.

Horvat lists the following reasons for accelerating growth among low income countries (presumably applicable to either the historical

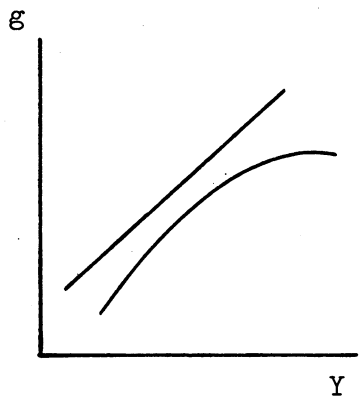
or cross-sectional case) [p. 384]: (1) a declining capital-output ratio; (2) combined factor productivity; (3) shifts to manufacturing; and (4) ease of borrowing technology from more advanced countries. Decelerating growth among high income countries is conversely attributed to a declining share of manufacturing in total output and to reduced possibilities of assimulating new technology from more developed countries.

I suggest that these reasons are neither convincing nor exhaustive. For example, it may be that developed countries have greater ease of producing, borrowing and assimilating new technology than other countries, since they possess the complements of trained manpower, sophisticated equipment and high levels of existing technology. There is, furthermore, at least one interesting alternative to Horvat's declining capital-output ratio and shift to manufacturing as an explanation for an intermediate stage of high growth, should it occur. This involves the distinction between stock and flow resources [Georgescu-Roegen, 1975, pp. 347-81]. Stock resources are non-renewable. The neoclassical concepts of capital accumulation and replacement may also be viewed as depletion of non-renewable resources. As a country learns to extract and process mineral and other stock resources, it may experience a spurt of growth. Yet eventually these resources become depleted and substitutes are more difficult to find and require greater investment of time and materials to make usable. Growth thus decelerates. Deceleration may also occur if the country adopts goals and policies which conflict with short-term growth, such as clean air and conservation.

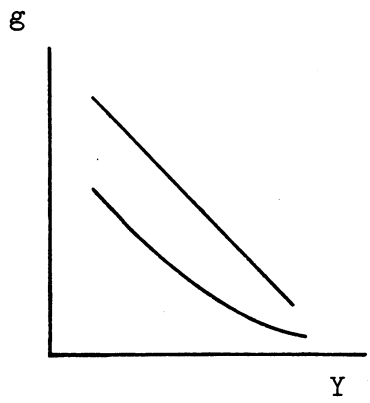
The above factors are of course merely suggestive of additional explanations for a long-term accelerating-decelerating pattern of growth, should it be found in particular cases.

CONCLUSIONS

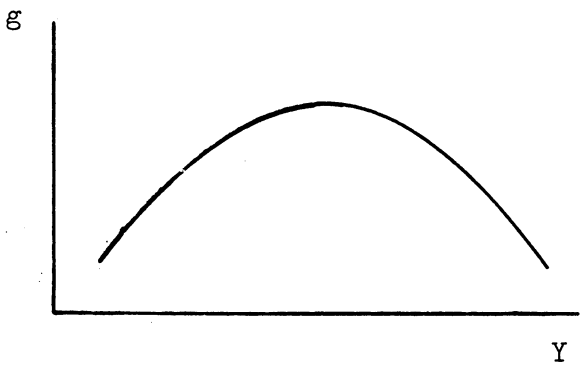
The relationship between the rate of growth and GDP per capita is weak or non-existent for cross-sectional data in the 1960 decade, whether growth rates are expressed in total or per capita terms. There is thus no evidence to suggest improvement in relative income disparities among countries.



(a) low income branch



(b) high income branch



(c) all income levels

Figure 1. Alternative representations of hypothesized relationship of growth rate and income level.

NOTES

[1] At a minimum, one would have to assume that modern LDC's will follow the same growth path as currently developed countries experienced. This assumption is untenable, as pointed out by Higgins in his critique of the "stage theories" of development [1968, pp. 174-294] .

[2] There are reasons for doubting this hypothesis at the outset, however. The economic history of the United States, for example, is marked by booms, depressions and phases of differing growth rates of varying lengths. Its unimpressive recent performance cannot be taken as evidence of a well-delineated phase of deceleration supporting the hypothesis. Similarly, countries such as Italy and the United Kingdom have been criticized for their post-war economic performance. One might find, nevertheless, that their growth during the period (e.g., 5.3 and 2.8% total growth per annum during the 1960 decade) are quite respectable when compared with other periods in their histories.

[3] The following countries comprise the sample (growth rate data are for the 1960-1970 period unless otherwise listed): Australia, Japan (1961-70), South Africa, Switzerland (1960-1969), Israel, Egypt, Ireland, Italy, Jamaica, South Korea, Mexico, Netherlands, Nicaragua, Norway, Pakistan (1960-1969), Paraguay, Peru, Argentina, Austria, Belgium, Bolivia, Brazil, Burma (1962-1970), Canada, Chile, Colombia, Denmark (1961-1970), Dominican Republic, El Salvador, Finland, France, West Germany, Greece, Guatemala, Honduras, India, Philippines, Portugal,

Puerto Rico, Spain, Sri Lanka (1963-1970), Sweeden, Thailand, Tunisia, Turkey, United Kingdom, Tanzania (1964-1970), United States, Venezuela, Ghana, and Uruguay.

In separate regressions, data for nine additional countries were included which did not meet the a priori criteria or for which some of the necessary data had to be estimated or extrapolated. Similarly, observations using GDP per capita estimates from other sources for seven centrally planned economies were combined with the original 51 observations and with the 60 observations on all market economies. In no case did the results differ substantially from those presented in equations (3) - (6) below.

[4] The point of division may be very important, since the addition or deletion of a few observations may considerably affect the regression estimates when the "explanatory power" of the regression is very low.

[5] The parentheses are Horvat's.

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