A MODEL OF INCOME DIFFERENTIALS BETWEEN DEVELOPING COUNTRIES

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Recently, Arrow stated that, "Inequality in economic development among countries and among groups and regions within a country provides a second, somewhat complicated difficulty for neoclassical theory. A purely neoclassical answer would explain differences in per capita income by differences in physical and human assets per capita. This of course raises the further question, how this came to be, a question which would require a fully dynamic model to answer; but I think the more compelling problem is that the differences in income seem much too vast to be explained by factor differences".[1] This paper is an attempt to examine the extent to which the neoclassical theory does provide an explanation of per capita income differentials between developing countries. A distinguishing feature of the paper lies in the fact that the single equation neoclassical model is treated as part of a set of a simultaneous equation model which explicitly allows for the role of demographic factors. The scheme of the paper is as follows. In Section I we present the model, Section II presents the results, and the last section briefly summarizes the findings.

I. The Model

The neoclassical explanation is a straight forward one. Consider the following production function:

$$Y = F(K,L) \tag{1}$$

where Y, K, and L are GNP, capital, and labor respectively.

Assuming that this production function is linear and homogeneous, it may be written in per capita terms as

$$\frac{Y}{N} = F\left(\frac{K}{N}, \frac{L}{N}\right) \tag{2}$$

where N is population and (L/N) represents total labor force participation rate. Thus equation (2) states that, abstracting from technical change, per capita income depends on per capita capital and the labor force participation rate. In other words, countries which exhibit high k(=K/N) and PR(=L/N), should be expected to have high per capita income and vice-versa.

The above model has one major short-coming and that is the exogenous nature of the labor force participation rate. The correct procedure would be to explicitly allow for the role of demographic factors as determinants of PR and thus in the determination of differences in per capita income. This is the procedure we follow.

For our purpose, we face an empirical problem before this can be done. The data on international labor force participation rates are highly inadequate and imprecise. Thus the estimation of an equation like (2) is very difficult. In order to overcome this difficulty, following demographic theory, we postulate that participation rates depend on dependency rates - a variable for which reliable data are available - such that

$$PR = f(DR) \quad f' < 0 \tag{3}$$

where DR stands for dependency rates. Equation (3) implies that the higher are the dependency rates, the lower will be the participation rates. Hence, a priori, we should expect a negative partial relationship between per capita income and dependency rates.[2]

Assuming that the empirical model is represented by a linear equation and further that quality differences in labor force are represented by differences in literacy rates and further that non-capital resources also affect per capita income, the equation to be estimated is given by

$$\underset{>0}{Y} = \underset{>0}{a} + \underset{<0}{bk} + \underset{<0}{cDR} + \underset{>0}{dDEN} + \underset{>0}{cLIT} \tag{4}$$

where the expected signs of the coefficients are indicated below the coefficients and DEN stands for population density which is used to measure non-capital resources, an admittedly crude measure as pointed out by Adelman.[3] LIT stands for literacy rate. Per capita energy consumption is used as a proxy for per capita fixed capital[4] and is measured in kilograms per capita coal equivalents.

We now assume that the dependency rate is an endogenous variable. To take account of this, we specify the following additional equation:

$$DR = a_o + b_o BR \tag{5}$$

$$BR = a_1 + b_1 FPR + c_1 y + d_1 IMR + c_1 LIT + f_1 ALF \tag{6}$$

$$FPR = a_2 + b_2 BR + c_2 AFL \tag{7}$$

$$IMR = a_3 + b_3 y + c_3 ALF + d_4 LIT + e_4 HB \tag{8}$$

where, in addition to the variables already defined,

- BR: birth rate per 1000
- FPR: female labor force partifipation rate
- IMR: infant mortality rate
- ALF: percentage of labor force in agriculture
- HB: number of persons per hospital bed

Detailed explanations for these specifications can be found in the author's other paper.[5] Therefore only brief comments on these equations are offered here.

Dependency rate equation

This equation is straightforward and its rationale has been ably summarized by Leff. Thus, "demographic theory indicated that a prolonged high birth rate will affect a population's age composition, placing a relatively large percentage of population in the younger age bracket".[6]

Birth rate equation

This equation embodies the hypotheses put forward by Adelman (1963), Becker (1960), Mincer (1963). Cain (1966), and Schultz (1969, 1973), among others. Very briefly, the inclusion of per capita income follows from the theory of consumer choice, as for example, argued by Becker. Female participation rate is included as a proxy for the, "opportunity income of women and their access to the labor market."[7] The inclusion of infant mortality is justified in terms of the replacement needs of a family for children {Gregory et.al. (1972), Schultz (1973)}. The role of education has been discussed extensively and need

not be elaborated here. The reason for the inclusion of the percentage of agricultural labour force is based on the well known argument that agricultural activity is more conducive to higher birth rates than non-agricultural activity.[8]

Female participation rate equation

Birth rates affect the supply of labor and is therefore included as an argument of this equation.[9] It is now well recognized that labor force participation rate is higher in largely agrarian economies[10] and we therefore expect a positive relationship between female participation rate and the level of non-industrial development where the latter is measured by the percentage of the labor force in agriculture.

Infant mortality equation

This equation is similar to the one used by Adelman. The variable, the number of persons per hospital bed, is used as an index of the availability of health care services.

For estimation purposes it is not necessary to estimate the entire model. Instead, we use the two-stage least squares method. In the first stage, we use all the exogenous variables as instruments to estimate DR which is the endogenous variable in equation (4). In the second stage, using this estimated value of DR, we estimate equation (4) by the method of ordinary least squares. This provides consistent estimates of the parameters of equation (4). Two important points about our method of estimation should be noted. First, the instruments used are derived from an a priorily defined model and second, we use all the exogenous variables as instruments and not a subset of them, which is always an arbitrary procedure.

II. The Results

The model was applied to a cross-section of forty developing countries. The countries included are: Argentina, Bolivia, Brazil, Ceylon, Chile, Colombia, Cost-Rica, D. Republic, Ecuador, El Salvador, Greece, Guatemala, Honduras, India, Indonesia, Israel, Japan, Jamaica, Jordan, Malaysia, Malta, Mexico, Morocco, Nicaragua, Pakistan, Panama, Paraguay, Peru, Philippines, Portugal, S. Korea, Spain, Taiwan, Thailand, T. Tobago, Turkey, UAR, Uganda, Uraquay, and Venezuela.

The period covered was the 1960's. The data were collected from the unpublished World Tables of the World Bank and various publications of the United Nations.

The results of equation (4) are as follows:

$$y = 601.1077 + \underset{(7.805)}{0.20789}k - \underset{(1.838)}{12.61856}DR - \underset{(0.690)}{0.07932}DEN + \underset{(1.366)}{1.87395}LIT$$

$$\bar{R}^2 = 0.808$$

We can see from these results that our version of the neoclassical model explains about 81% of the per capita income differentials between the developing countries. Except population density, all the coefficients exceed their standard error. The sign and significance of the coefficient of dependency rate is particularly noteworthy. Recall that we were forced to abandon the proper neoclassical model due to lack of information on labor force participation rates. We can see that the use of dependency rates gives fairly reasonable rates. At the same time, it also highlights the importance of demographic factors.

In order to examine the relative impact of various factors on per capita incomes, we calculated elasticities at the mean. These are given below:

TABLE 1
Elasticities

With respect to	Elasticity
k	0.41
DR	-1.60
LIT	0.33

If we consider k and LIT to represent crude indicators of investment in physical and human capital, respectively, we can see that their significance is somewhat similar. The elasticity with respect to dependency rates on the other hand is significantly different - almost four times. It would thus appear that developing countries would get a greater pay-off by reducing dependency rates, which ultimately means reducing birth rates. Our findings thus once again highlight the importance of population control for adequate economic development.

III. Conclusions

In this paper we have made use of the well-known neoclassical model to explain per capita income differentials between developing countries. However, we modified this model in two important ways. First, we replaced labor force participation rate by the dependency rate which is more reliably measured. And second, we treated the modified single equation neoclassical model as part of a simultaneous equation model which explicitly allowed for the role of demographic factors as determinants of per capita income differentials. The results turned out to be highly satisfactory to the extent that the model explained about 80 percent of the variation.

Depending on the availability of data, it would be worthwhile refining our model. This could be done in a variety of ways. First, equation (4) should be specified so as to include both male and female labor force participation rates in view of the fact that these rates show considerable variation. Then include equations explaining these two participation rates. Second, more refined measures of non-capital and capital resources and literacy could be used. Finally, the model could be disaggregated, making allowance for the so called 'dual' economy characteristic of these countries.

Footnotes

1/ Arrow [1974], p. 2.

2/ See also Enke [1973].

3/ Adelman [1963].

4/ See Kim [1969].

5/ See Gupta (1973).

6/ See Leff [1969], p. 887.

7/ Schultz (1969), p. 155. See also Mincer (1963) and Cain (1966).

8/ Schultz (1969).

9/ See Benham (1971) and Cain (1966, 1973).

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