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THE BIRTH RATE AND ECONOMIC DEVELOPMENT: AN EMPIRICAL STUDY

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Population growth and economic growth are interdependent. Excessive population growth would cancel economic growth. The question is whether economic growth will prevent excessive population growth. An important facet of this problem is to estimate statistically the effects of economic growth on the birth rate.

THE BIRTH rate has long interested economists as well as demographers. In recent years the emphasis of research by members of both professions has been on the facts and their consequences for economic welfare. Nearly all observers agree that preventive checks are necessary if living standards are to rise above the subsistence level in underdeveloped areas. But there is little agreement on the validity and usefulness of the proposition that economic development, per se, automatically will dampen birth rates. The purpose of my research was to test empirically the relationship between national birth rates and three basic measures of economic development: per capita income, ratio of population in farming, and infant mortality.

My study deliberately ignores the relationship between birth rates and demographic factors such as the age-structures of populations. It ignores also the roles played in determining birth rates by abortion, mechanical birth control devices, continence or rhythm, and late marriage. My study takes for granted that, for example, as the per cent of pregnancies terminated by abortion rises the birth rate declines.

Birth rates have relevance for economic growth and, as a corollary, living standards only through their effects on rates of population increase. Population changes reflect death rates as well as birth rates. Nevertheless, concentration on birth rates is called for since today death rates depend strategically on exogenous medical factors and hence can be taken as independent of economic variables. Also death rates in underdeveloped areas probably will continue to decrease and this trend almost certainly will be encouraged, not impeded. Thus, if our plans to permanently raise living standards in underdeveloped nations above the subsistence level are to succeed, preventive checks to family reproductivity are necessary. Accordingly it is important to estimate to what extent, if any, economic development, per se, tends to check a nation's birth rate. If there is no automatic dampening process, preventives will have to be politically, psychologically, or otherwise effected.

[1] I am indebted to my former colleague Phillip Nelson of the Graduate Faculty of the New School for Social Research for his constructive suggestions. Of course, he is not responsible for whatever errors may appear in this paper.

But perhaps a nation's birth rate automatically declines as its economic development proceeds, more specifically, as its per capita income rises and the ratio of its population in farming and its infant mortality fall.

A priori, in the sense of before examination, it may be suggested that a nation's birth rate is positively related to both its ratio of population in farming and infant mortality. Few would disagree. For, in general, the children of farm families begin to contribute to their own support and family income much earlier in life than the children of nonfarm families. And infant mortality also operates to shorten, though of course in a terrible fashion, the period of dependency during which parents must support their offspring. In addition, it may be urged that where infant mortality is high a high birth rate is required to achieve any desired family size.

The relationship between the birth rate and per capita income popularly is thought to be negative. But there is at least one reason for believing that the birth rate will rise as income increases, viz., income increments provide opportunities to families to raise additional children. Theoretical considerations cannot decide whether the birth rate is positively or negatively related to income. Moreover, existing empirical studies on the matter do not appear to be conclusive. The usual observation is that intercountry comparisons contradict the proposition that there may be a positive correlation between the birth rate and income. But this test is not a valid one because nations differ from one another in many respects other than income. A fair test requires controlling at least some of the factors other than income which strategically affect the birth rate.

The remainder of this paper is used to discuss the procedures and results of my attempts to quantify the relationship of a nation's birth rate to its per capita income, ratio of population in farming, and infant mortality. The partial regression of the birth rate (X_1) on per capita income in 1948 United States dollars (X_2), ratio of population in farming (X_3), and infant mortality rate (X_4) was computed for the thirty nations listed in Table I from data for the early 1950's. The only standard used in selecting nations was whether data were available on all variables.

The early 1950's is used as the time universe rather than a later period because, at the time of this research (1960–1961), the available data on ratio of population in farming pertained to 1952 or earlier in twenty-five of the thirty sample nations. An earlier period was not used because income data are not available for many of the pilot nations before 1930 and in the span from 1930 to the early 1950's the latter years appear to be the most normal years.[2]

[2] The abnormal conditions of the 1930–1950 period prevented testing for lagged relationships between the birth rate and the three independent variables. Theoretical psychology suggests that lags may exist with respect to all three variables and certainly it would be useful to employ weighted averages of past and present data in

TABLE I

BIRTH RATES, PER CAPITA INCOMES, RATIOS OF POPULATION IN FARMING, AND INFANT MORTALITY RATES IN THIRTY SELECTED NATIONS IN THE EARLY 1950's

Nation	Actual Mean Birth Rate 1953–1954[1]	Mean Per Capita Income 1953–1954 in 1948 U.S. Dollars[2]	Ratio of Population Classified as Farm Circa 1950[3]	Mean Infant Mortality Rate 1953–1954[4]
Venezuela	46.4	392	.40	68.5
Mexico	45.7	118	.61	87.8
Ecuador	45.3	44	.53	115.8[d]
Colombia	38.6	158	.53	106.8
Ceylon	37.2	81	.53	71.6
Puerto Rico	35.0	374	.37	60.2
Chile	34.0	187	.30	118.7
Canada	28.3	993	.19[c]	33.7
United States	24.7	1723	.12	27.2
Argentina	24.7	287	.20	62.0
New Zealand[a]	24.4	970	.19	24.9
Australia	22.7	885	.12	22.9
Hungary	22.3	200	.53	65.7
Netherlands	21.7	575	.14	21.6
Finland	21.6	688	.34	32.4
Philippines	21.3[b]	48	.69	108.7[e]
Ireland	21.2	572	.49	38.6
Japan	20.8	239	.42	46.7
Spain	20.3	244	.48	56.5
France	18.9	472	.25	44.4
Greece	18.8	134	.52	47.4
Norway	18.6	633	.19	21.7
Italy	18.0	295	.44	55.7
Denmark	17.6	906	.24	27.1
Switzerland	17.0	1045	.16	28.5
Belgium	16.7	775	.10	41.6
W. Germany	15.9	619	.15	44.6
England	15.3	901	.05	26.1
Sweden	15.0	910	.24	18.7
Austria	14.8	556	.22	49.1

[1] *Source. UN Demographic Yearbook, 1958,* Table 7.

[2] *Sources. UN Statistical Yearbook, 1956,* Tables 162, 157 and 160; *UN Statistical Yearbook, 1959,* Table 167; and W.S. and E.S. Woytinsky, *World Population and Production* (New York: The Twentieth Century Fund, 1953) Table 186.

[3] *Source. UN Production Yearbook, 1958,* Tables 4a and 5a. The former gives estimates of "Agricultural Population" and the latter of "Population Engaged in Agriculture." The two sets of data do not appear to differ systematically. Data used here are from Table 4a wherever possible; i.e., except in the cases of Mexico, Ecuador, Puerto Rico, Chile, United States, Hungary, Japan, and England.

[4] *Sources. UN Statistical Yearbook, 1959,* Table 4; and *UN Demographic Yearbook, 1958,* Table 10.

[a] Europeans only. [b] 1952–1953. [c] Interpolated for 1950 from data for surrounding years. [d] 1954. [e] 1952.

relating the birth rate to the three independent variables. In theory, we can quantify the relative importance to present behavior of the events of n, $n - 1$, $n - 2$, . . . and $n - n$ years ago. But there is not much point in attempting this task if the events in question are unusual. Finally, in this connection, it may be legitimately urged that errors in measurement tend to reduce relationships, and so my inability to use weighted averages of past and present data causes my relationships to be understated.

Simple averages of crude birth rates and infant mortality rates were computed for each nation from United Nations data. Ratios of population classified as farm also were obtained from United Nations data. Per capita incomes were computed from United Nations data together with information tabulated by the Woytinskys. Simple averages of real per capita products were computed for each nation from United Nations data. In turn, these averages were converted into per capita incomes expressed in 1948 United States dollars through a schedule given in W.S. and E.S. Woytinsky, "World Population and Production."[3]

As stated above, I computed the partial regression of the birth rate on the three independent variables. Results are as follows:

$$X_{c1\cdot234} = \underset{}{6.6} + \underset{(.0045)}{.006X_2} + \underset{(7.76)}{5.98X_3} + \underset{(.06)}{.25X_4}, \tag{1}$$

where X_1 denotes the mean birth rate, 1953–1954, X_2 denotes mean per capita income, 1953–1954, expressed in 1948 United States dollars, X_3 denotes ratio of population classified as farm circa 1950, and X_4 denotes mean infant mortality rate, 1953–1954.

$S_{1\cdot234} = 5.8$. $R^2_{1\cdot234} = .67$ and $F = 7.37$ which is significant at the .01 level. Coefficients of partial correlation are .25 for X_2, .11 for X_3, and .78 for X_4.

Doubtless the three independent variables are not, as assumed, totally independent of one another. The set of regression coefficients, giving a rough idea of the extent of their interdependence, is presented in Table II. One implication of this interdependence of the explanatory variables is that the coefficients of birth rates on each of them are somewhat corrupt. In the face of multicollinearity probably the best that can be done is to compute confidence intervals for the parameters. Confidence intervals can be computed at any desired level of confidence from the standard errors which are set forth above in the brackets placed beneath the numerical coefficients in equation (1).

TABLE II

REGRESSION COEFFICIENTS OF THE THREE INDEPENDENT VARIABLES
(X_3 and X_4 on X_2 and X_4 on X_3)

	X_2	X_3	X_4
X_2		−.0003	.−058
X_3			+118.0
X_4			

[3] All data sources are fully cited in Table I.

The results tend to confirm the Malthusian hypothesis that income increments generate birth rate increases as well as the more widely held hypotheses that birth rates decline with urbanization and decreases in infant mortality.

In terms of the proposition that economic development, per se, automatically will dampen birth rates, the results are mixed. What might be termed the infant mortality effect of economic development on family reproductivity definitely promises to produce lower birth rates in underdeveloped areas as they become developed. Similarly, the urbanization effect appears likely to bring lower birth rates. On the other hand, the income effect appears likely to bring higher birth rates.

Since income and the birth rate appear to be related positively, the effect of economic development on family reproductivity cannot be clarified definitively with the data of this research. Still some may believe that these data support the proposition that economic development will operate to dampen birth rates. To illustrate, suppose that for a generation later than the early 1950's, Venezuela's per capita income, X_2, is doubled. This means it would have risen by \$392. Using the estimates of interdependence in Table II, we find that this order of income change implies or will be accompanied by a .12 decrease in ratio of population in farming, X_3, and a 36.9 decrease in the infant mortality rate, X_4. In turn, the assumed dX_2 and the derived dX_3 and dX_4 mean that for a generation later than the early 1950's we will observe $X_2 = \$784$, $X_3 = .28$, and $X_4 = 31.6$ in Venezuela.[4] It is noteworthy that these levels are similar to the figures for Canada, Finland, and Denmark in the early 1950's. It would appear that economic development tends to produce roughly the same magnitudes of change as are implied by the simple correlation matrix of the three explanatory variables.

Given the above changes, it is a relatively simple matter to compute an interval estimating the accompanying change in Venezuela's birth rate, dX_1, at any desired confidence level. For example, at a .729 (or $.9^3$) level the lower limit is $dX_1 = (b_2 - 1.706S_{b2})(dX_2) + (b_3 + 1.706S_{b3})(dX_3) + (b_4 + 1.706S_{b4})(dX_4)$, where, in general, b_i is the estimated parameter for X_i and S_{bi} is the standard error of b_i. Similarly, the upper limit is $dX_1 = (b_2 + 1.706S_{b2})(dX_2) + (b_3 - 1.706S_{b3})(dX_3) + (b_4 - 1.706S_{b4})(dX_4)$. Substituting the appropriate values of the b_i, S_{bi}, and dX_i, we find that at a .729 confidence level, over the generation starting circa 1950,

$$-16.0 < dX_1 < +0.9$$

[4] The figures are obtained as follows. First, $dX_2 = \$392$ by assumption. In the early 1950's, $X_2 = \$392$, and $\$392 + \$392 = \$784$. Second, $dX_3 = (-.0003)(\$392) = -.12$. In the early 1950's, $X_3 = .40$, and $.40 - .12 = .28$. Third, $dX_4 = (-.058)(\$392) + (118)(-.12) = -36.9$. In the early 1950's $X_4 = 68.5$, and $68.5 - 36.9 = 31.6$.

and, since in the early 1950's $X_1 = 46.4$, a generation later

$$30.4 < X_1 < 47.3 .$$

The principle objection to inferring that economic development operates to dampen birth rates on the basis of the data of this paper is that a negative dX_1 is not certain. In the illustration above there is a .05 chance of $dX_1 > 0$.[5] Moreover the probability of $dX_1 > 0$ rises as the confidence level rises. For those who would set aside this objection, the data of this research may suggest that, changes in death rates aside, the so-called population explosion in underdeveloped areas is not a major problem but one that will be solved automatically if only we are able to solve the problem of economic development. But for those who accept this objection the ambiguity of the data of this research may suggest that policies must be devised to assure that continuing high birth rates do not offset or impede efforts to develop underdeveloped economies.

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[5] This result is obtained as follows. At the $.9^3$ level the interval estimating $dX_1 = |16.9|$; the positive subinterval $= |.9|$ or approximately 5 per cent of the interval.