

CORRELATIONS BETWEEN POPULATION  
GROWTH AND ECONOMIC GROWTH

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## ABSTRACT

In discussions of how population growth affects the growth of per capita income, studies are often cited which show that the two variables are uncorrelated cross-sectionally. Sometimes it is then inferred that the Malthusian scenario, according to which rapid population growth reduces economic welfare, is mistaken. This paper reviews the simple cross-sectional correlations between population growth and per capita income growth appearing in earlier studies, and uses both old and new data sets to obtain some more correlations. It is concluded that for periods during the last forty years, the correlations among low-income countries tend to be zero, while those among high-income countries and among all countries combined tend to be negative. The limitations of simple correlation for inferring causal linkages between population growth and per capita income growth are also discussed.

## RESUME

Dans les discussions concernant les effets de la croissance de la population sur la croissance du revenu par habitant, l'on cite souvent des études démontrant qu'il n'existe aucune corrélation entre ces deux variables. Par conséquent, on entend parfois que le scénario malthusien, qui constate qu'une croissance rapide de la population a des effets négatifs sur l'économie, est erroné. Cet article analyse les simples corrélations entre la croissance de la population et la croissance du revenu par habitant présentées dans des études précédentes et établit de nouvelles corrélations à partir de données recueillies antérieurement et récemment. On tire la conclusion suivante: au cours des quarante années récemment passées, les corrélations entre les pays pauvres sont généralement de zéro, alors que les corrélations entre les pays affluents et entre les pays pauvres et affluents ensemble sont généralement négatives. L'on discute aussi les problèmes associés à la tentative de déterminer, à partir d'une simple corrélation, des rapports de causalité entre la croissance de la population et la croissance du revenu par habitant.



## INTRODUCTION

What effect does population growth have on average living standards? This question continues to be vigorously debated. In the policy area, for example, donor organizations often advise Third World governments that economic welfare can be improved if fertility is reduced, but the governments are not always convinced by these arguments. The matter is not easily resolved by scientific inquiry, because it is not difficult to think up plausible hypotheses on both sides of the issue. Mechanisms have been suggested, in a long literature going back to Malthus, as to why faster population growth should threaten living standards. These include "diminishing returns" (more workers mean less capital and natural resources per worker, hence less output per worker) and "the burden of dependency" (higher fertility means more dependents per worker, hence a lower rate of saving and of capital formation). Mechanisms implying opposite consequences include "technological incentives" (faster population growth creates pressures which encourage innovation), "demand stimulation" (faster population growth raises consumption demand, with favorable Keynesian effects on output and investment), and "economies of scale".

Since a priori reasoning provides no clear answer to the question, it becomes especially important to look at the historical evidence relating population growth to economic welfare. One kind of evidence involves taking a group of countries and looking at the simple cross-national correlation between their rates of population growth and per capita real income growth over a certain period. The results of some of the most frequently cited studies of this type are summarized in Table 1. There is ammunition here for both antinatalist and pronatalist viewpoints, since some of the correlations are significantly negative and some have no statistical significance, the results varying between time periods and the groups of countries selected. It is the pronatalist side, however, that has drawn the most emphatic inferences from this body of evidence. Many authors have used what Cassen (1976) has called "the noncorrelation argument", claiming that these results amount to a decisive refutation of Malthusianism. Thus Lefebvre concludes that "l'observation dément les théories: la croissance

TABLE 1  
 CROSS-NATIONAL CORRELATIONS BETWEEN POPULATION  
 GROWTH RATE AND PER CAPITA INCOME GROWTH RATE

Study	Approximate period over which population growth and per capita income growth are measured	Correlation between average annual rate of population growth and average annual rate of growth of real per capita national income, with numbers of cases in parentheses: - Negative and significant (at 95% confidence level) 0 No correlation (at 95% confidence level) ... Nothing reported		
		Among low-income countries	Among high-income countries	Among all countries for which data available
Kuznets (1971)	1860-1967	...	0 (11)	...
Kuznets (1971)	1910-1967	...	0 (10)	...
Stockwell (1962)	1950-1960	- (16)	...	...
Thirlwall (1972)	1950-1966	0 (32)	- (17)	0 (49)
Kuznets (1967)	1952-1964	0 (40)	- (21)	- (63)
Easterlin (1967)	1957-1964	0 (37)	...	...
Stockwell (1972)	1960-1970	0 (26)	...	...
Chesnais & Sauvy (1973)	1960-1970	0 (76)	0 (16)	...
Lefebvre (1978)	1960-1975	0 (96)	...	...



de la population n'a pas eu les conséquences défavorables annoncées" (1978, p. 1224). Simon believes that "these overlapping empirical studies ... contradict the simple Malthusian theory" (1981, p. 261).

There are several gaps in Table 1, where for certain time periods and certain groupings of countries no correlation coefficient has been calculated. For some of the gaps, the relevant data are readily available. The purpose of this paper is to fill in some of these gaps, and also to look at coefficients applying to the period since 1975. In this way, a fuller picture of the historical experience can be obtained. Finally, some of the difficulties in interpreting this experience are discussed.

### SOME NEW CORRELATIONS FOR 1960-1983

In their analysis of data for the 1960's, Chesnais and Sauvy (1973) look at the correlation between population growth and per capita income growth in a group of 76 underdeveloped countries. No significant correlation is found, their result being shown as Equation 1 in Table 2. Similarly, they find no significant correlation among a group of 16 developed countries. Neither of the two groups, however, is complete. The authors exclude from the underdeveloped group countries which they regard as special cases (oil producers, communists, politically unstable, etc.), while the developed group is confined to Europe. No correlation is calculated for the totality of the 122 countries treated in the data source, which are the tables in the 1973 World Bank Atlas applying to countries with population exceeding one million. A correlation for all cases, however, would not be without interest. In the first place, the mechanisms (cited above) by which population growth is hypothesized to affect the economy could well apply to all situations, high-income as well as low-income, and communist as well as capitalist. In the second place, the economies of the world are not sharply divided into the dichotomies beloved of development theorists (MDC-LDC, North-South, Center-Periphery, etc.) but are rather evenly distributed along a continuum, so that there is no clear dividing-line between them.

However that may be, the correlation between population growth and per capita income growth among all 122 countries in the Chesnais-Sauvy data source is significantly negative (Equation 2).

TABLE 2  
TWO-VARIABLE REGRESSIONS  
RELATING POPULATION GROWTH AND ECONOMIC GROWTH

Equation Number	Dependent variable <sup>a</sup>	Independent variable <sup>b</sup>	Constant term	Coefficient on independent variable <sup>c</sup>	R <sup>2</sup>	Number of cases	Cases available in source but excluded from regression
1	Y <sub>1</sub>	X <sub>1</sub>	1.630	0.193 (0.436)	0.003	76	46 <sup>d</sup>
2	Y <sub>1</sub>	X <sub>1</sub>	4.347	-0.629* (0.278)	0.041	122	0
3	Y <sub>2</sub>	X <sub>2</sub>	2.836	-0.149 (0.310)	0.002	96	45 <sup>d</sup>
4	Y <sub>2</sub>	X <sub>2</sub>	2.832	0.094 (0.147)	0.003	141	0
5	Y <sub>2</sub>	X <sub>2</sub>	4.261	-0.596* (0.181)	0.073	140	1 <sup>e</sup>
6	Y <sub>3</sub>	X <sub>3</sub>	3.207	-0.786 (0.476)	0.036	75 <sup>f</sup>	30
7	Y <sub>3</sub>	X <sub>3</sub>	2.274	-0.373* (0.155)	0.172	30	75 <sup>f</sup>
8	Y <sub>3</sub>	X <sub>3</sub>	2.372	-0.449* (0.178)	0.058	105	0
9	Y <sub>3</sub>	X <sub>4</sub>	2.318	-0.417* (0.182)	0.048	105	0

NOTES: <sup>a</sup>Dependent variables:

- Y<sub>1</sub> average annual percentage increase in per capita real GNP, 1960-70  
 Y<sub>2</sub> average annual percentage increase in per capita real GNP, 1960-75  
 Y<sub>3</sub> average annual percentage increase in per capita real GNP, 1973-83

Data Source:

- World Bank (1973)  
 World Bank (1977)  
 World Bank (1985)

<sup>b</sup>Independent variables:

- X<sub>1</sub> average annual percentage increase in population, 1960-70  
 X<sub>2</sub> average annual percentage increase in population, 1960-75  
 X<sub>3</sub> average annual percentage increase in population, 1973-83  
 X<sub>4</sub> average annual percentage increase in population, 1965-73

Data Source:

- World Bank (1973)  
 World Bank (1977)  
 World Bank (1985)  
 World Bank (1985)

<sup>c</sup> Standard errors in parentheses. Asterisk indicates statistical significance at 95% confidence level.

<sup>d</sup> Developed capitalist countries, communist countries, some oil producers, some politically unstable countries.

<sup>e</sup> United Arab Emirates.

<sup>f</sup> Countries with 1983 per capita GNP under \$3,500.

Basically the same results are obtained from the data set used by Lefebvre (1978). His data come from the 1977 World Bank Atlas, and involve more countries (a lower bound of 300,000 for the population instead of one million) and a somewhat longer period of analysis (1960-75 instead of 1960-70). After excluding some special cases, he analyses a group of 96 underdeveloped countries and finds no significant correlation between population growth and per capita income growth (Equation 3). Lefebvre does not calculate the correlation coefficient for all 141 countries in his data set considered together. If this is done, no significant correlation is found (Equation 4). However, that result is heavily influenced by a single extreme case, that of the United Arab Emirates, which during the period in question went from desert poverty to oil-based affluence and brought in large numbers of immigrant workers. In consequence, the annual rate of increase in per capita income averaged 14 per cent in the Emirates over the fifteen-year period, while the annual rate of population growth also averaged 14 per cent. An anti-Malthusian conclusion is guaranteed with this observation in the sample. Removing the Emirates yields a significantly negative correlation among the remaining 140 countries in the data set (Equation 5).<sup>1</sup>

A diagram in Lefebvre's paper can be used to show visually why a lack of correlation among low-income countries is consistent with a significantly negative correlation among all countries considered together. In Figure 1 the circular black dots represent the 96 underdeveloped countries selected for Lefebvre's correlation, and it is clear from their distribution that no significant correlation between population growth and per capita income growth exists for this group.

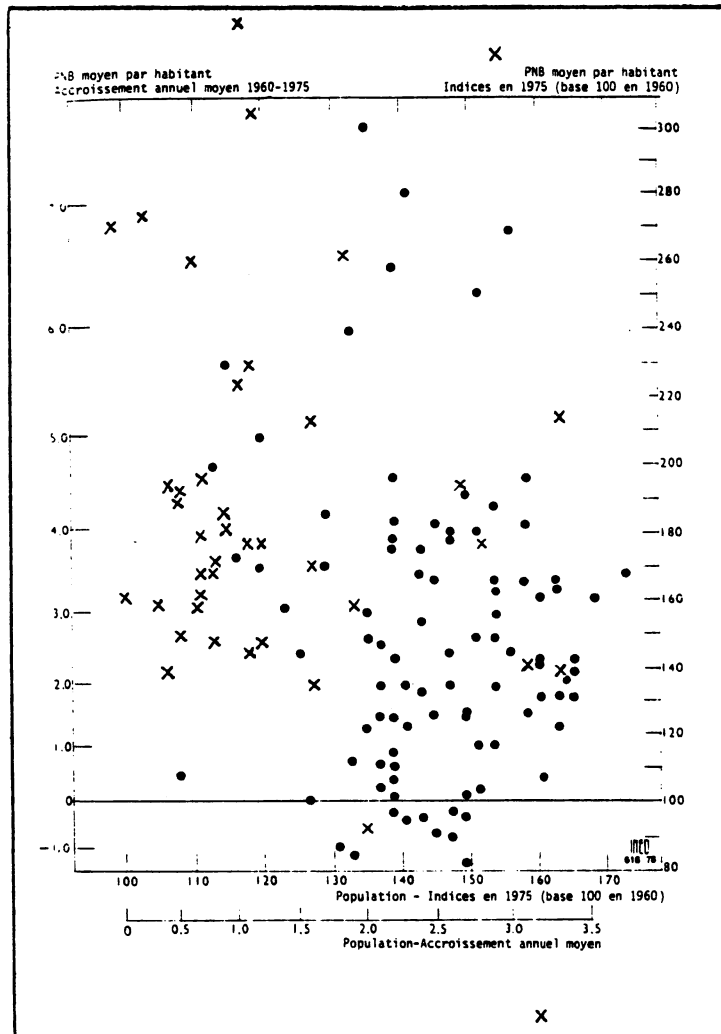
But if the other 45 countries treated in the data source are taken into consideration, and if small crosses representing them are added to Figure 1,

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<sup>1</sup>Among the remaining 140 countries, there are two extreme outliers which strengthen the negative correlation by combining rapid population growth with rapidly declining per capita income, namely Kuwait and South Yemen. When these two cases are removed, the correlation remains significantly negative.

FIGURE 1

GROWTH RATES OF POPULATION AND PER CAPITA INCOME, 1960-75



- ... 96 underdeveloped countries included in Lefebvre correlation
- x ... 45 other countries treated in Lefebvre data source

Unplotted Cases		
	Average annual per capita income increase	Average annual population increase
x Kuwait	-2.9%	8.6%
x Libya	10.5	4.1
x Oman	10.1	3.1
x United Arab Emirates	13.7	13.9

SOURCES: Diagram based on Lefebvre (1978), p. 1223; basic source for data is World Bank (1977).

a definitely negative correlation emerges. Most of these additional cases are high-income industrialized countries (both capitalist and communist) which are clustered in the zone where population grows slowly and per capita income grows more or less rapidly. Thus as Kuznets (1967) noted with regard to an earlier data set, the negative correlation for the world as a whole results from juxtaposing the high-income countries with their generally above-average per capita income growth and below-average population growth, alongside the low-income countries with their generally below-average per capita income growth and above-average population growth.

One last piece of useful evidence on these relationships is the experience over the last ten years, after the periods covered by the earlier studies cited. A convenient compilation is offered by the World Bank's World Development Report for 1985, which indicates growth rates of population and per capita income for the period between 1973 and 1983 among 105 countries with population exceeding one million. If we choose a per capita GNP of \$3,500 in 1983 as the dividing line between richer and poorer countries, once again we find no significant correlation between population growth and per capita income growth within the poorer group (Equation 6). But within the richer group, a significantly negative correlation exists (Equation 7), and the same is true when the two groups are combined (Equation 8).

#### DISCUSSION

We now combine in Table 3 the new correlations for 1960-83 with the earlier results which were presented in Table 1. A more complete picture of the historical experience is thus obtained, and the following pattern is discernible:

- a) In the different time-periods analysed, no cross-sectional correlation is normally found between the per capita income growth of low-income countries and their population growth. The sole exception among the eight correlations considered is that produced by Stockwell (1962), but that was based on a very small and perhaps biased grouping.
- b) Among high-income countries, at least for periods during the last forty years, the correlations normally found between population growth and per capita income growth are negative.

TABLE 3  
 CROSS-NATIONAL CORRELATIONS BETWEEN POPULATION  
 GROWTH RATE AND PER CAPITA INCOME GROWTH RATE:  
 AMENDED VERSION

Study	Approximate period over which population growth and per capita income growth are measured	Correlation between average annual rate of population growth and average annual rate of growth of real per capita national income, with numbers of cases in parentheses: - Negative and significant (at 95% confidence level) 0 No correlation (at 95% confidence level) ... Not calculated		
		Among low-income countries	Among high-income countries	Among all countries for which data available
Kuznets (1971)	1860-1967	...	0 (11)	...
Kuznets (1971)	1910-1967	...	0 (10)	...
Stockwell (1962)	1950-1960	- (16)	...	...
Thirlwall (1972)	1950-1966	0 (32)	- (17)	0 (49) <sup>a</sup>
Kuznets (1967)	1952-1964	0 (40)	- (21)	- (63)
Easterlin (1967)	1957-1964	0 (37)	...	...
Stockwell (1972)	1960-1970	0 (26)	...	...
Chesnais & Sauvy (1973)	1960-1970	0 (76)	0 (16)	- (122)
Lefebvre (1978)	1960-1975	0 (96)	...	0 (141) <sup>b</sup>
Present paper	1973-1983	0 (75)	- (30)	- (105)

NOTES: <sup>a</sup>Correlation coefficient becomes negative and significant when Israel dropped from data set.

<sup>b</sup>Correlation coefficient becomes negative and significant when United Arab Emirates dropped from data set.

The sole exception is the Chesnais-Sauvy result, but once again this is based on a very small group, and one moreover where there was remarkably little variation in population growth rates. Among the 16 countries involved (all in Western and Southern Europe), the average annual growth rate of population varied only from 0.4 to 1.5 per cent.

- c) When all countries are analysed together, there is a definite tendency for significantly negative correlations to emerge. Three of the five worldwide correlations listed in Table 3 are negative without further adjustment. The other two become negative when in each case one extreme outlier is dropped from the analysis. The influence of the Emirates on the correlation coefficient obtained from Lefebvre's data set has already been mentioned. In the case of Thirlwall's study, the extreme outlier is Israel, which combined a rapid increase in per capita income (averaging 5.4 per cent annually) with a rapid increase in population (4.5 per cent annually) during the years in question (1950-66). A major explanation for the Israeli performance is likely to be found in the very high rate of capital inflow occurring over this period, averaging about 20 per cent of GNP.

In sum, the historical experience reveals several negative correlations between population growth and per capita income growth. These are found among country groupings which are at least as valid as those yielding the "noncorrelations" stressed in the anti-Malthusian literature.

Of course, it is a long way from simple correlation to causation, and it seems fair to say that whatever correlation is obtained in this area, whether negative or zero, provides relatively little information about the effects of population growth on per capita income growth. In the first place, it is likely that causation between the two rates is reciprocal when both are defined over the same period of time, in which case a single correlation or regression coefficient is consistent with widely differing combinations of signs and magnitudes of the two reciprocal effects. In the second place, several of the hypothesized effects of population growth on economic welfare -- in particular those operating through the growth of the labor force and the growth of the capital stock -- are felt mainly in the long run, and will not produce changes in per capita income during the same period as the population increase.

As it happens, these two criticisms of the coefficients discussed in this paper can be accommodated within the world of simple correlation by

treating as the independent variable the rate of population growth during a period before that used for measuring the rate of per capita income increase. In this way, some of the lagged effects are recognized, and there is no possibility of reciprocal causation, because the independent variable is dated before the dependent variable. A regression of this form can be conveniently calculated from data in the World Development Report for 1985, treating as the dependent variable the growth rate of per capita income in 1973-83 and as the independent variable the population growth rate over the previous eight years (1965-73). A significantly negative correlation is found (Equation 9). Compared with the other negative correlations reported here, this is slightly more convincing as evidence that population growth may retard per capita income growth.

We say "slightly more convincing" because even Equation 9 is subject to other serious limitations which are inherent in simple correlation. In particular, an attempt to explain variations in per capita income growth must take account of other important determinants besides population growth. The omission of other determinants raises the probability that any simple correlation observed will be spurious. As for what these other determinants of economic growth might be, our preceding discussion of outliers suggests two obvious candidates: the inflow of foreign capital and the occurrence of mineral discoveries. The econometric literature in development has identified several others: trade policy, changes in the terms of trade, prolonged drought, the degree of political stability, and so on.

Incorporating other independent variables besides population growth in the regression analysis might remove the difference noted above between the nonsignificant correlations among low-income countries and the significant correlations among high-income countries. The variance of per capita income growth rates is much higher in the former group than in the latter, and the statistical noise in a simple correlation for low-income countries is so great that it may mask a real association between population growth and per capita income growth.

From this discussion, the shape of an econometric investigation of population and the economy more satisfactory than simple correlation begins



to emerge. All important determinants of economic growth should be included in the analysis; lags and reciprocal relationships should be allowed for; and all this should be done in the framework of a structural model specifying the linkages between income on the one hand and the different elements of population growth (fertility, mortality, migration) on the other.<sup>2</sup> Whether high fertility will be found to have a Malthusian effect on economic welfare in such an investigation, similar to the effect revealed in some of the simple correlations, remains to be seen.

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<sup>2</sup>For examples of econometric models which partially meet these requirements, see Browning (1982), Hazeldine and Moreland (1977), and Wheeler (1984).



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