

THE EFFECTS OF DEMOGRAPHIC VARIABLES
ON INCOME DISTRIBUTION

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Development plans of less developed countries include numerous goals. Achieving more rapid growth rates of per capita income and sharing the benefits of growth more widely are two prominent ones. Over the past fifteen years, increased attention has been given to the roles of high fertility and rapid rates of population growth in constraining the attainment of higher per capita incomes. However, there has been little analysis of the interrelationships of demographic factors and income distribution. Three recent pieces of research (Repetto, 1974; Rich, 1973; Kocher, 1973) have concluded that equalizing the distribution of income may reduce fertility. The essence of the argument is that within less developed countries high fertility is generally negatively associated with income. If the relationship is nonlinear in such a way that a small increase in the incomes of a poor couple reduces their fertility more than a small increase in the income of a couple with higher income, a redistribution of income from the rich to the poor will reduce the average level of fertility. Utilizing data from a variety of countries, Repetto, with due caution, claims to have found some empirical support for the proposition.

The purpose of this article is to suggest that empirically observed relationships between fertility and income distribution may be generated by an entirely different mechanism. In particular, high fertility and a rapid rate of population growth may be the sources of a less equitable distribution of income. Part I sets out the theoretical arguments for this position, and Part II provides a very rough empirical test of the hypothesis. Part III is a conclusion.

I. Theory

The relationships between demographic variables and income distribution are complex and not well understood. For that reason, I will only outline what seem to be the most important connections. No attempt will be made to assay the empirical magnitude of each of the interrelationships. Three demographic variables -- the rate of population growth, fertility, and mortality -- will be analyzed with respect to their influence on the distribution of income among individuals (the size distribution of income). Because high fertility and rapid rates of population growth lead to populations with very young age distributions, the impact of variations in the age structure on cross-sectional estimates of the distribution of incomes among individuals is also discussed.

I.1 The Rate of Population Growth

An important consequence of a more rapid rate of growth of population is that it may alter the distribution of income among labor earnings, profits, rent, and interest. In turn, a change in the functional distribution of income will alter the size distribution of income. The effect of population growth on the functional distribution of income is complex, depending inter alia on its consequences for the rate of growth of the factors of production (particularly capital and labor), the substitutability of factors for one another in production, the pricing mechanism, the composition of final demand, and the openness of the economy to international trade.

It has often been suggested that rapid rates of population growth diminish capital accumulation. Early studies argued that rapid population growth increased the ratio of dependents to adult members of the labor force, thereby raising the ratio of consumption to income. (Coale and Hoover, 1958; Barlow, 1967; Enke, 1967). More recent work has suggested that the magnitude of the dependency effect is less than might be supposed. Dependents are born into a family group so that an additional child's consumption is met partially by a reduction in the consumption of other members of the family, not just savings. And, if incomes are so low that there are no savings, increased numbers of dependents can have little effect on household savings. Finally, additional children may also induce other members of the household to increase their work effort and to augment family income.¹

Another criticism of the dependency burden approach is that it is really a model of household savings and household savings comprise only 30 to 40 percent of total savings. Other sources are business, government, and foreign sector savings. The impact of population growth on these sectors has not been much explored. Bilsborrow (1973) suggests that an increase in the number of dependents may marginally reduce business and government savings. In his macro-economic model, an increase in the number of dependents reduces household expenditure on non-agricultural goods, diminishing

¹ Kelley (1972) concludes from an analysis of an 1889 survey of U.S. families that additional children do stimulate work effort, but Bilsborrow (1974) concludes from cross country data that higher dependency rates have negative effects on female labor force participation.

business profits and savings and indirect taxes on business receipts. Reductions in taxes reduce government savings. In addition government savings are reduced if government expenditures are sensitive to population growth.¹

Empirical work on the effect of dependency burden is hampered by inadequate data (Mikesell and Zinser, 1973). In a cross-national study, Leff (1969) has shown that youth dependency depresses the ratio of savings to income, although Gupta (1971) shows that the relationship does not hold for countries with extremely low incomes.² On balance it would appear from available evidence that population growth does reduce savings and hence capital formation. Empirical estimates of the magnitude of the reduction are not very precise.

Thus far we have seen that population growth raises the ratio of labor to capital, of labor to land, and of land to capital. The connection between these factor changes and the distribution of income among factors is complex and can only be examined in the context of a general equilibrium model. It is likely that a more rapid growth of population will lead to an increase in the share of rent relative to labor's share. First, larger populations need to resort to more inferior land to supply agricultural output. Second, with faster population growth, lower capital accumulation permits less substitution of capital for land. Third, if rapid growth depresses per capita income, the consumption bundle will be more land intensive. The decreased ratios of capital to labor and of capital to land may result in a higher ratio of profits to labor income, but this hypothesis is less

¹ For a review of this argument, see Cassen (1973) and Sinha (1973).

² For further analysis of the empirical relationship, see Kelley (1973b).

certain and awaits empirical verification.¹

In short, it appears likely that a more rapid rate of population growth will lead to an increase in the ratio of profits and rent to labor earnings. Since the income from profits and rent is less equally distributed among individuals than labor income (Kuznets, 1963), a more rapid rate of population growth will lead to a less equal size distribution of income over time.

Fertility.

The higher is the level of fertility, given the level of mortality, the more rapid will be the rate of growth of population. Following the argument outlined above, income will be less equally distributed over time. Fertility differentials will also play a role, however.

It is generally the case in less developed countries that fertility is inversely related to family income and education of parents, although exceptions can occur if income levels are so low as to reduce fecundity to the point where fecundity is impaired. (Frisch and MacArthur, 1974)

For a given size distribution of income among individuals, the distribution of income among families will be less unequal, since low income individuals belong to larger family units. (Kuznets, 1963, p. 31) However, the size distribution of consumption will be less equal than the distribution

¹ Isbister (1973) suggests that a reduction in population growth will raise the share of profits in the Mexican economy. In his model, in the short run, reduced population growth lowers the relative price of food and money wages in the manufacturing sector, though stimulating increases in employment, output, profits and savings. In the long run, the low fertility population has a smaller labor force, and rural average earnings and the supply price of urban labor rises, with a tendency for profits and savings to decline. In his simulation, the ratio of profits to income initially rises and then eventually declines. It is unclear whether the same patterns would be observed if his model included savings from labor earnings as well as profits and endogenous demand for manufactured goods by the agricultural sector.

of family incomes since the numbers of persons per family is larger in low income families. For instance in Puerto Rico in 1953, the lower 60 percent of families received 30.3 percent of total income and the upper 5 percent received 23.4 percent of total income. Crudely adjusting the data for family size by re-estimating ordinal shares for individuals reduces the share of the lower 60 percent of individuals to only 26.8 percent and increases the share of the top 5 percent of individuals to 26.8 percent. (Kuznets, 1963, pp. 32-33) This crude adjustment overstates the inequality of consumption for two reasons. First, it assumes equal consumption weights for adults and children. Since consumption requirements of children are less than for adults and since a higher proportion of the members of low income families are children, conversion of individuals into equivalent adult consumers would lead to a somewhat more equal distribution of consumption. Second, the adjustment ignores economies of scale in consumption.¹

While there have been few studies of the individual connections between fertility, family, size, and consumption, the net effect has been examined. Wray (1971) finds that nourishment, health, and IQ are adversely affected by increases in family size.² To the extent that this/^{finding}is true, differential fertility reduces the future income of children born into large families

¹ Espenshade (1973) has shown that marginal expenditures per child decline with additional children in the United States. Although there are no estimates of economies of scale in consumption from LDC's, it is likely that they do exist.

² See Selowsky (1974) for a study of the effects of malnutrition on income.

by reducing investment in them and lowering the productivity of that investment.

Finally, children born into large families receive a smaller share of an already small inheritance.¹ Inheritance may be quite an important factor in altering the distribution of agricultural holdings over time.

To summarize this section, high fertility by raising population growth rates leads to a less equal size distribution of income with time. Since in LDC's, high fertility is generally associated with large differentials in fertility by income class, particularly in countries which have begun the modernization process, there is an additional reason to suspect that high fertility will be associated with a less equal distribution of income.

Mortality

Both the level of, and differentials in, mortality can affect the distribution of income. Consider first the level of mortality. Reduced mortality without a compensating decline in fertility leads to a more rapid population growth rate, depressing capital accumulation and causing a less equal distribution of income over time, as outlined previously. On the other hand, reductions in mortality may encourage

¹ See Meade (1966), Stiglitz (1969), Blinder (1973), and Pryor (1973). The last two articles examine also the effect of marriage patterns on income distribution.

savings, since high mortality may cause individuals to discount future returns at a high discount rate.¹

Differentials in mortality affect the relative rates of growth of components of the population and the rates at which groups discount the returns from savings. To some extent, the higher mortality of low income couples may counterbalance some of the impacts of differential fertility discussed earlier. On the other hand, mortality variations by income class may be an important source of differential fertility. The net effect on the measured distribution of income of an improvement of mortality conditions of the poor relative to the rich is most unclear. However, reduced mortality is itself a gain in welfare, and reductions in morbidity which normally accompany reduced mortality are likely to raise relatively the incomes of the poor.

In summary, the impacts of levels of, and differentials in, mortality on income distribution are not unidirectional, so that no firm predictions can be made in the absence of detailed empirical analysis.

Age Distribution

Population growth, fertility and mortality have been analyzed primarily with reference to the distribution of lifetime incomes. As is well known, high fertility and rapid rates of population growth lead

¹ Eugen von Böhm-Bawerk(1959, pp. 270-271) cites "consideration of the brevity and uncertainty of human life" as contributing to individuals valuing current utility more highly than future utility. Boulier (1975a) shows that high mortality lowers the average returns to investment in human capital and raises the variance of returns. This may discourage investment in human capital relative to investment in physical capital. The implication of this last point for income distribution is unclear.

to populations with young age distributions. Since income varies with age, the calculation of indices measuring the distribution of income will show different degrees of income inequality depending upon the age distribution even if each person in a population received the same lifetime income.

Table I is a rough attempt to measure the possible effect of age composition on measures of income distribution. The data in Table I are generated by applying the 1969 age-income profile of white U.S. males having income to two stable populations generated from a life table with an expectation of life at birth of 61 years, one population growing at a rate of three percent per year and the other not growing at all.¹ In constructing the income distribution measures, it was assumed that within each five year age group the proportion of males with income was the same as in the United States in 1969. All measures exclude males who did not receive any income.

Two features of the table stand out. First, the mean income is higher in the more slowly growing population, since it has a higher proportion of males in the high income ages. Second, all measures of income distribution show greater income inequality in the populations growing at three percent. The fraction of total income received by the poorest 40 percent of males ages 15 years and older was 21.7 percent

¹ A stable population is a population generated from unchanging age patterns of fertility and mortality. It has an age composition which does not vary with time. The life table (West mortality pattern) and the stable populations are found in Coale and Demeny (1966). The income data are from United States Bureau of the Census (1973), Table 245, p. 836.

in the fast growing population and 24.4 percent in the population with zero growth. Although these simulations are crude¹, they do suggest that cross-section measures of income inequality will reveal greater inequality in more rapidly growing populations.

II. Empirical Analysis

In this section, a rough empirical analysis of the effects of fertility and mortality on income distribution is attempted. The data are taken from Repetto's study. The analysis includes 49 less developed countries, where a less developed country is defined as a country with per capita income less than or equal to \$817, the per capita income of Venezuela.² Data generally refer to the period around the early and

¹ The author is planning a more refined analysis using micro-economic data which would permit adjustment for educational composition of the labor force and age-specific labor force participation patterns more commonly found in less developed countries. It is possible that age composition in LDC's has a somewhat smaller effect than shown in the simulation with U.S. data. First, a higher proportion of workers in LDC's is unskilled and the age-income profiles of unskilled workers are less steep and peak earlier than the profiles of non-manual or highly educated workers. Second, in many LDC's the education levels of younger cohorts exceed the educational attainment of older cohorts by a larger margin than in the U.S. Both factors lead to age-income profiles flatter than those used in the simulations. Hence, variations in the age structure will have a smaller impact on measures of income distribution than shown in Table I.

² Countries with higher per capita income are excluded since preliminary empirical work indicated that the structure of relationships among the variables in the more developed countries were not the same as in the less developed countries.

mid-1960's.¹ Demographic variables consist of a fertility index (FERT), the expectation of life at birth (LEXP), and population per square kilometer (DENS). The fertility index is the number of births divided by one-half the population in the age-group 15-64, an approximation to the general fertility rate. Economic and social variables include the Gini coefficient (GINI), the share of income received by the poorest 40 percent of the households (POOR 40), per capita income (YPC), and newspaper circulation per 1000 population (NEWS), an index of literacy. The means and variances of the variables are shown in Table 2.

Given the available data, the model may be formulated as:

- (1) $FERT = \alpha_0 + \alpha_1 GINI + \alpha_2 LEXP + \alpha_3 YPC + \alpha_4 YPC^2 + \alpha_5 NEWS + \alpha_6 DENS$
- (2) $LEXP = \beta_0 + \beta_1 \frac{1}{YPC} + \beta_2 \frac{1}{YPC^2} + \beta_3 GINI$, and
- (3) $GINI = \gamma_0 + \gamma_1 FERT + \gamma_2 LEXP + \gamma_3 YPC + \gamma_4 YPC^2$.

The square of per capita income is introduced in the first and third equations to take account of nonlinearities. The mortality equation specification assumes that there is an upper bound to life expectancy as per capita income increases (Wéry, *et. al.*, 1974, p. 101). Ordinary least squares estimation of the income distribution equation would

¹ For a full description of the data, see Repetto (1974).

lead to biased estimates of the parameters.¹ Hence, two-stage least squares was employed. Table 2 presents alternative estimates of the income distribution equation, one using the Gini coefficient as the measure of income distribution and one using the fraction of income received by the poorest forty percent of the households.

In the regression using Gini coefficient as the measure of income distribution, the coefficient on the fertility variable is significantly greater than zero at the .05 level (one-tail test), the coefficient of the income variables are significantly different from zero at the .05 level, and the coefficient of the expectation of life

¹ While Repetto's conclusion that a decrease in the inequality of income would reduce fertility may be correct, his regressions of fertility on the right hand side variables in the fertility equation do not provide very strong evidence since the coefficients obtained by this procedure are biased. My two-stage least squares estimates of the fertility and mortality equations are:

$$\begin{aligned} (1) \text{ FERT} &= -187.66 - 68.71 \text{ GINI} + 17.43 \text{ LEXP} - 45.46 \text{ YPC} - 1.79 \text{ YPC}^2 \\ &\quad (-.06) \quad (-.06) \quad (.08) \quad (-.15) \quad (-.04) \\ &\quad -1.36 \text{ NEWS} - 1.17 \text{ DENS} \\ &\quad (-.10) \quad (-.08) \\ (2) \text{ LEXP} &= 92.40 - 19.04 (1/\text{YPC}) - 1.18 (1/\text{YPC}^2) - 5.65 \text{ GINI} \\ &\quad (11.82) \quad (-1.50) \quad (-.15) \quad (3.10) \end{aligned}$$

"t"-statistics are in parentheses. The standard error of the fertility regression is 137.90 and the standard error of the mortality regression is 8.19. All variables have the expected signs in both regressions, except for LEXP in the fertility equation. In the fertility equation, increases in per capita income and greater income equality are associated with lower fertility. None of the coefficients in that regression are significantly different from zero; since the highest "t"-statistic is only .15. Multicollinearity is obviously a problem. In the mortality equation, increases in per capita income and greater income equality are associated with a higher expectation of life.

If the GINI coefficient is similar to that of developed countries (say GINI = .35 or 3.5 given the units in which it is measured for estimation purposes), then the life expectancy approaches 73 years as per capita income increases.

is not significantly different from zero. Since a higher Gini coefficient signifies a less equal distribution of income, the estimates imply that the higher is fertility the less equally is income distributed.

The results of the regression estimates using the share of income received by the poorest 40 percent of the households are quite similar to the estimates using the Gini coefficient as the measure of income distribution. The coefficient of the fertility variable is significantly less than zero at the .05 level, the coefficients of per capita income are significantly different from zero at the .05 level, and the coefficient of the expectation of life is not significantly different from zero. The estimates imply that higher fertility is associated with a smaller fraction of income going to the poorest 40 percent of the households.

Although the data used are clearly not of very high quality, the regression estimates suggest that higher fertility reduces income equality and that mortality has little effect. These results were predicted from the theoretical analysis. Whether the coefficients of the income variables reflect variations in lifetime incomes or in age distribution effects is unclear, however. Evaluated at the means of the independent variables, a 10 percent increase in the fertility index raises the Gini coefficient from .455 to .485 and reduces the share of income going to the poorest 40 percent of households from 14.33 percent to 13.05 percent.

III. Conclusion

In this paper, it has been suggested that the demographic patterns commonly found in less developed countries contribute to greater inequality

of income. The results further imply that reductions in the levels of fertility and the rates of growth of population may aid in the attainment of more equal distributions of income as well as higher per capita incomes.¹

¹ See Boulier (1975b) for an examination of the impact of various types of population policy on income distribution.

Table 1. Effects of Age Composition on Measures of Income Distribution.

<u>Age Group</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>Coefficient of Variation</u>	<u>Variance of Logarithms</u>	<u>Gini Coefficient</u> ¹
I. Rate of Population Growth = .03					
a) 15 and over	\$7612	\$3237	.425	.413	.350
b) 15 - 64	7778	3256	.419	.430	.357
II. Rate of Population Growth = 0.0					
a) 15 and over	8050	2949	.366	.285	.294
b) 15 - 64	8658	2792	.322	.289	.296

1. The Gini coefficient is calculated under the assumption that income is lognormally distributed.

Table 2. Two Stage Least Squares Estimates of the Regression Model.¹

$$(1) \text{ GINI} = .6298 + .0199 \text{ FERT} - .0148 \text{ LEXP} + .9940 \text{ YPC} - .0943 \text{ YPC}^2$$

(.26) (2.92) (-.40) (2.59) (-2.28)

$$(2) \text{ POOR40} = 30.6902 - .0858 \text{ FERT} + .0712 \text{ LEXP} - 4.2569 \text{ YPC} + .4076 \text{ YPC}^2$$

(2.90) (-2.80) (.43) (-2.47) (2.19)

Variable:	<u>GINI</u>	<u>POOR40</u>	<u>FERT</u>	<u>LEXP</u>	<u>YPC</u>
Mean:	4.55	14.33	148.92	55.96	3.15
Standard Deviation:	1.12	5.09	47.36	11.00	2.11

1. Variables are defined in the text. "t" statistics are in parentheses. There are 49 observations. The standard error of the first regression is .9706, and the standard error of the second regression is 4.3489.

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