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INCOME-RELATED DIFFERENCES IN NATURAL INCREASE: BEARING ON GROWTH AND DISTRIBUTION OF INCOME

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1. Differences in Natural Increase among Income Classes

The operating hypothesis here is as follows. If among the population in its reproductive ages (say women 18 to mid-40's and their husbands), groups are distinguished by long-term levels of family income (allowing for family size), the rate of natural increase will be found higher among the low than among the upper income groups. This hypothesis appears to hold for many developed countries during the long transition, in the course of industrialization and economic growth, from high to low birth and death rates. The basic shift began at the upper income levels, and spread only gradually downwards. The same hypothesis may have become relevant to many less developed countries, as they entered recently the phase of urbanization and modernization. Subordinate hypotheses would specify the negative association between income and fertility; and while admitting that the death rate is also associated negatively with income, would recognize that the income-related mortality differentials are, and were, much narrower than the fertility differentials--thus assuring a negative association between income and the rate of natural increase.

These statements may sound familiar, and are apparently amply confirmed by the findings in the demographic literature on

the subject.[1] Yet the evidence to support the main hypothesis, as formulated with precise relevance to the implications for growth and distribution of income, is difficult to come by. Long-term family income levels would have to be established for population groups at ages when most of the reproduction takes place--in so far as effects on fertility are concerned, and the income levels would have to be undisturbed by annual fluctuations, and with proper allowance for the phase of the long lifetime cycle of earnings and income (so that low incomes of physicians in their late 20's or early 30's are not mistaken for their long-term income levels). Furthermore, family income would have to be related to size of family. Data that would yield such information are quite different from the commonly available sample data on money family income, for a given year, and shown for family units of differing size (e.g. the data used in the two substantive tables below).

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[1]See, for example, the discussion of differences in fertility by economic status in United Nations, The Determinants and Consequences of Population Trends, New York 1953, pp. 86-87, which begins with the sentence: "That the poor have more children than the rich is a well established fact"--and then proceeds to summarize the findings, with proper qualifications. Other sources that summarize the evidence are the three papers (by Gwendolyn Z. Johnson, Clyde V. Kiser, and Richard and Nancy Ruggles on differential fertility in the European countries and in the United States, in Ansley J. Coale, ed., Demographic and Economic Change in Developed Countries, for the Universities-NBER Conference by Princeton University Press 1960 (pp. 36-72, 77-113, and 155-208); United Nations, Population Bulletin no. 7, 1963 (with special reference to conditions and trends of fertility in the world, New York 1965), particularly Chapters VIII and IX, pp. 122-51; and the Background Paper on Fertility, prepared by George W. Roberts on behalf of the United Nations, for the 1965 World Population Conference in Belgrade (mimeo).

While observations on fertility would have to be concentrated on the major reproduction ages (i.e., roughly from 18 to the mid-30's for the wife), data on mortality would have to be needed for the long span over which a given generation in its prime reproductive ages is replaced by its direct descendants entering their income earning and family formation careers; and such mortality data would have to be given with different death rates (or life tables) for the several long-term income levels. A full test of the quantitative dimensions of the main hypothesis here is probably impossible with the present data, and would certainly be out of place here.

Yet it is possible to accept the hypothesis as plausible, not only because of the direct evidence on the negative correlation between income (although annual) and fertility and hence implicitly the rate of natural increase, but also because of much more numerous findings on differential fertility (and natural increase) by degree of rurality (rural vs. urban, and small cities vs. large cities), by occupation (manual unskilled vs. white collar professional), and by industry of attachment (agriculture and mining vs. manufacturing and services)--all of which are fairly closely and negatively correlated with implicit income differentials.[1] Under the circumstances

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[1]Discussion of these differentials can be found in the reference cited in footnote 1, p. 1. See also Peter M. Blau and Otis Dudley Duncan, The American Occupational Structure (New York, John Wiley, 1967), particularly Chapter 11, Differential Fertility and Occupational Mobility, pp. 361-400.

we can assume that the hypothesis is sufficiently plausible to warrant exploration of its implications; and use the available data only to illustrate and convey the sense of the magnitudes involved.

The data selected for this illustrative presentation relate to the United States, a country for which relevant statistics are available, and one that, despite the high level of economic development, still shows substantial income-related differentials in fertility (and implicitly in rates of natural increase).[1] All the data relate to 1960, the last census year for which a wide coverage of the detailed statistics on fertility by income class is available and one that comes close to a high level of the post-World War II birth rate in this country. Even so, the two tables that follow omit a variety of possible and otherwise interesting detail.

The summary measures in Table 1 suggest several findings.

(i) The ratio of children under 5 to married women, which reflects fertility over the last quinquennium reduced by death rates over that period, is consistently, at every age level of the

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[1]It would have been of interest to use data on rates of natural increase, or at least fertility, by family income classes for a less developed country. But no such data are available. The evidence would have to be derived from sample data on family income for families of differing size, a task complicated by the importance of the extended family in some less developed countries (so that large size does not necessarily mean large numbers of children). Such exploration was not feasible here. The whole field of economic determinants of differential rates of natural increase within the less developed countries requires systematic study yet to be undertaken.

Table 1 · Children under 5 and Children Ever Born, per 1,000 Married Women, by Age of Woman and 1959 Family Money Income, United States, March 1960

	# of wives (000's)	Median Family Money Income ($)	Children per 1,000 Wives — Family Income Classes (in 000's $) Less than 2	2 to 3.99	4.0 to 6.99	7.0 to 9.99	10.0 and over	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. Children under 5								
Wives Aged 20-24								
1. White	3,028	5,158	1,300	1,306	1,260	887	819	1,124
2. Nonwhite	292	3,265	1,674	1,596	1,408	1,000	1,000	1,511
3. Total	3,321	4,983	1,397	1,346	1,267	891	825	1,218
Wives Aged 25-29								
4. White	3,967	6,012	1,342	1,325	1,304	1,113	1,030	1,237
5. Nonwhite	414	3,851	1,595	1,445	1,264	924	915	1,339
6. Total	4,381	5,855	1,417	1,349	1,301	1,105	1,028	1,247
Wives Aged 30-34								
7. White	4,585	6,504	932	867	845	760	771	817
8. Nonwhite	459	4,102	1,261	1,060	872	707	646	966
9. Total	5,044	6,330	1,031	908	847	758	767	830
Wives Aged 35-39								
10. White	4,880	6,880	582	538	504	418	410	468
11. Nonwhite	451	4,337	870	690	589	441	383	633
12. Total	5,331	6,698	667	568	511	419	409	482

Table 1 (continued) Panel A (concluded)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Wives Aged 40-44								
13. White	4,382	7,223	270	249	223	178	158	200
14. Nonwhite	388	4,205	462	345	280	220	192	320
15. Total	4,771	6,868	321	267	228	180	158	209
Wives Aged 45-49								
16. White	3,972	7,095	63	62	52	42	38	48
17. Nonwhite	343	3,864	137	139	106	83	74	118
18. Total	4,315	6,836	82	80	56	43	39	53
B. Number of Children Ever Born								
Wives Aged 35-39								
19. White	4,880	6,880	3,316	3,053	2,737	2,515	2,440	2,672
20. Nonwhite	451	4,337	4,432	3,537	3,081	2,527	2,340	4,059
21. Total	5,331	6,698	3,625	3,148	2,765	2,516	2,448	2,727
Wives Aged 45-49								
22. White	3,972	7.095	2,935	2,729	2,364	2,228	2,244	2,383
23. Nonwhite	343	3,864	3,579	3,023	2,637	2,573	2,757	2,969
24. Total	4,315	6,836	3,091	2,779	2,385	2,260	2,257	2,430

Notes

Lines 1-18: Taken or calculated from U.S. Bureau of the Census, U.S. Census of Population:1960. Subject Reports. Women by Children under 5 Years Old, Final Report PC (2)-3C, Tables 56 and 57, Washington, D.C. 1968, pp. 114-117. The median income was calculated from the more detailed income distribution given in the source.

Lines 19-24, columns 3-8: Taken or calculated from U.S. Bureau of the Census, U.S. Census of Population:1960. Subject Reports, Women by Number of Children Ever Born. Final Report PC (2)-3A, Washington, D.C. 1964, Table 38, pp. 187-198.

wife, higher at the low family income levels than at the high (lines 1-18). The cumulative effects of this are confirmed by the ratios of children ever born (not reduced by deaths) to wives aged 35-39 and 45-49 in lines 19-24.

(ii) This negative association between family income and fertility (and implicitly rate of natural increase) is more conspicuous for the nonwhites, with their higher general level of fertility and lower median income levels, than for the whites. With the rise in income levels, fertility for the nonwhites declines much more sharply than for the whites; and for some high income levels, the rates for the two groups become about the same, or that for nonwhites is lower (lines 4 and 5, columns 5-7; lines 7 and 8, columns 6-7; lines 10 and 11, column 7; lines 19 and 20, columns 6-7).

(iii) Comparing the cumulative ratios of children ever born in lines 19-21 with those in lines 22-24, we find that with the over-all higher birth rates in 1945-59 dominating lines 19-21 than those in 1935-49 dominating lines 22-24, the spread in birth rates between the lower and upper income groups, absolute and relative, is also wider in lines 19-21. Thus, for whites the range between the top and lowest income groups (columns 7 and 3) is 26.4 percent of the higher fertility ratios in line 19 and 23.5 percent in line 22; for the nonwhites, the range (in percent of the top fertility level) is 47.2 percent in line 20 and 23.0 percent in line 23; for total population the two ranges are 32.4 percent in line 21 and 27.0 percent in line 24. Apparently, when birth rates are kept down by adverse

circumstances, the reduction is proportionately greater at the high fertility, low income levels, than at the upper income, low fertility levels; and the relative income-related differences in fertility are narrower.

(iv) Although the point is not covered in Table 1, one may add that the ratios, either of children under 5 or of children ever born, to wives at different age levels, reveal the same consistent negative association with family income, when we distinguish urban and rural groups; or subgroups among the non-farm population by degree of urbanization.

While the summary measures in Table 1 illustrate the prevalence of the negative association whose implications are explored below, they tend to understate, by a substantial margin, the differences in rate of natural increase associated with long-term family income per person (or per consuming unit). There are several sources of such understatement. First, the grouping in Table 1 is based on income for the current year. High secular incomes, associated with low fertility and rate of natural increase, if reduced for the year by a transient factor, would therefore be grouped with low incomes and tend to reduce the birth rates or rates of natural increase shown; and the same effect would be produced by low, long-term incomes raised temporarily to high levels during the single year. Second, the income classification makes no allowance for low life-cycle phases of long-term high incomes (e.g., for the early years already cited of medical practitioners or lawyers); yet clearly the birth rate and

natural increase patterns of these groups are set by their high lifetime incomes. Third, even assuming mortality rates somewhat higher for the low than for the high income groups, the effect of differences in fertility on those in rate of natural increase tend to be greatly magnified with the subtraction of attrition by mortality. Thus, assume that the entries in line 19 refer to the income levels of a cohort all through the childbearing period, and relate the cohort at the end of the period when the parental generation has practically moved out of the labor force and of full time earning. If so, the 2,000 husbands and wives in line 19, column 7, would have produced 2,440 children; and allowing for an attrition of 10 percent, would yield 2,196 survivors, a net rise of 9.8 percent. The 2,000 husbands and wives in line 19, column 3, would have produced 3,316 children; and allowing for an attrition of 20 percent, would yield 2,653 survivors, or a rate of natural increase of 32.6 percent.[1] Finally, the family income

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[1]The illustration is clearly crude and exaggerated. The survival rate to the age of say 70 (from the age of 30) is from 94.4 percent of the original cohort to 53.8 for white males, and from 90.3 to 39.9 for nonwhite males, an attrition rate of about 43 percent for white males and 56 percent for nonwhite males (see U.S. National Center for Health Statistics, United States Life Tables: 1959-61, Washington, D.C., December 1964, Tables 5 and 8, pp. 16-17 and 22-23). If we use these as proxies for the top and bottom income levels in line 19, and also allow for an attrition of children ever born of 7.6 percent for the top income group and 14.3 percent for the lowest income group (corresponding to survival rates from age 0 to age 40 for white and nonwhite males, respectively), the survivors would be (2,000 x 0.44) + (3,316 x 0.857) = 3,722 for line 19, column 3, and (2,000 x 0.57) + (2,440 x 0.924) = 3,395 for line 19, column 7. Even here the rate of natural increase for the low income group, of 86 percent, is distinctly higher than for the high income group, 70 percent. But the major relevant difference is in the second of the two brackets in the two equations above--in the number of descendants who at the end of the period (continued on p. 10)

used for the classification in Table 1 is not adjusted for the number of persons or consuming units in the family. Yet the low income family that tends to produce more children in the early years of the production period increases in size, as compared with the upper income family with its smaller number of children born somewhat later; and even if the two families start, in our analysis, with husband and wife, by the time the wife is in her late 20's or early 30's, the low income family will be larger than the high income family; yet it is the former that will continue to have more children. A reclassification of families by per person or per consuming unit income would shift many large, multi-children families to the lower income levels, and many small, no-children families (including unmarried adults, not covered in Table 1) to higher income levels, than they are now in Table 1. The contrast between a greater number of children per wife in the lower income brackets than in the higher income brackets would thus be substantially accentuated.

This latter comment is of importance because it points to the fact that a greater proportion of children than of adults is in families at low income levels; and this implication bears on the assumptions that we can make concerning growth in per capita product of the descendants

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(footnote 1 continued from p. 9) account for all of the working force (with the parental generation 70 years of age or older). And it is the rise in the economically active members of the population, in the 2nd generation relative to the 1st, that is important. It was potentially 2,000 each in the illustration for the 1st generation; it grew to 2,842 and 2,255 respectively, a rise of 42 percent for the low income group and about 13 percent for the high income group.

of low and high income groups. Table 2 is included here partly because it illustrates the association between number of children and income per person or per consuming unit in the family; and partly because it separates nonfarm families, for whom money income is by far the dominant type of income.

This table exploits the availability of classification of families by money income and number of related children under 18; and combining this information with that on family by the number of persons, presents an estimate of the numbers of adults and of children, within each of the number-of-children groups among families. The details of the calculation are described in the notes to the table: the important point, worth mentioning here, is that the calculation over-estimates the number of adults in column 1, the 0 children group, and under-estimates them in the other columns--thus understating the differences in real income per unit between families with large numbers of children and those with small numbers or no children.

The major finding of the table is in lines 10-12 for urban families and lines 22-24 for rural nonfarm families. These lines reveal that while arithmetic mean income per family rises from the 0 children families to the families with 2 or 3 children (lines 10 and 22), and then declines but moderately for families with more than 3 children, the reduction to a per person or per consuming unit (with a somewhat exaggerated reduction of a child under 18 to one-half of a consuming unit) shows a sharp decline in family income with increase in the number of children. Thus income per unit for a family with 5 or more

Table 2 Distribution of Families by Number of Related Children under 18, by Number of Persons, and by Average Family Money Income (1959), Urban and Rural Nonfarm, United States, March 1960

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A. Urban Families							
1. Number of children in family	0	1	2	3	4	5 and more	Total
2. Number of families (000's) by groups in line 1	11,845	5,512	5,052	2,869	1,290	1,052	27,620
3. Number of persons in family	2	3	4	5	6	7 and more	Total
4. Number of families (000's) by groups in line 3	9,546	6,176	5,525	3,352	1,620	1,361	27,620
5. Estimated no. of adults, groups in line 1 (000's)	30,043	11,024	10,104	5,738	2,580	2,104	61,193
6. Estimated no. of children, groups in line 1 (000's)	0	5,512	10,104	8,607	5,160	6,312	35,695
7. Estimated no. of adults per family, groups in line 1	2.54	2.0	2.0	3.0	2.0	2.0	
8. Estimated persons per family, groups in line 1	2.54	3.0	4.0	5.0	6.0	8.0	
9. Estimated consuming units per family, groups in line 1	2.54	2.5	3.0	3.5	4.0	5.0	

Table 2 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A. Urban Families (concluded)							
10. Arithmetic mean income per family, groups in line 1 ($)	6,438	6,524	6,770	6,722	6,356	6,015	6,525
11. Family income per person, groups in line 1 ($)	2,535	2,175	1,688	1,344	1,053	752	A-2,090 C-1,435
12. Family income per consuming unit, groups in line 1 ($)	2,535	2,610	2,257	1,921	1,589	1,203	A-2,377 C-2,004
B. Rural Nonfarm Families							
13, Number of children in family	0	1	2	3	4	5 and more	Total
14. Number of families (000's) by groups in line 13	4,658	2,686	2,847	1,873	848	730	13,642
15. Number of persons in family	2	3	4	5	6	7 and more	Total
16. Numbers of families (000's) by groups in line 15	3,827	2,811	3,008	2,046	1,022	928	13,642
17. Estimated no. of adults, groups in line 13 (000's)	12,166	5,372	5,694	3,746	1,696	1,460	30,134

Table 2 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
B. Rural Nonfarm Families (concluded)							
18. Estimated no. of children, groups inlline 13 (000's)	0	2,686	5,694	5,619	3,392	4,380	21,771
19. Estimated no. of adults per family, groups in line 13	2.61	2.0	2.0	2.0	2.0	2.0	
20. Estimated persons per family, groups in line 13	2.61	3.0	4.0	5.0	6.0	8.0	
21. Estimated consuming units per family, groups in line 13	2.61	2.5	3.0	3.5	4.0	6.0	
22. Arithmetic mean income per family, groups in line 13 ($)	5,491	5,895	6,424	6,541	6,200	5,370	5,943
23. Family income per person, groups in line 13 ($)	2,104	1,965	1,606	1,090	1,033	671	A-1,729 C-1,240
24. Family income per consuming unit, groups in line 13 ($)	2,104	2,358	2,141	1,869	1,550	1,074	A-2,049 C-1,791

Notes

The underlying data are from U.S. Bureau of the Census, Trends in the Income of Families and Persons in the United States: 1947 to 1960, Technical Paper no. 8, Washington, D.C. 1963, Table 4 (for persons per family), pp. 100-113, and Table 5 (for related children per family), pp. 114-129. Lines 1-4, 10, 13-16, and 22, are directly taken, or calculated from this basic source.

Lines 5-6 and 17-18: The number of adults is calculated on the assumption that the excess of families with 0 children over families with 2 persons is allocable

Table 2 (continued)

Notes (concluded)

among families with 3, 4, etc. persons in accordance with the shortage of families with 1 child relative to families with 3 persons, of families with 2 children relative to families with 4 persons, and so on---recognizing that the average number of children per family in the group with 5 and more is roughly 6; and that the average number of persons per family in the group with 7 or more is roughly 8 (these averages for the open-end classes are derived from the more detailed data from the same source for more recent years, specifically 1968 through 1970). This assumption leaves just two adults per family unit in all groups of families with children, and shifts all excess of adults into the group with 0 children. Given the assumption (and the means for the open-end classes), the derivation of the totals in lines 5-6 and 17-18, and of the averages in lines 7-8 and 19-20, is automatic.

Lines 9 and 21: Calculated on the assumption that a child under 18 is equivalent to .5 consuming unit, that for an adult being 1.0. This is a rough approximation, and probably understates the consuming unit equivalent per child.

Lines 11-12 and 23-24, column 7: The entries here are weighted arithmetic means, using the income per person or per consuming unit and the numbers in lines 5-6 and 17-18 as weights---A standing for adults (weights in lines 5 and 17) and C standing for children (weights in lines 6 and 18).

children is between a third and a half of the per unit income for families with no children or only one child.

It follows that a large proportion of children is in families with rather low per unit income, a much larger proportion than among adults. The two sets of arithmetic mean incomes in column 7, lines 11-12 and 23-24, are intended to summarize this difference in average economic status of children as compared with adults. On a per person basis, the average family income of the universe of children is about 30 percent lower than the average family income of the universe of adults (lines 11 and 23, column 7); on a per consuming unit basis, the shortfall for children averages about a seventh. But the distributions are more important than the summary arithmetic means: a substantial proportion of children is in families whose per person or per consuming unit income is much below the average for the relevant universe, whether it be all urban or all rural families.

The statistical evidence of the type summarized in Tables 1 and 2, particularly in Table 2, could be extended to other years in this country; and perhaps to other developed countries. But their value is necessarily only illustrative; and we can rest with the presumption that the negative association between the rates of natural increase and levels of family income per relevant unit is persistent and significant--even if the income differences represent differences in rurality, occupation, industry attachment, and the like; that this association will be found, with differing and changing amplitudes, in both economically developed and in the less developed countries, in current years and probably in the future. We can now turn to exploring the implications,

the possible bearing on growth and distribution of income.

2. Implications for Growth and Distribution of Income

In considering the effects of the higher rates of natural increase among lower income groups on growth and distribution of income, we deal with notional quantities and illustrative examples. Indeed, in view of the lack of data specifically relevant to the properly formulated variables in the negative association, any substantive research would have to focus for a long while on samples of limited scope and of too narrow a base to yield broad findings. The purpose here is mainly to suggest the directions in which possibly significant implications lie, to raise the questions rather than to provide the answers.

Table 3 begins with a set of realistic figures relating to an initial distribution of income among quintiles (lines 1-3)--realistic in that such shares are found in the statistically recorded distributions of income among families, although usually for annual income. (Indeed, distributions in several less developed countries show even wider inequalities.) It then introduces various differentials in rate of natural increase among given income groups (Cases 1-3); and with the help of one major assumption calculates the effect of these differentials on total and per unit income at the end of the period of increase in numbers. The major assumption is that over the period, the per unit income grows at the same percentage rate for the groups and their descendants in the several initial quintiles. Thus, the assumption specifies that the original relative inequalities in per unit income among the quintiles

Table 3 Effect on Growth of Income per Unit of Differentials in Rate of Increase of the Different Income Groups (With a Given Inequality in Size-Distribution of Income)

	Quintiles					
	First (1)	Second (2)	Middle (3)	Fourth (4)	Top (5)	Total (6)
Initial Shares						
1. Number	20	20	20	20	20	100
2. Total income	4	8	16	24	48	100
3. Income per unit	0.2	0.4	0.8	1.2	2.4	1.0
Case 1						
4. Assumed % increase in numbers	100	75	50	25	0	
5. Terminal numbers	40	35	30	25	20	150
6. % shares, line 5	26.7	23.3	20.0	16.7	13.3	100.0
7. Assumed terminal income per unit:						
a. line 3 x 2.0	0.4	0.8	1.6	2.4	4.8	
b. line 3 x 1.5	0.3	0.6	1.2	1.8	3.6	
c. line 3 x 1.25	0.25	0.5	1.0	1.5	3.0	
d. line 3 x 1.0	0.2	0.4	0.8	1.2	2.4	
8. Total terminal income , line 6 times:						
a. line 7a	10.68	18.64	32.00	40.08	63.84	165.24
b. line 7b	8.01	13.98	24.00	30.06	47.88	123.93
c. line 7c	6.675	11.65	20.0	25.05	39.90	103.275
d. line 7d	5.34	9.32	16.00	20.04	31.92	82.62
9. First component of short-fall (change in share in numbers)	6.7	3.3	0	-3.3	-6.7	

Table 3 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)
Case 1 (concluded)						
10. Second component of shortfall (deviations in per unit income):						
a. line 7a	-1.6	-1.2	-0.4	0.4	2.8	
b. line 7b	-1.2	-0.9	-0.3	0.3	2.1	
c. line 7c	-1.0	-0.75	-0.25	0.25	1.75	
d. line 7d	-0.8	-0.6	-0.2	0.2	1.4	
11. Total shortfall (line 9 times lines 10a-10d)						
a. for line 8a	-10.72	-3.96	0	-1.32	-18.76	-34.76
b. for line 8b	- 8.04	-2.97	0	-0.99	-14.07	-26.07
c. for line 8c	- 6.70	-2.475	0	-0.825	-11.725	-21.725
d. for line 8d	- 5.36	-1.98	0	-0.66	-10.04	-17.38
Case 2						
12. Assumed % increase in numbers	50	37.5	25	12.5	0	
13. Terminal numbers	30	27.5	25.0	22.5	20	125.0
14. %, line 13	24.0	22.0	20.0	18.0	16.0	100.0
15a. Total terminal income (line 12 times line 7a)	9.6	17.6	32.0	43.2	76.8	179.2
16a. Sources of shortfall of total in line 15a from 200	(4.0) x(-1.6) = -6.4	(2.0) x(-1.2) = -2.4	(0) x(-0.4) = 0	(-2.0) x(0.4) = -0.8	(-4.0) x(2.8) = -11.2	-20.8

Table 3 (concluded)

	(1)	(2)	(3)	(4)	(5)	(6)
Case 3						
17. Assumed % increase in numbers	70	60	50	40	30	
18. Terminal numbers	34.0	32.0	30.0	28.0	26.0	150.0
19. %, line 18	22.7	21.3	20.0	18.7	17.3	100.00
20a. Total terminal income, line 17 x line 7a	9.08	17.04	32.00	44.88	83.04	186.04
21a. Sources of shortfall of total in line 20a from 200	(2.7) x(-1.6) = -4.32	(1.3) x(-1.2) = -1.56	(0) x(-0.4) = 0	(-1.3) x(0.4) = -0.52	(-2.7) x(2.8) = -7.56	-13.9

remain unchanged with the increased numbers of surviving units and their descendants.

The significance of this assumption, which is retained throughout this illustrative exercise, is discussed below; and will become clearer as we note the various effects that the calculations in Table 3 suggest. They may be listed briefly:

(i) If the rate of growth of per unit income is assumed to be g, the inverse association between initial income level and the rate of increase in numbers, yields an aggregate per unit growth that falls short of g. The source of this shortfall is the rise in the share of the survivors and descendants of the lower income brackets, which means an increase in relative weight in the terminal distribution of groups with per unit income below the expected countrywide average (i.e., initial income times 1 + g).

(ii) The proportional shortfall is the greater, the larger g, the assumed growth rate of per unit income (compare lines a-d, under line 11, column 6). With g assumed to be 100, 50, 25 percent, the shortfall is 34.8, 26.1, and 21.7 percentage points respectively. But the effect in reducing total rate of growth per unit is the more striking, the lower the assumed g. Thus, the 100 percent growth rate of income per unit is reduced, in the aggregate, to 65 percent, i.e., to two thirds; the 50 percent growth rate is reduced to 24 percent, i.e., to less than half; and the 25 percent growth rate was cut to 3.3 percent, i.e., almost completely offset (all of this for Case 1, see lines 8a to 8c, column 6).

(iii) This shortfall in the aggregate growth rate per unit is partly a function of the magnitude of the differences assumed in the

rate of natural increase (i.e., of numbers) among the initial quintiles. It is the absolute differences among the rates of increase in numbers, rather than the relative differences in these rates, that are important. Thus, in Case 2 the relative disparities in rate of increase in numbers among the quintiles are the same as in Case 1, with that for the 1st quintile being double of the increase rate in total population; that for the 2nd quintile being one and a half times of the aggregate rate of population increase; and so on (compare lines 4 and 12). But in Case 1 the aggregate rate of population increase is 50 percent, double that of Case 2, and the absolute differences in rates of increase among the quintiles are double those of Case 2. In consequence, for the same g, of 100 percent, the shortfall in Case 2, of 21 percentage points is only somewhat over half that for Case 1, of 34.8 percentage points. And the reduction in the shortfall is further marked in Case 3, in which the rate of increase in numbers among quintiles differ much less than in Case 1, both on an absolute and relative basis.

(iv) It is clear that with the rate of increase in per unit income being the same for all initial quintiles, the negative association between rate of increase in numbers and initial income level must result in an aggregate rate of growth of income per unit short of g. If it is desired that the aggregate growth rate in per unit income reach g, either the growth rate (the same) assigned to each initial quintile must be above g, or the assumption of equality of growth rates of income among the initial quintiles must be abandoned.

If it is abandoned, the modification, involving raising growth rates for some quintiles more than for others will necessarily change the

size-distribution of income from that assumed originally. If it is the growth rates of the lower quintiles that are to be raised, thus making for lesser inequality, it is important to note that the shortfall represents a large magnitude relative to the shares of the lowest two quintiles as derived before the modification. Thus, in Case 1a the total income of the lower two quintiles, the only ones that show large deviations below the countrywide average, was 10.68 + 18.64 or 29.32 (line 8a, columns 1 and 2); whereas the shortfall that had to be offset amounted to 34.76. Even for Case 3a,the shortfall to be offset was 13.96, compared with the total income of the lower two quintiles of 26.12 (line 20a, columns 1 and 2). Adding the shortfall, for the purpose of reaching g, to the income for the lower two quintiles would raise the growth rates of their per unit income strikingly, compared with the growth rates initially assumed and retained for the higher quintiles.

Before we discuss the significance of the assumptions and the relevance of the implications suggested in Table 3, it would be well to round out the illustration and consider the effect of variations in the range of income inequality among the initial quintiles--given a fixed set of differentials in rates of increase of numbers among low and high income levels. The relevant illustrations are in Table 4.

(v) The extent of initial income inequality is clearly of effect on the magnitude of the shortfall, once we assume a given differential in rates of increase in numbers negatively associated with income levels, and the same growth rate in per unit income for all initial income levels. The greater the initial income inequality, the greater the shortfall. Thus, Cases 2 and 3, which begin with income inequality somewhat

Table 4 Effect on Growth of Income per Unit of Differing Initial Inequalities in the Size Distribution of Income (With Given Differentials in Rate of Increase of Numbers Among the Several Income Groups)

	Quintiles					
	First (1)	Second (2)	Middle (3)	Fourth (4)	Top (5)	Total (6)
Assumed Differences in Rate of Increase of Numbers						
1. Initial shares in numbers	20	20	20	20	20	100
2. Assumed % increase	100	75	50	25	0	
3. Terminal numbers	40	35	30	25	20	150
4. %, line 3	26.7	23.3	20.0	16.7	13.3	100.0
Case 1						
5. Initial shares in income	4	8	16	24	48	100
6. Initial income per unit	0.2	0.4	0.8	1.2	2.4	1.0
(here proceed with lines 7-11 of Case 1 of Table 3, which is identical with Case 1 here)						
Case 2						
7. Initial shares in income	7	9	12	30	42	
8. Initial income per unit	0.35	0.45	0.60	1.50	2.10	1.00
9a. Assumed terminal income per unit (line 8 times 2)	0.7	0.9	1.2	3.0	4.2	
10a. Total terminal income (line 9a times line 4)	18.69	20.97	24.00	50.10	55.86	169.62
11a. Sources of shortfall in line 10a from 200	6.7 x(-1.3) = -8.71	3.3 x(-1.1) = -3.63	0 x(-0.8) = 0	-3.3 x(1.0) = -3.30	-6.7 x(2.2) = -14.74	-30.38

Table 4 (concluded)

	(1)	(2)	(3)	(4)	(5)	(6)
Case 3						
12. Initial shares in income	11	15	18	23	33	100
13. Initial income per unit	0.55	0.75	0.90	1.15	1.65	1.00
14a. Assumed terminal income per unit (line 13 times 2)	1.10	1.50	1.80	2.30	3.30	
15a. Total terminal income (line 14a times line 4)	29.37	34.95	36.00	38.41	43.89	182.62
16a. Sources of shortfall in line 15a from 200	6.7 x(-0.9) = -6.03	3.3 x(-0.5) = -1.65	0 x(-0.2) = 0	-3.3 x(0.3) = -0.99	-6.7 x(1.3) = -8.7	-17.38

narrower than that in Case 1, show more moderate shortfalls than the latter.

(vi) The major effect is associated with total deviations of quintile shares from equality, rather than with the range between the top and bottom. Thus, in Case 2, line 7, initial inequality is characterized by a range of 6.0, half that of Case 1, line 5. Yet the reduction in the shortfall, from 34.8 to 30.4, is relatively minor (the sum of deviations from equality for Cases 1 and 2 is the same, at 64.0). It is only in Case 3, where the sum of deviations from equality, in line 12, is halved, that the reduction in the shortfall (to 17.4) becomes significant, the latter being half of that in Case 1. The reason, of course, is that second component in the product forming the shortfall (lines 11a and 16a) is a direct reflection of the deviation of the quintile share from equality.

Given that the shortfall is a function of initial income inequality, of the assumed differentials in rate of increase in numbers, and is likely to be most reductive of aggregative rate of increase in per unit income when the assumed rate of growth in per unit income is moderate, what is the realism of the basic assumption and what is the meaning of the implied shortfall? (a) Is it realistic to assume the same rate of increase of per unit income for the low and the high ordinal groups in the initial size distribution of income? (b) What is the significance of the shortfall of the actual aggregate growth rate of per unit income, relative to some imaginary aggregate growth rate that would be attained with no natural increase differentials negatively associated with income?

(a) Beginning with the first question, let us consider it over a fairly long period, so that we shall be dealing largely with the per unit income of the descendants, 2nd generation, compared with the per unit income of the parents, the 1st generation, within the initial quintiles. Let us also view the units here as workers rather than as families or persons, implying that the rate of natural increase of workers is also inversely related to the incomes of workers. Are there grounds for assuming that the increases in per worker income or product are a function of the initial level, so that relative or percentage increases tend to be similar among the various per worker income groups?

Examining this question with reference to long-term income levels, not those affected by transient changes or by a phase in a long life-span of incomes (for which the question can be answered more easily), one may note factors that would yield different answers. On the one hand, the low income levels (and the high fertility and natural increase rates) are associated with attachment to traditional sectors (such as agriculture, handicrafts, etc.), which provide diminishing opportunities for employment and force the members and descendants of a low income quintile to migrate to other sectors and areas--toward modern industry and urban communities. This prevalence of migration toward greater employment and higher income opportunities among the members and descendants of the lower income quintiles would, all other conditions being equal, make for a higher rate of growth of per worker income and product than would be true of the upper quintiles, which are already attached to the more urbanized and advanced sectors of the economy and for whose members and descendants the possibilities of such upward migration may be more

restricted. On the other hand, growth in per worker product partly depends on the investment made in the human being, in the way of education, formal and informal, and in the way of raising his capacity to face increasingly complicated problems of adequate participation in the economy and society. Here the low income level of the parents in the lower quintiles and the associated low educational levels would make for a much lower per capita investment in the descendants, absolute and even in relative terms (relative to income of parents) than would be true of higher quintiles. (One should bear in mind particularly the contribution of the parental household to informal training and education of descendants.) To the extent that this is so, the growth in per worker incomes among the lower quintiles may be at a lower percentage rate than among the upper quintiles and their descendants.

The two groups of factors just noted, closely associated with the differences in rate of natural increase among the lower and higher income brackets, may be qualified by other factors--among them government intervention to assist by providing real services in the way of education and health largely to the low income groups; and tendencies toward monopolization and restriction of high level economic opportunities, combined with economic discrimination against some groups within the population. The relative weights of the two major, and the subordinate factors, making for narrowing and widening inequality in the distribution of income, have probably changed in successive phases of economic growth in the presently developed countries; and may differ widely in the several less developed countries. To attempt a general appraisal,

and thus to test the realism of assuming unchanging relative inequality, would require much more organized knowledge than is presently available.

We used the assumption as a simplifying step; but this is little more than an excuse, and should not be interpreted so as to neglect the major problems that lurk behind the negative association whose implications we are considering. For given the association and the higher rates of increase in numbers among the low income groups, the ameliorative mechanisms--be they migration to better employment and economic opportunities, or provision of government assistance to offset the negative effects of low income on investment in children, or others--carry costs of their own, and may not be sufficiently effective to avoid even long-term shortfalls and widening of income inequalities. In the process of internal migration that accompanied economic growth, the migrant, from the high fertility families, had to go through a process of adjustment and assimilation that kept him for a long while at the lower income levels. And in recent decades the sharp accentuation of income-related differences in rates of natural increase in the less developed countries, due to a rapid decline in death rates probably more marked among the low than among the high income groups, must have contributed to the accelerated internal migration, increased unemployment and underemployment, and apparently a widening of inequality in the size distribution of income.

The purpose of these comments is to stress that if reduction or limitation of relative income inequality is an important desideratum--so long as it does not seriously curb the growth rate of total income per capita--the negative association between rate of natural increase and income levels represents a continuous threat and problem; and that we

need to know much more how this problem was resolved in the past growth of presently developed countries, and the magnitudes that it is assuming in many less developed countries today. Our use of the same growth rates in per unit income of the several ordinal groups in the initial size distribution of income is a simplification which, in disregarding the persistent threat of widening inequality, may be on the optimistic side and should be replaced by more realistic assumptions as soon as more specific knowledge accumulates on this aspect of economic growth.[1]

(b) Given the result that a negative correlation between rates of natural increase and initial income levels, combined with an identical growth rate of per unit income in the several quintiles, will necessarily yield an aggregate growth rate per capita or per worker short of that assumed for the initial income groups, what is the significance of the

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[1]The Blau-Duncan study, referred to in footnote 1, p. 3, appears to suggest, for the experience of the United States, a less pessimistic picture. The members of the labor force of lower social origin (i.e., with lower level occupations, and presumably lower income levels, of parents) show greater upward mobility than sons of parents of higher occupational and presumably higher income levels (see footnote 1, p. 402); and the discussion in Chapter 11 does not show close negative association between differential fertility and upward occupational mobility. But there is a question as to whether these results would be confirmed for a more sensitive variable like per unit family income; for differential movements on the income scale, relative to the changing absolute per unit income; and particularly for the less developed countries, in which the impact of differences in rates of natural increase (given higher population growth rates) and lower growth rates in per capita income (as compared with the developed countries) may be so much greater. At any rate, there is no basis for arguing that a long-term income level, if low, automatically guarantees a higher rate of increase in per unit income than an initial middle or high income level (stochastic and phase elements having been removed by definition): there is nothing that would prevent an initially low secular income level from rising not more (or less) than the rest, and thus remaining relatively as low or lower than at the start.

shortfall? Should we be concerned about it, as if it were a loss of some possible real attainment; or is it just an arithmetic artifact, without real significance? This question may seem particularly appropriate, because in a recent paper I argued that for many types of analysis an aggregate rate of growth of income per capita should be derived by weighting by numbers the percentage growth rates of per capita income of the various income groups within the population (which procedure would, in the illustrations in Tables 3 and 4 remove any shortfall).[1]

The answer to the question depends upon whether we can assume significant constraints to the rate of growth of per unit income---for say a given growth rate of total population (or total labor force). If we can argue that for an over-all growth rate in numbers over the period of, say, 50 percent, the top level of attainable growth in income per unit is, say, 50 percent---and that it is roughly the same for per unit income in the lower and in the upper quintiles---then the shortfall resulting from the negative association under discussion is significant. For it means that, without this negative association, the country, while still achieving a 50 percent rise in income per unit for each quintile and its descendants, could also attain a growth rate of total income per unit of 50 percent--and not a rate reduced by a shortfall; and thus attain a growth of total income of 125 percent, not the significantly lower figure attainable under conditions in which the 2nd generation, stemming

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[1] See "Problems in Comparing Recent Growth Rates for Developed and Less Developed Countries," Economic Development and Cultural Change, Vol. 20, no. 2, January 1972, pp. 185-209, particularly in the present connection, pp. 197 and 199.

from the low income levels, would be proportionately more numerous. And regardless of any distributional considerations that attainment of higher aggregate per unit and total income is significant.

It does seem more realistic to assume fairly close constraints on the percentage growth rates of per unit income, given an assumed rate of increase in total numbers, than to argue for absence of such constraints. After all, the investments in improvement of quality of labor must be limited to a moderate proportion of initial income or product; and proportional gains from migration to the more productive sectors are restricted by limitations on the volume of migration and by the ties between the post and premigration income levels. And, with some straining, we may accept the notion that the limits on the percentage growth rate of per unit income or product are roughly the same for the several initial quintiles and their descendants. If so, it would seem that the negative association between rates of natural increase and initial income spells real losses in yielding a growth rate of total and per unit income that falls significantly short of that attainable without such negative association.

And yet this conclusion must be seriously qualified. For doing away with the negative association between rates of natural increase and initial income levels means, implicitly and particularly under the conditions of the same aggregate rate of increase in numbers, a more equal size distribution of income per consuming unit than would exist with the negative association; and this may reduce the flow of savings for investment in material capital. This might, in turn, reduce the feasible rate of growth in per unit income below those attainable otherwise. Hence,

what would be gained by removing the shortfall between the actual aggregate growth in per unit income and one otherwise feasible would be lost because of the possible reduction in the limits of the feasible. We are thus back to the old problem of choice between the returns from the more equal size-distribution of income in the way of greater productivity rise among the lower income group due to greater investment in human beings, and the returns from a more unequal size-distribution of income in the way of greater contributions to savings and material capital formation.

3. Summary

The paper began with the recognition of a feature of demographic growth, widely observed in both developed and less developed countries--the marked differences between the higher rate of natural increase in the lower income groups and the lower rates in the upper income groups. In attempting to explore the implications of this association, abstracting from differences or changes in the aggregate rate of natural increase, we proceeded to illustrate changes in an initial cohort of income groups (quintiles) as they were transformed into the next generation groups, of different relative size. While the discussion was in terms of a single cohort, it could be applied to a succession of cohorts--yielding a succession of generations of descendants. The results would be either a repetition or a cumulation, depending upon whether the initial series was of identical cohorts just moving in time, or a series that reflected cumulative changes of earlier differences in rates of natural increase

among the several ordinal groups within the income distribution.

The negative association between rates of natural increase and initial secular income levels clearly poses a major problem, if wider inequality in the size-distribution of income is to be avoided--since lower income levels of parents mean proportionately lower investment in quality of the descendants and hence possibly lower growth rates in the per capita income of the lower income groups and their descendants. The magnitude of the problem and of the necessary compensating offsets, is clearly a function of the differential spread in the rates of natural increase and of the initial differences in income levels of parents. If no offsets are provided, all other conditions being equal, the negative association between rates of natural increase and initial income levels, would result both in widening of income inequality and probably keeping down the growth rate of aggregate income per unit (per person or per worker). The conditions being equal involves the same aggregate growth rate in population or labor force; the "probably" refers to the likely negative balance of the opportunity losses in higher human quality at the lower income end over the possible gain from greater savings at the lower fertility, upper income end.

This conclusion, particularly with respect to widening income inequality, was not explored here and was only stressed as a possible qualification on the realism of the basic assumption used in the illustrative analysis, viz. that the growth rate in per unit income product is the same for the several ordinal groups in the initial income distribution (i.e., quintiles or deciles), while their numbers would be increasing at different rates.

Given this assumption, which assures rough constancy in relative inequality in the income distribution, we considered the influence of the negative association between natural increase and income on growth of aggregate product or income per unit (person or worker). The illustrative analysis shows that the combination of an assumed growth rate in per unit income, the same for all ordinal groups, with the greater growth in numbers among the lower income brackets, yields a growth rate in total income per unit that is lower than the basic growth rate assumed for per unit income within each ordinal group. This shortfall is relatively greater, the larger the differential in rates of natural increase, the wider the income inequality among the original ordinal groups, and the lower the assumed growth rate identical for all ordinal groups.

It proved difficult to establish the significance of this shortfall unequivocally. Even if we assume realistic limits to percentage growth of per unit income or product, and roughly equal limits for the several ordinal groups in the initial income distribution, it is not clear that, for a given growth rate of total population or labor force, reduction in the negative association between rate of natural increase and initial income level would raise the growth of total income per unit (by reducing the shortfall). For the implied reduction in the association would also imply a less unequal income distribution, which in the process of movement from the parental cohort to that of descendants might mean a lesser relative volume of savings and hence of investment in material capital. To arrive at determinate conclusions, we need empirical evidence on the weights of various factors or offsets, which tend to narrow or widen income inequality, and which, in so doing, may affect

investment in human relative to investment in material capital.

Given the substantial differences in rates of natural increase negatively correlated with income, the implications for growth of income per capita or per worker, and for the size-distribution of income in the process of growth, must clearly be important. But since the operating factors are of conflicting effect, it is not possible to derive firm conclusions as to these implications, without empirical findings on the magnitude of these factors in different phases of economic growth and at different levels of economic development. There is obvious need for such empirical findings, both for the developed and the less developed countries; and only few of the available data on size distribution of income and on demographic patterns are effectively relevant to this need.