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EDUCATION, ECONOMIC GROWTH, AND GAPS IN INFORMATION

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THIS brief paper concerns a rather speculative and wide-ranging document on economic growth. It is not a study of the economics of education, but in it I was forced to make a foray into this field. The entire study focuses—in quantitative terms—upon three questions. What have been the sources of past United States growth? What will be the probable future growth rate? How much could the future growth rate be altered by various actions that might be considered?

My interest in the sources of past growth arose partly because quantitative estimates were needed to approach the other two questions, but mainly because of the feeling that a systematic and simultaneous look at all the possible sources of growth should give rise to a more objective appraisal of each than the more usual examination of only one source in isolation.

Tables 1 and 2 show the estimates. One shows the sources of growth of total real national income, the other of real national income per person employed. The tables divide growth broadly between the contribution of increased inputs and that of increased output per unit of input.

The general approach to measurement of the contribution of increased inputs is simple (although there are some fairly complicated refinements that I shall not discuss here) and rather conventional. If all inputs increase 1 per cent, output should increase 1 per cent. (I actually assume output will increase more than 1 per cent, but the excess is shown separately in the tables as the contribution of economies of scale.) If labor earnings represent 73 per cent of the national income, then labor must represent 73 per cent of total inputs, and a 1 per cent increase in labor input alone will increase national income by 0.73 per cent. There are considerable advantages in using growth rates rather than percentage changes in the calculations, and this is what I have actually done. Thus, if labor input increased at an average annual rate of 1 per cent over some period and labor earnings averaged 73 per cent in this period, the assumption is that the increase in labor inputs contributed 0.73 percentage points to the growth rate of total real national income. (This result is subject to several refinements, but it indicates the general approach.)

I treat a change in the average quality of labor in exactly the same way as an increase in its quantity, and it is here that education comes into the study. If, in the previous example, the average quality of labor increased at an average annual rate of 1 per cent because of more education, 0.73 points in the growth rate would be ascribed to this factor.

My study devotes a chapter to education, in which the estimation of changes in the average quality of the labor force resulting from education is described. In brief, earnings differences between groups of males of similar age, classified by education, are taken to represent differences in their contributions to production or quality. Educational groups differ not only by the fact of education but by natural ability, amount of experience, and other factors. Of the total earnings differentials, three-fifths are assumed to *result* from differences in education and associated offsetting differences in work experience, as distinguished from natural ability, energy, and other factors. This provides weights for combining groups with different amounts of education. Distribu-

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<div align="center">TABLE 1</div>

ALLOCATION OF GROWTH RATE OF TOTAL REAL NATIONAL INCOME AMONG SOURCES OF GROWTH

	PERCENTAGE POINTS IN GROWTH RATE			PER CENT OF GROWTH RATE			
	1909–29* (Commerce)	1929–57	1960–80†	1909–29* (Commerce)	1909–29* (Kendrick-Kuznets)	1929–57	1960–80†
Real national income............	2.82	2.93	3.33	100	100	100	100
Increase in total inputs........	2.26	2.00	2.19	80	71	68	66
Labor, adjusted for quality change.................	1.53	1.57	1.70	54	48	54	51
Employment and hours...	1.11	.80	.98	39	35	27	29
Employment...........	1.11	1.00	1.33	39	35	34	40
Effect of shorter hours on quality of a man-year's work...............	.00	−.20	−.35	0	0	−7	−11
Annual hours........	−.23	−.53	−.42	−8	−7	−18	−13
Effect of shorter hours on quality of a man-hour's work........	.23	.33	.07	8	7	11	2
Education...............	.35	.67	.64	12	11	23	19
Increased experience and better utilization of women workers.............	.06	.11	.09	2	2	4	3
Changes in age-sex composition of labor force.....	.01	−.01	−.01	0	0	0	0
Land....................	.00	.00	.00	0	0	0	0
Capital.................	.73	.43	.49	26	23	15	15
Non-farm residential structures.................	.13	.05	....	5	4	2	....
Other structures and equipment.................	.41	.28	N.A.	15	13	10	N.A.
Inventories.............	.16	.08	N.A.	6	5	3	N.A.
United States owned assets abroad................	.02	.02	N.A.	1	1	1	N.A.
Foreign assets in United States................	.01	.00	N.A.	0	0	0	N.A.
Increase in output per unit of input.....................	.56	.93	1.14	20	29	32	34
Restrictions against optimum use of resources..........	N.A.	−.07	.00	N.A.	N.A.	−2	0
Reduced waste of labor in agriculture.............	N.A.	.02	.02	N.A.	N.A.	1	1
Industry shift from agriculture...................	N.A.	.05	.01	N.A.	N.A.	2	0
Advance of knowledge.......	N.A.	.58	.75	N.A.	N.A.	20	23
Change in lag in application of knowledge.............	N.A.	.01	.03	N.A.	N.A.	0	1
Economies of scale—independent growth of local markets.................	N.A.	.07	.05	N.A.	N.A.	2	2
Economies of scale—growth of national market........	.28	.27	.28	10	10	9	8

* "Commerce" and "Kendrick-Kuznets" headings refer only to the growth rate of total product. Contributions in percentage points under the Kendrick-Kuznets heading would be identical with those shown under the Commerce heading except for "Real national income," 3.17; "Output per unit of input," 0.91; and "Economies of scale—growth of national markets," 0.32.

† Growth rate based on high-employment projection.

Note: Contributions in percentage points are adjusted so that the sum of appropriate detail equals totals. Per cents of the growth rate have not been so adjusted.

TABLE 2

ALLOCATION OF GROWTH RATE OF REAL NATIONAL INCOME PER PERSON EMPLOYED
AMONG SOURCES OF GROWTH

	PERCENTAGE POINTS IN GROWTH RATE			PER CENT OF GROWTH RATE			
	1909–29* (Commerce)	1929–57	1960–80†	1909–29* (Commerce)	1909–29* (Kendrick-Kuznets)	1929–57	1960–80†
Real national income..........	1.22	1.60	1.62	100	100	100	100
Increase in total inputs per person employed.............	.66	.67	.48	54	42	42	30
Labor, adjusted for quality change.................	.42	.57	.37	34	27	36	23
Effect of shorter hours on quality of a man-year's work...............	.00	−.20	−.35	0	0	−12	−22
Annual hours..........	−.23	−.53	−.42	−19	−15	−33	−26
Effect of shorter hours on quality of a man-hour's work...............	.23	.33	.07	19	15	21	4
Education...............	.35	.67	.64	29	23	42	40
Increased experience and better utilization of women workers.............	.06	.11	.09	5	4	7	6
Changes in age-sex composition of labor force.....	.01	−.01	−.01	1	1	− 1	− 1
Land....................	−.11	−.05	−.04	− 9	− 7	− 3	− 2
Capital..................	.35	.15	.15	29	22	9	9
Non-farm residential structures.................	.07	.01	N.A.	6	4	1	N.A.
Other structures and equipment...............	.17	.10	N.A.	14	11	6	N.A.
Inventories.............	.08	.03	N.A.	6	5	2	N.A.
United States owned assets abroad...............	.02	.01	N.A.	2	1	1	N.A.
Foreign assets in United States.................	.01	.00	N.A.	1	1	0	N.A.
Increase in output per unit of input......................	.56	.93	1.14	46	58	58	70
Restrictions against optimum use of resources..........	N.A.	−.07	.00	N.A.	N.A.	− 4	0
Reduced waste of labor in agriculture.............	N.A.	.02	.02	N.A.	N.A.	1	1
Industry shift from agriculture....................	N.A.	.05	.01	N.A.	N.A.	3	1
Advance of knowledge......	N.A.	.58	.75	N.A.	N.A.	36	46
Change in lag in application of knowledge.............	N.A.	.01	.03	N.A.	N.A.	1	2
Economies of scale—independent growth of local markets.................	N.A.	.07	.05	N.A.	N.A.	4	3
Economies of scale—growth of national market........	.28	.27	.28	23	20	17	17

* "Commerce" and "Kendrick-Kuznets" headings refer only to the growth rate of total product. Contributions in percentage points under the Kendrick-Kuznets heading would be identical with those shown under the Commerce heading except for "Real national income," 1.57; "Output per unit of input," 0.91; and "Economies of scale—growth of national markets," 0.32.

† Growth rate based on high-employment projection.

Note: Contributions in percentage points are adjusted so that the sum of appropriate detail equals totals. Per cents of the growth rate have not been so adjusted.

tions of the labor force by years and days of schooling were then constructed. This permitted a series representing the average quality of labor, as affected by education (including its impact on experience) to be derived.

The results may be summarized as follows:

1. From 1929 to 1957 the amount of education the average worker had received was increasing almost 2 per cent a year, and this was raising the average quality of labor by 0.97 per cent a year, and contributing 0.67 percentage points to the growth rate of real national income. Thus, it was the source of 23 per cent of the growth of total real national income and 42 per cent of the growth of real national income per person employed. (Note, however, that the contribution of all sources making a positive contribution exceeded 100 per cent, since there were also adverse developments.)

2. Additional education contributed only a little more than half as much to growth between 1909 and 1929 as between 1929 and 1957.

3. From 1960 to 1980, education will contribute a little less to growth than it did in 1929–57. The contrast would be much sharper were it not for an expected shift in labor force composition toward the younger, better-educated age groups.

4. For the longer run, it seems quite impossible to maintain the *past rate of increase* in the quantity of education offered the young. A sharply accelerated improvement in the quality of education would be needed to prevent the contribution of education to growth from declining.

Clearly, there are a number of points at which additional information would permit the estimates to be improved. Much the same gaps plague those who have been studying a related subject, the return to education, and to close them would be of broad interest.

1. My attempt to adjust for changing quality of labor resulting from additional education is confined to formal schooling. On-the-job training and other relevant forms of adult education are wholly omitted for lack of information. I am not even sure whether this increased or decreased, per worker, during the periods with which I am concerned. Mincer's study of on-the-job learning is a welcome beginning of investigation of this subject.

2. My measure of the amount of education received by the labor force is strictly quantitative (years and days). I frankly despair of getting a measure that would adjust for changes in the quality of a day's schooling.

3. The Census data on years of schooling received suggest that respondents systematically overstate their education, the prevalence of overstatement increasing with age. If this is so, projections of educational achievement forward or backward by the cohort method are biased, and I have introduced an adjustment to my series in an attempt to eliminate this bias. The 1960 Census data provide one check on the validity of this adjustment. Aside from this, the reasons that each age cohort reports itself so much better educated in 1950 than in 1940 is a subject that should yield to intensive research.

4. Another assumption is that increasing the number of days of school per year has raised the average quality of labor by the same amount as a similar percentage increase in the number of years of schooling. I see no way to check this assumption from economic statistics. Educators may have some judgments concerning it.

5. The assumption that three-fifths of observed income differentials for males at the same age result from more education (as offset by less experience) is the one I consider to be the most arbitrary and important. The question involved

here is crucial for all studies of the economics of education. Given a large amount of resources, and given the assumption that the associated variables that concern us most are aptitude, application, and neighborhood environment and characteristics closely associated with neighborhood, it seems to me that this question might be fairly well resolved. We could get the school records of children in, say, the fourth grade in 1925 from a large number of schools, classify them by school grades, intelligence quotient, and school, and track them down to find out their current earnings and how far they went in school. To reverse the process and track a large sample of current adults back to get their early records might be easier. It would also be less satisfactory but possibly not so unsatisfactory as not to be worthwhile. The University of Pittsburgh's "Project Talent" plans to follow the careers of present students, for whom complete data are available, for twenty years. This should provide an ideal test but results are far in the future.

6. It was necessary for me to assume (to measure the contribution of education to growth) that the improvement in female labor (and labor of males under twenty-five) as a result of increased education paralleled that of males. Census cross-classifications of annual income, education, and weeks and hours worked would make it possible to eliminate this assumption.

7. More information on any changes in income differentials associated with amount of education would be useful (my estimates assume no change), especially if the reasons for any change could be deduced.

The three following comments are less closely tied to the estimates presented.

First, one would like to see some elaborate tabulations made from the 1960 Census that would cross-classify the data for income by education by sex and age (at least for adult males) with a large number of other variables—geographical location, industry, occupation, perhaps place of birth, as a minimum. It is not evident what this would show, but I am enough of a pragmatic empiricist to be confident we would learn much that is of great interest. At the least, we would get some idea of the extent to which many of the income differentials we commonly observe when people are classified by residence, industry, etc., are merely reflections of differentials in education.

Second, it would be instructive to reproduce my national tabulations (or something better) on a regional basis. How much of the narrowing of regional income differentials is the result of the narrowing of differentials in the education of the labor force? Of this, how much is due to differential changes in educational systems and how much to migration? Unfortunately, I do not know where long-term data could be obtained; special tabulations from the 1940 and 1960 Census could cover this time span, at least for the first question.

Third, my study deals only with education in general, without distinction as to course of study. Income differentials for individuals classified by type of education would be illuminating and presumably helpful both to students selecting high-school and college programs and to attainment of a rational allocation of resources. My impression, which I hope is wrong, is that hardly any information exists except for that on graduates of professional schools (other than earnings of college graduates on their first jobs, which is not very helpful).

All reference to the relationship of costs and returns from education is omitted because others know a great deal more than I about the subject.