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# THE PRODUCTIVITY OF EDUCATION IN CHILE

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# THE PRODUCTIVITY OF EDUCATION IN CHILE

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That improved quality of the work force is a major source of economic growth is now recognized by virtually all observers. The problems remaining are those of more exact formulations of the role that this improved quality plays, or can play, and the accumulation of further evidence on its quantitative significance. The present paper reports some evidence on the rate of return on the costs of education in Chile. From this evidence we then seek to deduce some more general observations on the role that education has played in the Chilean development effort. The evidence is of general interest for a number of reasons. The data permit an estimating procedure that is more reliable and more revealing than any I have seen for a developing country. The results show a rate of return on educational costs below those frequently quoted for other countries and below our estimate of the rate of return on physical capital.

Further, the results presented here are different in several respects from those obtained by Professor Arnold C. Harberger and Marcelo Selowsky in their recent paper on the sources of economic growth in Chile.[1] Finally, there is reason to believe that the results and arguments worked out here are applicable to developing countries other than Chile.

Part I describes the general outline of the model underlying the calculations, in Part II the rates of return are discussed, and some general hypotheses about the role of education in Chile and other developing countries based on these calculations are considered in Part III. A brief description of the data is provided in an appendix.

I

The purpose of this section is to establish a simple framework within which the various aspects of education's role in development may be considered.

The labor force is assumed to be divided into a number of narrowly defined occupational groups. Within each group the expected relationship between the marginal product of labor ( measured by wage rates ) and the level of education ( i.e., the number of years of school attendance ) may be described by the curve shown in Diagram I. This curve indicates that a few years of education results in a rather sharp

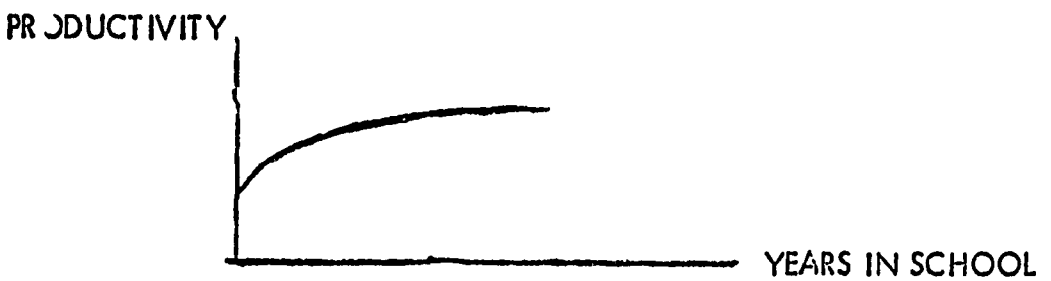


DIAGRAM I

increase in productivity over that achievable with no education, but that decreasing returns set in at a rather early stage. The justification of the assumption of diminishing returns rests on two considerations. For the simpler tasks ( such as clerking, gardening, chauffering ) education beyond the level required to read, write, and do elementary arithmetic can add little to the productivity of labor because the demands the job place on the worker are so very limited. For more complex tasks (e.g., engineering, nuclear physics, medicine ) where the demands of the job are virtually limitless, the capacity of class room work to add to productivity declines. It seems reasonably clear that once the student has gained full command of the material, additional school attendance can neither increase that command not add to the

individual's effectiveness in its application. Continued learning and increased productivity in such occupational categories depend on the person's ability to teach himself or to find stimulus to growth outside formal class room exercises.

The intersection of the curve with the vertical axis indicates that a person with no education can enter the occupational category represented in the diagram. In other more formidable occupational groups, some positive amount of education is necessary for entrance into employment, and a curve representing these groups would not intersect the veetical axis. Also the position of the curve is expected to be higher, the more demanding are the educational requirements for entrance into the occupationl The position ( and possibly the slope ) of the curve is also affected by the age of the worker. As a worker grows older he gains experience which, like education, adds to his productivity. Also some jobs depend heavily on physical strength, and the curve for these activities will shift as the worker ages and becomes less able to perform such tasks. The curve of Diagram I then applies to a particular age as well as to a narrowly defined occupational category.

For the entire economy we may visualize a sequence of curves linked together in the manner shown in Diagram II. Curves PA, P'A', P"A", etc. are the productivity

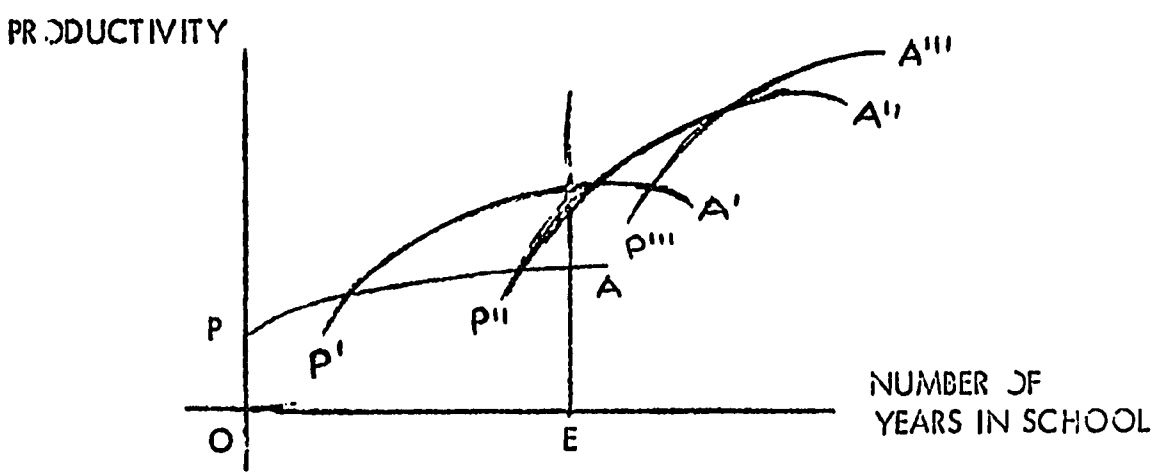


DIAGRAM II

curves for individual occupational groups derived in the preceding paragraphs. While dimishing returns to education occur within a given occupational category, an individual who has more education than another also has the option of moving into positions where his productivity can be higher. By this movement among job categories diminishing returns to education may possibly be offset. Diagram II is also drawn for a specific age.

The returns on the investment in education are of course realized over a lifetime, and to look at the productivity picture for a specific age is not sufficient. The final analysis must be in terms of present values and rates of return. In Diagram III the vertical axis measures the present value of the increase in productivity ( earnings ) over a lifetime that can be attributed to education. For example, RT measures the present value of the lifetime earnings due to six years of education if the worker is

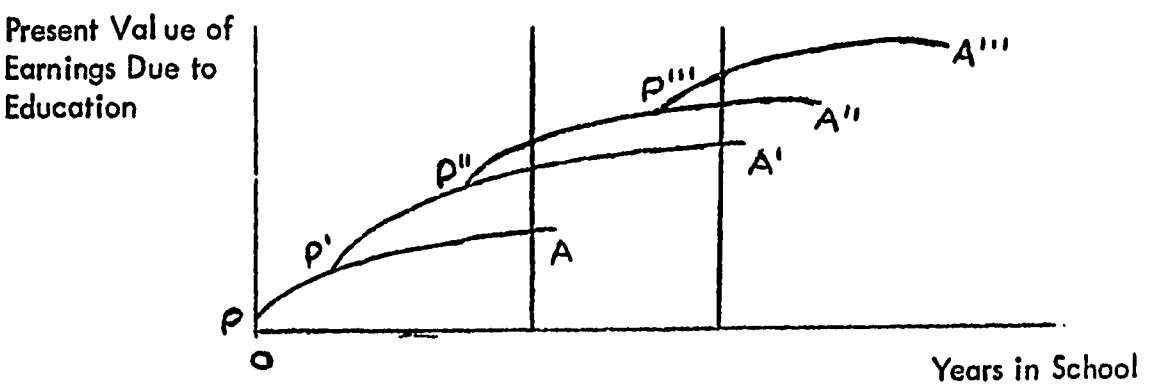


DIAGRAM III

engaged in the most productive activity open to him, P'''A'''.[2] Calculations of present values require a discount factor. If the "shadow price" of capital is used for the discounting, a comparison of the present value thus obtained with the cost of a given level of education will indicate whether or not investment in that level of education is earning acceptable returns. In the empirical work given in the next

section, the procedure is slightly different. The internal rate of return on various levels of education is computed, and this rate is then compared with that obtainable on "conventional" capital.[3]

In a long run equilibrium situation the rates of return on all types of capital ( including educational capital ) are equal. If an observed rate of return on educational capital is different from that on other forms of capital, then it is necessary to ask why. The productivity of education has two aspects, that applicable "within" a given occupational category and that applicable "across" job categories. If the rate of return on ( say ) seven years of education is below the opportunity cost of physical capital, this may be due to "too many" persons with this level of education relative to the supply of complementary factors. Consequently the productivity of capital in persons with seven years of education falls by virtue of a conventional variable proportions argument. Curve P'''A''' then drops to a level that represents this "too low" rate of return. More realistically ( and more in the spirit of the model ) the argument would be that job opportunities in the P'''A''' category had not kept pace with the number of laborers possessing the qualifications for entrance. Some laborers with seven years of education are therefore forced into less demanding ( e.g., P''A'' ) where their extra education makes them only slightly more productive than are persons with four years in school. In this case the P'''A''' remains in its equilibrium position, but there are not enough slots to utilize the available supply of qualified laborers, and the rate of return on educational capital falls below that on other forms of capital as workers are forced to take jobs less productive than they are equipped to handle. If the too low rate of return on educational capital is explained in these terms then

the policy implications are evident: fewer investible resources should be allocated to education and more to other capacity increasing activities.

There are however other reasons why rates of return on education may be below the opportunity cost of capital. Three other reasons seem especially important. The productivity of education may be low for a given occupational category because students learn so little in school. The productivity of a gardener, for example, may be greatly increased if he has the ability to read and write, but the quality of the school system may be such that attendance at school does not result in his learning to read and write within a reasonable length of time. It is necessary then to distinguish between the productivity of education, as defined by the curves of the preceding diagrams, and the quality ( or the productivity ) of the school system itself, defined in terms of the capacity of this system to accomplish its tasks of teaching. If the quality of the education system is such that the average student does not learn what is intended for him to learn, the explanation of the low return may be the quality of the schools rather than the existence of "too many" educated workers. In this case, trained manpower can be a bottleneck to development at the same time that the rate of return on investment in education is below that obtainable on other forms of capital. In particular a low rate of return on educational capital explained in terms of the low quality of the school system does not necessarily mean that "too many" resources are engaged in education. Indeed, if greater expenditure on education would raise the quality of training supplied by the schools, then this situation may well call for increased outlays on education.

Another important reason why the rate of return on education might appear too low has to do with market imperfections of a particular kind. For an individual from

a less than wealthy family, opportunities for investment other than education are virtually nil in most developing countries. The shadow price of capital for the economy may be twently percent and the rate of return on a college education fifteen percent, but for an individual the forms of investment alternative to education may well yield him five percent. This possibility is re-enforced when note is taken of the fact that part of the investment in education is in the form of forgone income: one cannot invest forgone income in the stock market even where it functions on a large scale. The consequence is an overinvestment in education, but this overinvestment is explained in terms of rational calculations on the part of the economic agents involved. Such market imperfections create policy implications different from those implied by the previous explanations of the "too low" rate of return on education. The policy issues are more intractable as well. Neither raising tuition costs nor screening out more applicants is likely to be acceptable to many governments, and perfecting the capital market to the point that the problem disappears is a weak and distant need indeed.

A final explanation of low rates of return that may be important has to do with inertia, tastes, ignorance, geographical and social immobility, and prestige considerations that affect the extent to which workers are aware of and respond to job opportunities for which their education has qualified them. The attack on this problem calls for more widely available information, policies to facilitate mobility, and similar changes that help to make the economy better able to utilize the resources that it has.

The preceding discussion has sought to describe one framework within which the productivity of education may be examined. Emphasis was placed not only on the rate of return on the cost of education, but also on the necessity to explain why that

rate is what it is. The explanation is, as shown above, an essential ingredient in understanding the policy implications of an observed rate of return. The task now is to apply these constructs to the Chilean data.

II

The data on which the calculations are based are described in an appendix. Two points are noted here. "Income from job: per month" is used as the measure of productivity. This is a narrower concept than total income and presumably is more directly related to productivity than is total income. Secondly, education refers to elementary, secondary and university school attendance. Various types of technical and trade school education are not included. The data apply to a sample taken in June 1962.

The sample was divided into nine age groups, shown in the first column of the table. The basic calculations were regressions of income from job ( productivity ) W, on the number of years of school attendance for the various age groups, E. The argument of Part I did not lead to a specific form for these regressions, but it did suggest that the relationships were non-linear. It seemed useful then to employ the simplest non-linear equation available.[4] Consequently, a curve of the form $W = a + bE + cE^2$ was fit ( by least squares ) to the observations in each age group. These equations estimate the productivity of education "across" job categories in the manner described by Diagram II. The results are shown in the accompanying table. The wage rate given by the equation for a specified level of education may now be referred to as the expected wage for an individual in a given age group with that level of education. Some comments on these curves may be useful.

A. The Productivity-Education Relationship

The nine equations shown in the table form a rather consistent pattern. The a's rise steadily for the first five age groups ( until the age of 45 ), and decline regularly thereafter. The a's show the expected wage for a person with no education, and their time pattern then is explained chiefly in terms of the accumulated experience and the changing physical strength of the worker as he grows older. These considerations lead us to expect the observed rise in the expected wage rate in the first half of the working life and the subsequent decline.

The negative b's ( together with the c values given ) in the first three age groups result in the expected wage rate for a person with two or three years of education being below that expected for a person with no education at all. That b is negative only for the first three age groups suggests that young persons with some education may accept a job with a starting salary below that available in jobs requiring no education in anticipation of later compensating increases in wage rates. Suppose Diagram II applies to a 25 year old group. A person with O E years of education may voluntarily choose activity P"A" even though activity P'A' would yield a higher immediate income, if he thinks that by the age of 40 his income will be high enough to compensate for his current sacrifice. The person with zero education does not have this option. The fact that all present values of income streams attributable to education are positive indicates that some compensation does in fact take place. This negative phase does however dampen the productivity of education for all groups, and especially for those who leave school after two or three years.

The b's rise in value from age 35. The biggest jump occurs between age groups five and six, a period that in this and other respects seems to be a watershed. The

Regression Equations of Education and Wage

Income in Chile

| Age Group | Equation | $R^2$ | F |
|---|---|---|---|
| 1 ( under 24 ) | $W = 54.95 - 4.06E + 1.01 E^2$<br>(13.88) (4.70) ( .41 ) | .32 | 12.23 |
| 2 ( 25-29 ) | $W = 60.03 - 2.58 E + 1.03 E^2$<br>(18.34) (4.64) ( .26 ) | .52 | 60.40 |
| 3 ( 30-34 ) | $W = 67.87 - 5.00 E + 1.56 E^2$<br>(20.49) (5.24) ( .29 ) | .53 | 105.97 |
| 4 ( 35-39 ) | $W = 57.09 + 3.90 E + 1.01 E^2$<br>(31.01) (7.76) ( .42) | .40 | 50.25 |
| 5 (40-44 ) | $W = 58.96 + 4.65 E + .93 E^2$<br>(28.23) (6.69) ( .35 ) | .50 | 72.26 |
| 6 (45-49) | $W = 27.65 + 13.74 E + 1.01 E^2$<br>(44.81) (10.69) (.54) | .54 | 68.27 |
| 7 ( 50-54 ) | $W = 19.93 + 17.81 E + .73 E^2$<br>(34.11) (8.23) ( .43) | .53 | 83.26 |
| 8 ( 55-59 ) | $W = 16.72 + 19.53 E + .51 E^2$ | | |
| 9 ( over 60 ) | $W = 13.51 + 21.24 E + .30 E^2$<br>(39.62) (10.73) ( .58 ) | .46 | 40.66 |
| 10 ( Age groups 1/4 ) | $W = 63.72 - 3.61 E + 1.39 E^2$<br>(12.83) (3.22) (.18) | .47 | 224.30 |
| 11 ( Age groups 5/9 ) | $W = 34.35 + 11.89 E + .08 E^2$<br>(15.74) (3.76) ( .19 ) | .51 | 296.71 |

Source: See Appendix

Footnote: page 9b

Footnote

A brief comment on these results is in order. In no equation are all coefficients significantly different from zero at conventional levels of significance. However all F's are large showing that the relationship is significant at very demanding levels of significance. When the standard error of one of the coefficients is large relative to the value of the coefficient ( e.g. the equation for the 4th age group ), then the conclusion is simply that this coefficient in this equation is not significant. Where the standard errors for both coefficients b and c are relatively high ( the coefficients are significant at low levels of significance as in the equation for the 7th age group ), the high F indicates that while neither E nor $E^2$ alone is very reliable both together are. One would feel much more comfortable with the results where all coefficients several times their standard error, but the convincing magnitudes of the F's leave no doubt that there is a significant relationship between W and E.

Finally if the sample is divided into two age groups only ( under 40 and over 40, Age groups 10 and 11 in the table ) all coefficients except b for Age group 10 are significant at the .05 level and that b is significant at the .20 level. The arguments and conclusions in the text can also be built around these two equations.

See the appendix on the data for the peculiarities of the equation for Age group 8.

size of the change in b between these two age groups is quite large, and this fact does not lend itself to an obvious explanation. The c's are all positive. In terms of the model of Part I, the positive c's suggest that the diminishing returns to education expected for the narrowly defined occupational groups are offset by the more highly educated workers being able to acquire slots in more demanding, more productive activities. A possible explanation of the decline in the values of the c's in the after-50 age group is offered in the next section.

The most important aspect of the equations of the table is the implied long pay off period for the investment in education. The values of the b's and c's show that the difference between the starting wage for a person with ( e.g. ) four years of education and one with 17 years ( a university graduate ) is much less than is the expected difference at age 50.[5] This result has obvious implications for both the rates of return and for trying to understand more clearly education's role in the Chilean development effort.

Comments on the statistical significance of the equation are given in the note appended to the table. A remark or two on the explanatory power of the equation is useful here. In general the equations explain about one-half the variance in wage income. There is no test as to whether an $r^2$ of about .5 makes sense or not. We know of course that there are many factors other than education that offset the wage one receives. These factors range from native intelligence and ambition to luck and personal tastes in selecting occupations. An $r^2$ of .9 or so would be suspect as it would leave so little explanatory power to these other important variables. An $r^2$ of .20 or so, on the other hand, would mean that education alone was of so little importance

that it was hardly worth considering as a major variable explaining variation in earning power. General information for Chile and other similar countries suggests clearly that this latter conclusion is not acceptable. In this vague, heuristic sense then the $r^2$'s appear consistent with economic ( as opposed to statistical ) sense.

B. The Age/Income Profile

Diagram IV shows the age-income profile for the various education levels. Expected wage rates are plotted at the mid-point of each age group and the lines are then drawn to connect these points giving interpolated values for each age. Age of entry into the labor force is assumed ( quite arbitrarily ) to be twenty years of age for persons with twelve or fewer years in school, and 25 years for persons who complete at least one year of university work.

The broad picture shown in Diagram IV is also consistent with general evidence on age/income profiles: modest growth in the 20-30 year old group, a tendency to stabilize for a few years, then a marked increase in the early and mid-forties, followed by a levelling off or decline as one's working life draws to a close. The lines for all educational groups show the fifth age period to be something of a key period here also. For the poorly educated ( less than four years of education ) wage rates begin to fall in this period relative to preceding periods as declining physical strength offsets any affect accumulated experience may have. For workers with from four to eight years of education wage rates level off, but do not decline. This result suggests employment in tasks requiring some skill or accumulated knowledge and little dependence on physical strength.

For individuals with higher education the increase between the fifth and sixth age group is much sharper than that for the less educated. The decline after the sixth

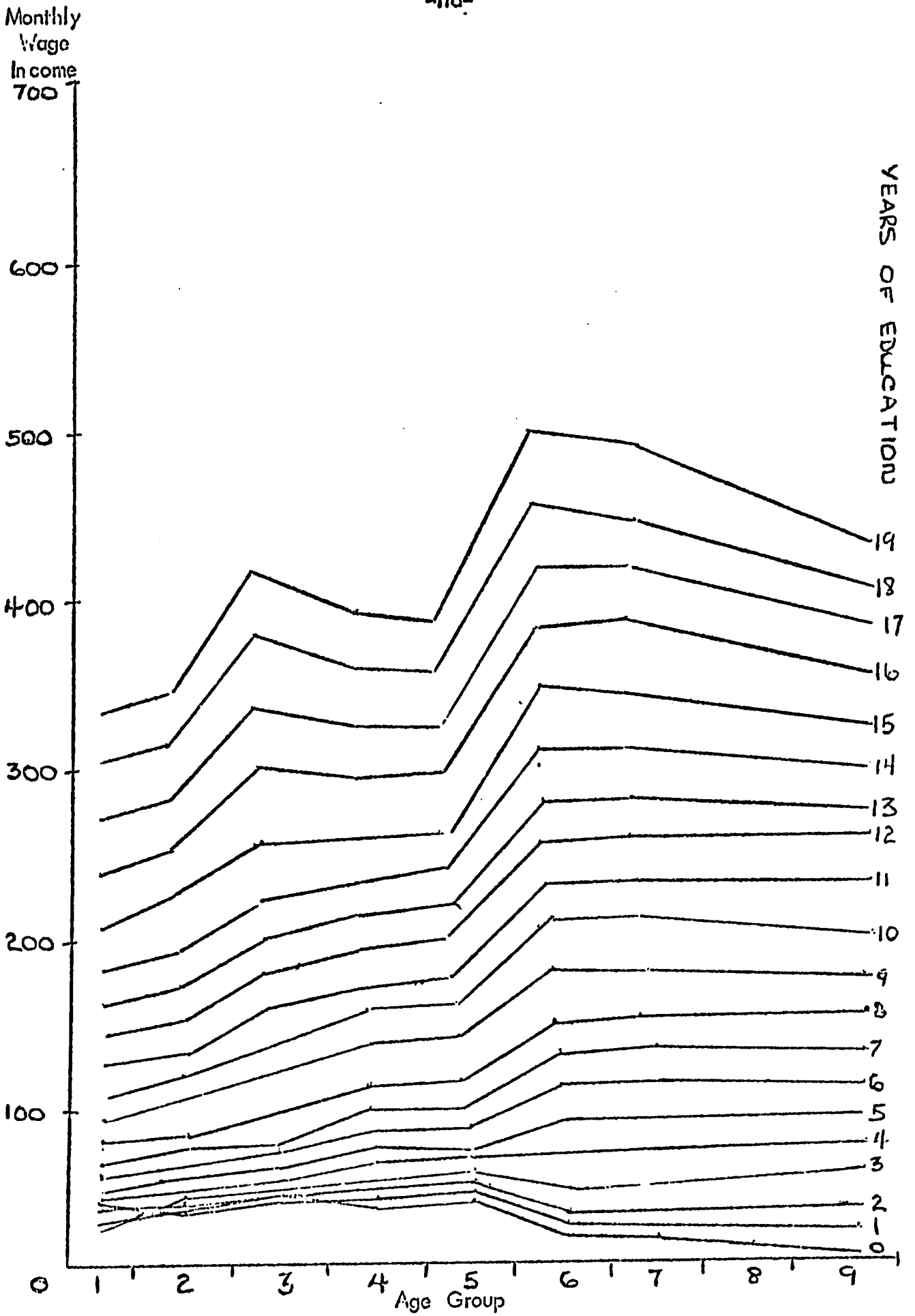
Monthly Wage Income
700
600
500
400
300
200
100
0
1
2
3
4
5
6
7
8
9
Age Group
YEARS OF EDUCATION
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0

Diagram IV

period is also much more abrupt, especially for persons with some university training ( more than twelve years ). This general picture is to be expected but the sharpness of the changes is surprising. It is well known that persons "peak" earlier and that retirements occur earlier in lower income countries than in richer ones. Also obviously early retirements are concentrated among people who can afford to stop working, i.e., people whose income was above average during their working lives.[6] This result then flows from convention and social practices affecting membership in the labor force rather than the health and physical strength factors that were used to explain the fall in wage income for older, poorly educated workers. To the extent then that able bodied, well educated persons withdraw from the labor force after that age 50 to 55 educational capital thereby goes unused.[7] In terms of the effect on the rate of return, this result has only modest importance as most of the income due to education that is earned late in life is discounted away. Even so the early retirements may still represent a significant loss to the economy. In a given time interval the contribution that education makes to output is not meansured by the interval rate of return, but rather by this rate corrected for the age distribution prevailing in that period. Since the evidence is clear that education's pay off period is long, the ( apparent ) withdrawel from the labor force of educated persons at the age that the full effects of their superior education are beginning to be realized must reduce by a significant amount the contribution that education can make to growth over a given period. This is true even though, as noted, the effect of early retirements on the internal rates of return is small.[8]

Both the age/income profiles and the wage/education relationships conform in general to a priori expectations and both also yield a rather consistent picture.

While the data indicate that some of the observed patterns are extreme, the evidence would appear to warrent using the results for further calculations.

C. The Rate of Return on Investment in Education

Given the data and calculations just described plus information on costs of education in Chile ( described in the appendix ) the computation of the internal rate of return can be done in a quite straight-forward way. One may compute the rate of return for any combination of years of education and corresponding wage differentials. The most obvious are comparisons of a completed primary school education ( six years ) with no education, a completed secondary ( twelve years ) with completed primary, and a completed university (seventeen years ) with completed secondary. These combinations of years are first considered and then other combinations following.

1. The Rate of Return on Primary, Secondary, and University Completions. From the equations of the table the expected wage income for each age group for a person with six years of education can be obtained as well as that for a person with zero education. The difference between the two figures, call it D, for any given age is attributable to the difference in education. The present value of this series of differences may be written as

$$\sum_{n=1}^{45} D\ (1 + r_e)^{-n}$$

where $r_e$ is the rate of return on a completed primary education and n is the relevant number of years for which it is necessary to discount.[9] The cost of an elementary school education in 1962 was about 130 escudos per year per student ( see appendix ). To find the rate of return on the total cost of a primary education we solve

$$\sum_{t=1}^{6} 130\ (1+r_e)^t = \sum_{n=1}^{45} D\ (1+r_e)^{-n}$$

for $r_e$, and get something less than 18 per cent. If we perform similar calculations to determine the rate of return on a completed secondary education relative to completed primary, the result again is about 18 percent, somewhat more this time. A comparison of a completed university education with a completed secondary education yields a rate of almost 14 percent.[10]

2. Rates of Return on Other Combinations of Years of Education. It is important to recognize that the 18 percent return on a completed primary education computed above is not the measure of the rate of return on total resources engaged in primary education. Total costs must include the cost of educating those students who do not complete their six years. Similarly estimates must be made of the wage differential associated with each year of education rather than simply with the sixth year. The rate of return on the cost of primary education on the resources engaged in primary education then is a weighted average of these six rates of return. These calculations have special relevance for the dropout problem as well as other matters associated with allocation questions.

The total cost of primary education, and hence the total educational capital created by primary education, is the sum of the costs incurred in educating all persons attending primary school whether they complete the full six years or not. Write $l_1$, $l_2$, ..., $l_6$ for the number of students who complete grades one through six, estimated from the sample data, and the total cost of primary education is

$$T\,C_{ep} = l_1\ 130\,(1+r) + l_2 \sum_{t=1}^{2} 130\,(1+r)^t + \ldots\ldots\ldots + l_6 \sum_{t=1}^{6} 130\,(1+r)^t$$

and the ratio

$$\frac{l_1\ 130\ (1+r)}{T\ C_{ep}} = c_1$$

is the share of costs ( the share of educational capital ) embodied in individuals who attend school for only one year. Similar ratios, written as $c_2, c_3, \ldots, c_6$, define the share of educational capital embodied in persons who complete 2,3,..., 6 years of school. Write $r_1$ as the rate of return on one year of education relative to none, then $c_1$ is the share of total primary capital that earns this rate of return. A similar argument applies to the years 2, 3, ..., 6. So the rate of return on resources engaged in primary education ( $r_{ep}$ ) is

$$r_{ep} = c_1\, r_1 + c_2\, r_2 + \ldots\ldots\ldots + c_6\, r_6$$

In the computation of the c's what discount factor should be used? The use of the internal rate of return itself is undesirable for this varies from group to group, and it seems more satisfactory to use the same discount for all groups. The rate most suitable would be the opportunity cost of the investible resources used in primary education. For reasons defended in the next section a rate of 20 percent was used in the calculations of the c's.

For the first six years of education $r_{ep}$ is 16.5.[11] The values of $r_1, r_2, \ldots, r_6$ are ( rounded off ) 9, 9, 12, 14, 16, and 18. As noted in the Appendix the data were taken from a sample in the greater Santiago area. Here the proportion of students who

enter the first grade and complete the sixth is much higher than in other parts of the nation. The sample showed $c_6$ to be 64 percent, and for the nation as a whole available data indicate a figure well below 50 percent. The rate of return on the costs of primary education in Chile then is significantly less than 16.5 percent.

The $r_i$ ( $i = 1 \ldots 6$ ) follow an expected pattern, rising steadily after the second year. An artificial premium doubtless attaches to the completion of the primary program, but an extra year of primary education can also have decided effects on the type of job one can manage and the firmness with which one knows certain things - e.g., arithmetic or capacity to read involved instructions. These r's show also that there is an incentive, in the form of higher returns, to complete the full six years of primary education. For example, the student who completes five years of education earns 16 percent on his investment. The sixth year relative to the fifth, however, yields about 30 percent, and the third relative to the second an even higher figure. To say the same thing in a slightly different way: resources used to train students who drop out before their sixth year earn significantly lower returns than do resources used to train students for the full six years.

For secondary and university education the results are surprising. Each year within the program yields about the same return as does the completed program. For example, a person who drops out of secondary school after two years will earn about 18 percent as will the person who completes the full six year program. Similarly university drop outs earn about the same 14 percent as do university graduates.[12]

Resources used in secondary education then earn the highest return, 18 percent, those in primary education something less than 16.5 percent and university education about 14 percent.[13] The final questions are these rates high, low, or average? The

most satisfactory way of answering this question is to compare these rates with those obtained on other forms of capital, especially plant and equipment. To estimate the rate of return on conventional capital, $r_c$, in Chile is difficult indeed. In another study of Chilean industrialization, an effort was made to arrive at an estimate. The results of that investigation were that $r_c$ surely exceeded 20 percent and for purposes of comparison with $r_e$ a rate as high as 25 percent could be defended. Though the crudity of the estimate is to be emphasized, it does permit a firmly held conclusion that the rate of return on conventional capital has exceeded that on educational capital by a substantial margin in recent years.[14] As emphasized in Part I an essential part of the education question is why the rate of return is what it is, in particular why the rates computed here are lower than notes frequently quoted. This question will occupy attention in Part III.

## III

The purpose of this final section is to call attention to a few generalizations that seem justifiable in light of the model of Part I and the empirical evidence of Parts II and III.

That there are "too many" resources in education relative to the quantity available for other forms of capacity-creating activity seems reasonably clear. This is especially clear at the university level. The fourteen percent rate of return on university education suggests that many university graduates are forced into pedestrian white collar jobs that can be performed equally well by a secondary school graduate. The chief explanation of this situation is the type of market imperfection referred to in Part I. The demand for education at all three levels considered in this

paper has risen rapidly in recent years in Chile ( and elsewhere in Latin America ). This demand springs largely from the rapid population growth, and rests on a quite rational basis, namely investment in education has prospects for most individuals of a return considerably higher than available alternatives. For these individuals the fact that $r_e \leqslant r_c$ is not relevant in their decisionmaking. As noted in Part I for the government of Chile to seek to solve this misallocation by limiting enrollment is neither practical politically, nor, as argued below, will such limitation attack the source of the difficulty.

A second point that emerges reasonably clearly is that educated personnel, as defined here, are not a bottleneck to Chilean development in the sense that ( say ) imports are. Thus a sharp increase in the supply of people with university degrees would not produce the increase in the growth rate that a marked increase in ( say ) the flow of foreign exchange would.[15] This follows directly from the evidence on the rates of return on education, and is also implied by the long payoff period of education in Chile. If the economy were in a position where it had hit an educated manpower constraint then the presumption is that wages of young secondary school or university graduates would be bid up relative to the wages of the less educated. The evidence shows the opposite . It is not until after age 40/45 that major differences between educated and uneducated appear. Educated people tend to be more successful in working their way up to more demanding positions, to taking advantage of opportunities, and of adjusting to new situations than do the less well educated. The effect of the type of education considered here then is not so much to create a specific skill, the demand for which already exists, rather it is to create an ability to learn

and understand the demands placed upon one in given lines of employment.

Do the data suggest any generalizations about the effect of the quality of the educational system on the rate of return? Note has already been taken of the rapid rate of growth of enrollments, and of the evidence suggesting a rising rate of dropouts. Systematic evidence over time on teacher/student ratios, availability of teaching materials, educational level of faculty, and other (presumed) measures of the quality of a school system are not available. It is however difficult to believe that these characteristics have not moved adversely in recent years in face of the heavy increase in demand for places in the school system.

The finding that the rate of return on incomplete secondary and university education is about equal to that on completed programs also has implications for the quality of the educational product. General evidence in Chile suggests rather clearly that persons who have completed a secondary or university program have an advantage in getting a job relative to one who has not obtained his diploma. The fact that the rates of return are about the same on dropouts as on graduates however suggests that advancement is not greatly facilitated by completing a degree program. In the case of primary education the rising rate of return on successive years of attendance indicates that an additional year in school at this level does make a person relatively more effective in his job. That an extra year at the secondary or university level does not have a similar consequence for advancement - despite advantages in employment - is consistent with the hypothesis that the quality of the educational system is part of the explanation of the relatively low rates of return presented here. If graduates are hired more readily than non-graduates, this suggests that employers do attach a premium to the completion of the particular program. If their advance is,

relative to the costs of their education, no more rapid than that of the dropout, then we are entitled to conclude that part of the explanation of the low rate of return is to be found on the supply side, i.e., in terms of the quality of the product the educational system turns out. That this result should be present in higher education, and not in primary is reasonable. Demands on teachers and teaching skills is less in the latter than in the former. Expensive equipment ( laboratory, calculators, books ) play a smaller role in primary education than in secondary and university education. Also the possibility of parental help and influence is much greater at lower levels, and this type of teacher's aid can be important in a crowded, understaffed, poorly paid school system.

Other explanatory factors appear less important. Geographic or job immobility does not seem damaging in Chile, as might be the case in larger, more heterogeneous societies, nor does job information consitute a significant barrier. The post-50-55 retirement has some effect, but even if it did not occur, the relationship between $r_e$ and $r_c$ would not be markedly changed. Firm quantitative evidence on the extent to which highly trained Chileans leave the country is not available. Bits and pieces of data indicate that the magnitude of such a flow is less in Chile than in other Latin American countries ( Argentina, for example ), and probably is not a major factor in the Chilean scene. Finally, the measure of labor's productivity used here was limited to the return received by the worker, and no effort was made to estimate any external effects attributable to education. These exist, of course, and are possibly important. They include negative effects (e.g., unrest created by graduates who cannot find jobs to suit their training ) as well as positive, but probably most observers would agree that the net external effect of education is positive. From the allocation standpoint,

these external effects must not only be positive but must exceed those associated with conventional capital formation to modify the results given above. That this is the case in Chile is by no means clear, and there is not justification for the conclusion that if all external effects were included in the arguments the relationship between rates of returns on conventional and educational capital would be markedly different from that given above.

The prime emphasis that many observers give to education in a development program rests on the assumption ( usually implicit ) that the educational system is an effective training institution or can easily be made into one. One frequently encounters the argument that productivity in the industrial or agricultural sector is low, and the advocacy of education as a means of solving that low productivity. This approach will not work unless the educational system is itself already productive in the sense that students going through its programs learn what they set out to learn. And one can easily doubt that an effective educational system will exist in an economy where productivity in most other sectors is low. Further, abundant evidence in the currently rich countries of the world shows it is much easier to increase productivity in manufacturing or agriculture activity than it is to raise the effectiveness of an educational program. Given the difficulties of knowing what changes to make and then the even greater difficulty of making the changes in existing educational programs, it may well be that not using resources to try to improve the quality of education of the labor force allowed more resources to be used in activities where productivity was in fact higher, and the difficulties of increasing it further were not so great as in education. Hence the rate of growth of GDP was higher with a rate of return on education than it would have been if sufficient resources had been allocated to education to ensure that the quality of

education of the labor force improved.

The final conclusion then is not the surprising and risky one that education in Chile is not a significant source of growth. It is rather that increases in productivity are at the heart of the developement process and that such increases must apply to the educational system as well as to other sectors, i.e., an unproductive educational system cannot be the source of productivity growth in other sectors of the economy. Increasing the productivity of educational institutions may well be much more difficult and time-consuming than raising the productivity of the manufacture of refrigerators and automobiles. Hence more investment in refrigerators and automobiles leads to a faster rate of growth than does investing in education.

This paper has argued that there is evidence that the effectiveness of educational institutions in Chile is not as great as is necessary to support the burden that they are asked to bear. While not claiming to know or to recognize what changes can or should be accomplished to help relieve the difficulty, recent changes and the proposals for further change seem to offer many reasons for optimism about the future of Chilean education. This seems definitely to be the case in the narrow field of economics.

## Appendix: The Data

The data used to calculate the equations discussed in the text were obtained as a by-product of a survey on unemployment conducted by the Instituto de Economia, Universidad de Chile. This survey was chiefly concerned with determining the amount of unemployment as well as various characteristics of the labor force. The survey was limited to the greater Santiago area, and the observations used were limited to male members of the labor force. The data on education, age, and wage income for the calculations reported here were taken directly from the answer sheets completed in the course of the interviews. The description of the survey indicates that it was well conceived and well carried out. Although one can never be sure on such matters, one seems justified in accepting the observations as constituting a satisfactory random sample.

The survey itself included over 2500 observations. A number of these were arbitrarily omitted. Occupations where the relationships between wage and productivity is recognizably vague or non-existent were not included. The most obvious of such cases were members of the clergy and of the armed forces, but there were some others as well. Workers who worked less than full time were excluded, although "full time" is a vague notion and arbitrary decisions were inevitably necessary. Similarly, certain extraordinarily high salaries were ommitted. These were few in number, and although there is some effect on the results because of these exclusions it could not be very large. The number of observations exceeded 100 in all age groups.

The "wage income" is meant to be income earned in current employment, not total income. Included are estimates of payments in kind, e.g. rent, meals, clothing, and the like. The figure quoted referred to that received during the month preceding the

survey: Statements on salaries or wages are open to many questions, but in general they are more accurate than statements on total income. Also, the relationship between income from employment and productivity is more direct and more meaningful than that between total income and productivity. In particular a regression between income from employment and education is less likely to be dominated by considerations relating to the demand for education than is a regression between total income and education. It is usually assumed that high salaried people understate their income when responding to a questionnaire. This may be true in the present case. It may also be true that persons with university education overstate their income because of matters of pride. In general however one suspects that the salary figures are understated at the upper levels.

Education refers to the number of years of school attendance completed, and is limited to primary, secondary, and university categories. Excluded were those with specialized education of a wide variety of sorts. This exclusion rested simply on considerations of time and availability of data. It would of course be necessary to consider the role of specialized education in a more complete study. Harberger and Selowsky found a rate of return of 29 per cent on "technical education" in their study, but it is not clear what they included under this heading. The number of respondents in the entire sample reporting any specialized education was quite small, less than 5 per cent of the total.

People have been known to forget or misreport their age, but as interest is only in five year age groups the problem here is minor.

The cost estimates are taken from an unpublished paper of Raul E. Yver, "The Cost of Education in Chile," reported in the Harberger and Selowsky study. The estimates presented in Yver's paper refer to 1959, and have been adjusted here to 1962 prices by

simply multiplying by the price index. Such an adjustment is, of course, quite rough, and assumes, among other things, that the real income of teachers, school administrators, and other academic officials has not risen. Yver's data include estimates of foregone earnings of students in school as well as the direct outlays on education. Cost estimates are available for primary, secondary, and university education. Costs for each year of education in a given category are assumed to be the same. This is a reasonable approximation, although costs probably rise somewhat between years at the university level. His estimates with our adjustments show a cost per student per year of 130 Esendos for primary ( the first six years ), 577 Esendos for secondary ( the second six years ), and 2025 Esendos for university.

The methods of estimation used by Yver are conceptually quite acceptable. There are no alternative data to serve as a check. In comparison with some other university programs in other Latin American countries the estimates appear low. If one believes that high salaried, well educated people understate their salaries, then perhaps "too low costs" are matched by "too low" salaries, and the consequent rate of return "about right." There is no empirical evidence to support such an assumption however.

Finally, two acts of doctoring were performed. In the table the equation for age group 8 is shown in parentheses. It was obtained as a simple average of age groups 7 and 9. The computed equation for age group 8 is $W = 70.36 - 8.24E + 2.23 E^2$, an equation that makes little sense in the context of the entire set of equations. No reason for this maverick behavior could be found, but it is so inconsistent with the other evidence that the averaging process seems justifiable. Alternatively ( as noted in the footnote to the table ) one may use only Equations 10 and 11, and the argument of the paper still holds.

The second doctoring has to do with the fact that a large proportion ( about one quarter ) of the observations had completed six years of education, i.e. had completed primary school only. If all of these observations were included in the calculations then the equations are so strongly influenced by this one educational group that their meaning becomes open to considerable question. We first took a "random sample" from those who completed six years of education and computed the equations with these observations. We then performed the calculations omitting grade six entirely. There was surprisingly little difference in the results. It appeared somewhat neater to omit the six year education group completely, and the equations in the table are those computed in this way. While not defending this procedure as having any firm statistical base, I do not believe that this particular omission reduces the validity of the equations.

## Footnotes

1. Arnold C. Harberger and Marcelo Selowsky, "Key Factors in the Economic Growth of Chile: An Analysis of the Sources of Past Growth and of Prospects for 1965 - 1970" ( Mimeographed ).. This paper was prepared for the conference, "The Next Decade of Latin American Economic Development" held at Cornell University April 20-22, 1966 and will presumably be published. A full scale review of the results of the Harberger-Selowsky is not possible here, but is contained in the larger study mentioned in the preceding footnote. Footnote comments will be made where their results are directly relevant to the discussion given here.

2. In the curves of Diagram III rates of return are calculated on X years of education relative to zero education. We are also interested in the rate of return on ( e.g. ) the completed secondary school relative to completed primary and other combinations of years. In an equilibrium situation all those rates are presumably the same.

3. The model developed here is similar in its basic form to a number of other such models found in the literature. See especially A. K. Sen's "Comment" in The Residual Factor and Economic Growth prepared by the Organization for Economic Cooperation and Development, Paris, 1964: Frederick Harbison and Charles A. Myers, Education, Manpower, and Economic Growth, McGraw-Hill, New York 1964 especially Chapter 8-10: and Henry J. Bruton, Principles of Development Economics, Prentice-Hall, Englewood Cliffs 1965, Chapter 12. Mark Blaug, "The Rate of Return on Investment in Education in Great Britain", The Manchester School of Economics and Social Studies, September 1965 is an excellent review ( and defense ) of the rate of return approach to a study of the economics of education.

4. One might put the equation in logarithms, but it seems more realistic to speak of two more years of education than of 5 per cent more education.

5. The long pay off period for education shows up in data for other countries. See Gary S. Becker, Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education, New York: National Bureau of Economic Research, distributed by Columbia University Press, 1965, and the paper by Mark Blaug cited in footnote 4.

6. This point will help account for the decline in the C's noted earlier.

7. One might argue that if a person is able to accumulate assets of sufficient magnitude to enable him to retire and live on his property income, the property income itself should be attributed to his education. To limit the measure of the productivity of education to wage income then understates the contribution of education to a person's earning power. But the property income is the product of the accumulated assets, not of education, and the accumulation itself due to saving and not to education. The return attributable to education is the higher income received during the working life, not the return on the assets that the higher income and saving permitted to be accumulated.

8. Several investigations have used the internal rate of return to measure the contribution of education to output in a given year. This is incorrect. The internal rate of return depends on the time shape of education produced wage income. In a given year however the return is not affected by this fact, and one must use some kind of an age-weighted measure. Given the age income profile shown in Diagram IV and the rapidly growing, hence youthful population in Chile in recent years, the internal rate of return is surely significantly larger than an age-weighted rate applicable in a given recent

year would be. See Mary Jean Bowman, "Schultz, Denison, and the Contribution of 'Eds' to National income Growth," The Journal of Political Economy, October 1964.

9. As noted earlier all persons with less than a university education are assumed to enter the labor at age 20. They retire at age 65, hence n goes up to 45.

10. Harberger and Selowsky in their paper cited in footnote 2 find rates equal to 24, 17, and 12 for the same combination of years of education for the year 1960. Their cost data are the same as those used here ( except they are in 1960 prices ). Their income estimates are simply average incomes for the three levels of education with no breakdown on an age basis. Their significantly higher rate of return on elementary education is possibly due to their not using an age weighted figure. This might be less important for the other two categories ( secondary and university ) as the observations here are probably for a generally older group and neglecting the age distribution would have less effect. Their 24 per cent applies only to completed primary education, not to the rate of return on all resources engaged in primary education.

11. If in the computation of the c's in the definition of $r_{ep}$ the individual internal rates of return were used, $r_{ep}$ is 16.0. The slight difference between the two is a coincidence resulting from the heavy weight given to $c_6$ in the calculations.

12. Drop outs are virtually universally lamented, but there is of course nothing economically relevant ( in the rate of return sense ) about the length or content of most academic programs. If a person wants to learn algebra, then "dropping out" after algebra is learned may well be quite rational. Diagram I tells us that it is the productivity of education that determines the optimum number of years attendance, not an arbitrarily set diploma course.

13. Becker, in his study cited in footnote 6, finds a rate of return of 14 per cent for (a certain group of ) college graduates in the United States.
The similarity of this figure with that obtained for Chile can be said rather confidently to illustrate nothing.

14. The estimates of $r_c$ were derived from various "consistency tests" ( e.g. if we know capital's share and the capital-output ratio we can derive an estimate of the profit rate, etc. ), direct estimates from sample surveys and the national accounts, and from estimates based on individual industry reports. Also it is important to note that considerable underutilization of capital capacity exists in Chile, and this underutilization surely dampens the profit rate. In policy questions as to investment allocation decisions a rate of return on fully utilized capital is the relevant measure, rather than the actual rate. All these considerations lead to an $r_c$ well over 20 per cent as the figure to compare with $r_e$. Harberger and Selowsky assume a rate of 15 per cent, a figure frequently heard in Chile, but this rate does not jive with other evidence and I am now convinced it is too low.

15. Several developing countries seem to be in a position where the supply of university educated people is increasing more rapidly than the economy can generate jobs at wage rates sufficient to yield acceptable rates of return. See the Harbison and Myers book ( Chapter 6 ) cited in note 4.