B70.19
S468

LA General

PN-ABI-482
Isn 72355

PRELIMINARY DRAFT: NOT FOR PUBLICATION OR QUOTATION.

ISN 72355
PNABI 482

EDUCATION AND ECONOMIC GROWTH: SOME INTERNATIONAL COMPARISONS

by

Marcelo Selowsky

Economic Development Report No. 83

December 1967.

Portions of this research were supported by the Project for Quantitative Research in Economic Development of Harvard University through funds provided by the Agency for International Development under Contract CSD-1543.

A.I.D.
Reference Center
Room 1656 NS

NOTE:

This study is a part of "Education and Economic Growth: Some International Comparisons", Ph.D. Dissertation submitted to the Department of Economics, University of Chicago.

I am indebted to Professors Arnold Harberger and Gregg Lewis for helpful comments and suggestions. The shortcomings remaining in the study are, of course, my own responsibility.

Marcelo Selowsky,
Harvard University
November 1967

Education and economic growth: some international comparis
ons.

370.19 Selowsky, Marcelo.
S468 Education and economic growth: some international comparisons. Dec. 1967.
Part of dissertation (Ph.D.) - Chicago Univ.
Preliminary draft.
Contract no. AID/csd-1543.

1.Education and development - Mexico.
2. " " " - Chile.
3. " - India.
4. Education and development.5.Mexico.6.Chile.
7.India.I.Contract.II.Title .II.Harvard Univ.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iii
LIST OF TABLES	v
LIST OF ILLUSTRATIONS.	ix
Chapter	
I. INTRODUCTION.	1
II. A REVIEW OF METHODOLOGY	4
Two Approaches to the Measurement of Education's Contribution to Growth	
The Internal Rate of Return to Education	
III. EDUCATION AND ECONOMIC GROWTH: A QUANTITATIVE STUDY OF THREE COUNTRIES	22
Mexico: 1940-1964	
Chile: 1940-1964	
India: 1950-1960	
IV. INTERNATIONAL COMPARISONS AND CONCLUSIONS	67
Appendixes	
A. MEXICO: STATISTICAL APPENDIX	79
B. CHILE: STATISTICAL APPENDIX	98
C. INDIA: STATISTICAL APPENDIX	124

LIST OF TABLES

Table		Page
1.	Mexico: End of Year Enrollment	26
2.	Mexico: Leavers of the Educational System .	28
3.	Mexico: Gross Entrance to the Labor Force . by Years of Schooling Completed	30
4.	Mexico: Exits from the Labor Force by Years of Schooling	31
5.	Mexico: Educational Distribution of the Active Population at the End of Each Year	32
6.	Mexico: Labor Quality Index	36
7.	Mexico: Growth of Output, Labor Force and Quality of Labor Index, 1940-1964	37
8.	Mexico: Sources of Growth, 1940-1964	39
9.	Mexico: Percentage Contribution of Factor Growth to the Growth Rate	40
10.	Mexico: Contribution of Improvement in Labor Quality to the Yearly Growth by Levels of Schooling	41
11.	Mexico: Rates of Return and Annual Growth Rate of Educational and Physical Capital . .	43
12.	Chile: Entrants to the Labor Force by Years of Schooling	47
13.	Chile: Exits from the Labor Force by Years of Schooling	48

LIST OF TABLES - Continued

Table		Page
14.	Chile: Labor's Quality Index	49
15.	Chile: Yearly Increase in Labor's Quality Due to Education	50
16.	Chile: Sources of Growth, 1940-1964 . . .	52
17.	Chile: Contribution of Improved Education to the Yearly Growth by Levels of Schooling	56
18.	Chile: Rates of Return and Annual Growth Rate of Educational and Physical Capital	57
19.	India: Average Annual Income of Males by Level of Education and Age	60
20.	India: Distribution of the Male Population by Educational Level and Age Groups . . .	60
21.	India: Active Population by Years of Schooling	61
22.	India: Sources of Growth, 1950-1960 . . .	63
23.	India: Educational Capital Embodied in the Labor Force	66
24.	India: Marginal and Total (social) Internal Rates of Return to Education	66
25.	Growth Contribution Expressed as a Fraction of the Observed Growth Rate	69
26.	Annual Increase in Labor Quality due to Education ($\dot{Q}/Q$) and Its Contribution to Growth: United States, Mexico and Chile	71
27.	International Comparisons of Factor Endowment	77

LIST OF TABLES - Continued

Table		Page
28	Mexico, 1960: Educational Distribution of the Population by Age and Sex and Estimated Educational Distribution of the Active Population	80
29	Mexico: Approval Coefficient	81
30	Mexico: Ratio of Active Population to Population not at School	87
31	Mexico: Marginal Rates of Entrance of Leavers of Different Grades	88
32	Mexico: Marginal Rate of Entrance (Males and Females) of Leavers of a Particular Year	89
33	Mexico: Deaths by Sex and Age Groups . .	90
34	Mexico: Exits from the Labor Force Due to Death by Sex and Age Groups	91
35	Mexico: Exits from the Labor Force by Age Groups	92
36	Mexico: Distribution of the Male Population by Age and Years of Schooling	93
37	Mexico: Functional Distribution of Income	94
38	Mexico: Change in Labor'a Quality Index and Contribution of Education to Growth by Level of Schooling	95
39	Mexico: Costs of Education and Aggregate Educational Capital in 1963 Prices . . .	96
40	Mexico: Distribution of Secondary . . .	97

LIST OF TABLES - Continued

Table		Page
41	Chile: Average Attendance of Students: 1928-1964	99
42	Chile: Pass/Average Attendance Ratio . .	101
43	Chile: Leavers of the School System . . .	102
44	Chile: Ratio of Active Population to Population Not at School	106
45	Chile: Marginal Entrance Ratio	107
46	Chile: Marginal Ratio (Males and Females)	108
47	Chile: Deaths by Sex and Age Group . . .	109
48	Chile: Active and Total Population by Sex and Age Group, 1950	110
49	Chile: Exits from the Labor Force by Sex and Age Groups	111
50	Chile: Educational Distribution of the Labor Force: 1960	112
51	Chile: Educational Distribution of the Labor Force at the End of the Year. . . .	113
52	Chile: Change in Labor's Quality Index and Contribution to Growth by Level of Schooling	114
53	Chile: Costs of Educational and Aggregate Educational Capital	115
54	Chile: Monthly Income in E° of January 1964	117
55	Chile: Age-Earnings Equations: Urban Males and Females	118
56	Chile: Age-Earnings Equations: Rural Males	119

LIST OF ILLUSTRATIONS

Figure		Page
1.	Mexico: Ratio of Active Population to Population Not at School: Males	85
2.	Mexico: Ratio of Active Population to Population Not at School: Females	86
3.	Chile: Ratio of Active Population to Population Not at School: Males . . .	104
4.	Chile: Ratio of Active Population to Population Not at School:Females . .	105
5.	Chile: Age Earnings Equations Urban Males	120
6.	Chile: Age Earnings Equations Urban Males (M) and Females (F)	121
7.	Chile: Age Earnings Equations Rural Males	122
8.	Chile: Age Earnings Equations Rural Males (M) and Rural Females (F). . .	123
9.	India: Age Earnings Profiles: Males	125

CHAPTER I

INTRODUCTION

The study of the sources of economic growth has become in the last ten years an important part of the economic literature. A frequent approach to this problem has entailed the use of an aggregate production function: the typical result has been that the traditional factors -- labor and capital -- explain only a fraction of the observed changes in output, leaving a substantial "residual" or unexplained part of the growth rate.

For several countries the increase in the amount of education of the labor force, and therefore in its productivity, has explained a substantial part of this residual. This result has shifted attention from the earlier postwar emphasis on physical capital toward a more general conception of capital accumulation in which human capital plays a more important role.[1] This treatment of education emphasizes that the increase in education per man (and the consequent contribution to growth) does not come free but involves the use of real resources, and accordingly includes education in the general context of allocation of investment resources according to priorities set by their relative

---

[1] See Harry G. Johnson, "Comments on Mr. John Vaizey's Paper" in The Residual Factor and Economic Growth (Paris: OECD 1964); T. W. Schultz, "Reflections on Investment in Man," Journal of Political Economy (October, 1962), Supplement.

(social) rates of return. This is particularly relevant for underdeveloped countries where the past emphasis in investment planning has been on the use of (physical) capital-output ratios which neglect explicit treatment of the labor input as a source of growth.

Earlier studies of the contribution of education to the growth rate have been carried out mainly for the United States and some European countries, all of them rather highly developed and with no great differences in their per capita income.

The purpose of this study is to analyze the role of education in a group of countries with sharp per capita income differences.

The first part of Chapter II analyzes two equivalent approaches to the measurement of education's contribution to growth; I call them the "index" approach and the "educational capital" approach, the main characteristics of the latter being the use of the internal rate of return to education. In this part we also call attention to the fact that earlier studies of the role of education in economic growth have neglected the contribution to the growth rate of maintaining constant the average educational level of the labor force. This contribution has typically been classified as part of the growth attributable to increases in the labor force. The second part of Chapter II analyzes the difference between the concept of internal rate of return to education to be used for the purpose of measuring education's contribution to growth and the one relevant for investment decisions "vis-a-vis" other investment projects.

Chapter III studies the past contribution of education to growth in relation to other productive factors, for three countries: Mexico, Chile and India. A comparison of the rate of return on physical capital and education is also made in order to

assess the appropriateness of the past allocation of investment between both types of capital and draw lessons for future policy.

Chapter IV compares the result of those countries with comparable figures for the United States. The findings suggest a rising contribution of education to growth in Mexico and Chile in contrast to a constant contribution for the United States.

Finally, an international comparison of factor endowment ratio is made. It is found that the biggest difference in factor endowment refers to educational capital per worker, which is substantially bigger than the differences between physical capital per worker. This suggests that the differential amount of educational capital per head between countries should be able to explain cross-country differences in per capita income.

CHAPTER II

A REVIEW OF METHODOLOGY

The purpose of this chapter is to analyze two different approaches to the measurement of the contribution of education to economic growth; we will call them the "index" approach and the "educational capital" approach. The latter approach makes use of the internal rate of return to education, a concept widely used in making investment decisions.

The second part of the chapter analyzes the differences between the internal rate of return that is appropriate as a device for measuring education's contribution to growth and the rate concept relevant for decisions on allocation of investment resources.

Two approaches to the measurement of education's contribution to growth

a) Let us begin by specifying a production function of the following form:

(1) $Y = F[K, L_o, L_1, \ldots, L_n]$

where Y is aggregate output, K is the flow of services of the physical capital stock, and L_o, L_1, ..., L_n are man-hour inputs of members of the labor force with 0, 1, ..., n years of schooling, respectively.

Differentiating (1) with respect to time, we get (where the dots show time derivatives):

$$(2)\quad \dot{Y} = f_K\dot{K} + f_{L_o}\dot{L}_o + f_{L_1}\dot{L}_1 \ldots F_{L_n}\dot{L}_n$$

where the f's are partial derivatives. If we assume perfect competition, we can rewrite (1) as:

$$(3)\quad \dot{Y} = f_K\dot{K} + \sum_i w_i\dot{L}_i$$

where w_i is the real wage of individuals with i years of schooling. Define $L \equiv \sum_i L_i$, so that $\dot{L} = \sum_i \dot{L}_i$. Equation (3) then can be written as:

$$(4)\quad \dot{Y} = f_K\dot{K} + w_o\dot{L} + \sum_i (w_i - w_o)\,\dot{L}_i$$

where $f_K\dot{K}$ is the contribution of physical capital to growth, $w_o\dot{L}$ the contribution of "brute force," that is, of the "uneducated" component of all members of the labor force, and $\sum_i (w_i - w_o)\dot{L}_i$ is the contribution of education.

Education's contribution can be disaggregated into two components. Define $a_i = \frac{L_i}{L}$. Then $\sum_i \dot{a}_i = 0$, and we get:

$$(5)\quad \sum_i (w_i - w_o)\,\dot{L}_i = \dot{L}\sum_i (w_i - w_o)\,a_i + L\sum_i w_i\,\dot{a}_i$$

$L\sum_i w_i\dot{a}_i$ is the contribution to growth of changes in the relative distribution of workers by years of schooling. $\dot{L}\sum_i (w_i - w_o)a_i$ is the contribution to output of the increase in the labor force that is needed to maintain the distribution by years of schooling constant. We will call this term the contribution of the "maintenance" component.

Equation (4) can be written as:

$$(6)\quad \dot{Y} = f_K\dot{K} + \left\{w_o + \sum_i (w_i - w_o)a_i\right\}\dot{L} + L\sum_i w_i\dot{a}_i$$

The average wage $\bar{w}$ is $\sum_i w_i a_i$. Therefore we can rewrite (6) as:

$$(7)\quad \frac{\dot{Y}}{Y} = \alpha_K\frac{\dot{K}}{K} + \alpha_L\frac{\dot{L}}{L} + \alpha_L\sum\frac{w_i}{\bar{w}}\dot{a}_i$$

where α_K and α_L are the shares of physical capital and labor on output. For empirical purposes we must write (7) as:

$$(8)\quad \frac{\dot{Y}}{Y} = \alpha_K\frac{\dot{K}}{K} + \alpha_L\frac{\dot{L}}{L} + \alpha_L\frac{\dot{Q}}{Q} + \text{a residual}$$

where the residual is the amount of the growth rate not explained empirically by the other terms on the right of (8) and $\frac{\dot{Q}}{Q} = \sum_i \frac{w_i}{\bar{w}}\dot{a}_i$ is the increase in the index of average "quality" of the labor force. In other words Q is a weighted education-per-man index where the weights are earnings by years of schooling.[1] In this framework $\alpha_L\frac{\dot{L}}{L}$ is the contribution of labor of constant "quality" or education and $\alpha_L\frac{\dot{Q}}{Q}$ is the contribution of <u>improved</u> education to growth

---

[1]The growth rate of the labor quality index can also be obtained in the following way. Define the wage bill, S, as:

$$(1')\quad S = \sum_i w_i L_i$$

where w_i is the average wage of persons with i years of schooling and L_i is the aggregate man-hours worked by these persons. Let $a_i = L_i/L$, enabling (1') to be written as:

$$(2')\quad S = L\sum_i w_i a_i$$

Differentiating this with respect to time and dividing by S we get:

$$(3')\quad \frac{\dot{S}}{S} = \frac{\dot{L}}{L} + \sum_i\frac{w_i}{\bar{w}}\dot{a}_i + \sum_i\frac{\dot{w}_i}{\bar{w}}a_i$$

where $\bar{w} = \sum_i a_i w_i$ is the average wage in the labor force.

The last term on the right hand side is the average increase in wages due to all forces except changes in the educational composition of the labor force; it is the increase that comes mainly from increased physical capital per unit of labor and from technical

Most of the studies of the contribution of education to growth have used the term $\alpha_L \frac{\dot{Q}}{Q}$ as the measure of this contribution. From equation (6) we can see that this procedure understates the contribution of education by $\frac{\dot{L}}{Y} \sum (w_i - w_o)a_i$ or the contribution of the "maintenance" factor. In equation (8) this factor is included in $\alpha_L \frac{\dot{L}}{L}$.

The total contribution of education to the aggregate growth rate is therefore:

$$(9) \quad \left\{ \frac{L}{Y} \sum_i (w_i - w_o)\, a_i \right\} \frac{\dot{L}}{L} + \alpha_L \frac{\dot{Q}}{Q}$$

$$(10) \quad \alpha_E \frac{\dot{L}}{L} + \alpha_L \frac{\dot{Q}}{Q}$$

where $\sum_i (w_i - w_o)a_i$ is the average rental of education in the labor force (which we will call $\bar{r}$) and α_E is the share of those rentals in total output. From now on we will call $\alpha_E \frac{\dot{L}}{L}$ the contribution to growth of maintaining constant the average level of schooling and $\alpha_L \frac{\dot{Q}}{Q}$ the contribution to growth of the increase in the amount of schooling per head.

b) The "educational capital" approach can also be expressed in a production function framework. I begin by specifying a production function of the following form:

$$(11) \quad Y = F\,[K, L, E]$$

where K is the physical capital stock (the flow of services from capital is here assumed to be proportional to stock), L is the flow of "brute force" labor services and E is the stock of educational capital (again the flow of services is assumed to be proportional to stock).

---

progress. Call this term λ, then:

$$(4') \quad \frac{\dot{S}}{S} = \frac{\dot{L}}{L} + \sum_i \frac{w_i}{w} \dot{a}_i + \lambda$$

The second term on the right hand side is the $\frac{\dot{Q}}{Q}$ term of equation (8).

If F is linear and homogeneous we can express the growth rate as:

$$(12) \quad \frac{\dot{Y}}{Y} = \alpha_K \frac{\dot{K}}{K} + \alpha'_L \frac{\dot{L}}{L} + \alpha_E \frac{\dot{E}}{E}$$

where the α's are partial elasticities of production and also factor shares under conditions of perfect competition.

We can rearrange (12) as follows:

$$(13) \quad \frac{\dot{Y}}{Y} = \alpha_K \frac{\dot{K}}{K} + \alpha'_L \frac{\dot{L}}{L} + \alpha_E \frac{\dot{L}}{L} + \alpha_E \frac{\dot{e}}{e}$$

where $e = \frac{E}{L}$ is educational capital per unit of labor input. $\alpha'_L \frac{\dot{L}}{L}$ is the contribution to growth of "brute force" and $\alpha_E \frac{\dot{L}}{L} + \alpha \frac{\dot{e}}{e}$ is the contribution to growth of education, where $\alpha_E \frac{\dot{L}}{L}$ is the contribution of the "maintenance" factor and $\alpha_E \frac{\dot{e}}{e}$ is the contribution of increased education per head.

We can see that the contribution of education in the "educational capital" approach is equal to that measured in the "index" approach if and only if $\alpha_L \frac{\dot{Q}}{Q} = \alpha_E \frac{\dot{e}}{e}$. We now prove this. For this purpose we treat $\alpha_E \frac{\dot{e}}{e}$ as $\alpha_L \frac{\dot{Q}}{Q}$ was treated in the "index" approach in footnote 1, page 6. The educational capital bill is:

$$(14) \quad S_E = L \sum_i (w_i - w_o)\, a_i = L \sum_i r_i\, a_i$$

where w_o is the wage earned by a person with zero years of schooling, and r_i is the rent on the educational capital of a person with i years of schooling. We can write the educational capital bill as:

$$(15) \quad S_E = L \sum b_i e_i a_i$$

where $r_i = b_i e_i$; b_i is the (gross-of-depreciation) rate of return on the educational capital of a person with i years of schooling and e_i is the amount of this capital. Differentiating this equation with respect to time and dividing by S_E:

$$(16) \quad \frac{\dot{S}_E}{S_E} = \frac{\dot{L}}{L} + \frac{1}{\sum_i b_i e_i a_i} \left\{ \sum_i b_i e_i \dot{a}_i + \sum_i b_i a_i \dot{e}_i + \sum_i a_i e_i \dot{b}_i \right\}$$

At this step we introduce the same assumption as that in the "index" approach, namely, that education is to be valued at base year relative wages (see equation (7)).

Given the above assumption and recalling that λ is the secular growth rate of wages (due to all forces except changes

in the educational distribution) we can write (16) as:[1]

$$(17)\quad \frac{\dot{S}_E}{S_E} = \frac{\dot{L}}{L} + \frac{\sum_i b_i e_i \dot{a}_i}{\sum_i b_i e_i a_i} + \lambda$$

where

$$\lambda = \frac{\sum_i b_i a_i \dot{e}_i + \sum_i a_i e_i \dot{b}_i}{\sum_i b_i e_i a_i}$$

It is clear that if this approach is to lead to the same results as the "index" approach we must take as the measure of $\dot{e}/e$ the index $\sum_i b_i e_i \dot{a}_i / \sum_i b_i e_i a_i$. That is, we must calculate the educational capital at base-year prices and qualities. Assume that we have done so. Then:

---

[1] This result comes from differentiating $r_i = b_i e_i$, namely:

$$(17')\quad \dot{r}_i = \dot{b}_i e_i + b_i \dot{e}_i$$

we know

$$\dot{r}_i = \lambda\, r_i = \lambda b_i e_i \text{ so:}$$

$$(17'')\quad \dot{b}_i e_i + b_i \dot{e}_i = \lambda\, b_i e_i$$

In other words the change in the educational rental r_i can be decomposed into a change in the gross rate of return ($\dot{b}_i$) and a capital gain or loss ($\dot{e}_i$) of the educational capital embodied in the individual.

If all costs of education are labor payments then b_i will be zero because costs and returns to education expand proportionally at λ percent. In this case r_i changes only because of changes in the value of e_i and the first term of the right hand side of (17') becomes zero.

(18) $$\alpha_E \frac{\dot{e}}{e} = \frac{S_E L}{Y} \frac{\sum_i b_i e_i \dot{a}_i}{S_E} = \frac{\bar{w} \cdot L}{Y} \sum_i \frac{b_i e_i}{\bar{w}} \dot{a}_i$$

Since $\sum_i b_i e_i \dot{a}_i = \sum_i (w_i - w_o)\dot{a}_i$ and $\sum_i \dot{a}_i = 0$ we know:

(19) $$\sum_i b_i e_i \dot{a}_i = \Sigma w_i \dot{a}_i$$ therefore we have:

(20) $$\alpha_E \frac{\dot{e}}{e} = \frac{\bar{w} \cdot L}{Y} \sum_i \frac{w_i}{\bar{w}} \dot{a}_i = \alpha_{Li} \sum \frac{w_i}{\bar{w}} \dot{a}_i$$

as in the "index" approach.

Two major questions remain: (a) Although it is clear that the term $\frac{1}{\sum_i b_i e_i a_i} \left\{ \sum_i b_i a_i \dot{e}_i + \sum_i a_i e_i \dot{b}_i \right\}$ of equation (16) must be λ if the two approaches are to come to the same result, on what <u>real</u> ground should this term be eliminated from the labor quality index? b) In calculating the absolute level, as distinct from an index of educational capital, what rate of return should be used?

If the <u>quality</u> of given "years of schooling" changes, the term above-mentioned will measure in part these changes. In principle this change in quality should not be left out of either the "index" approach or the "educational capital" approach. In principle it can be included in both methods.

In other words λ is the combined effect of increases in the quality of schooling and of other sources not related to education (increase in physical capital per head, technical progress, etc.). The rise in rewards of the existing stock of educated labor due to these other sources is not a contribution of education to growth; it rather represents a transfer to existing educated labor (in the case of capital accumulation) or a benefit received by labor due to external effects of other activities (in the case of technical progress).

Only the lack of data on the improvement of the quality of education and its effect on wages (and therefore on e_i and b_i) forced us to neglect the possible contribution of improved quality of given amounts of schooling as one component of λ. As a consequence the term

$$\frac{1}{\sum_i b_i e_i a_i} \left\{ \sum_i b_i a_i \dot{e}_i + \sum_i a_i e_i \dot{b}_i \right\}$$

in the "educational capital" approach and $\sum_i \frac{\dot{w}_i}{w} a_i$ in the "index" approach (being both equal to λ) are left out of the expression measuring education's contribution to growth.

To answer the second question we have to realize that the "educational capital" approach can be applied in two ways: one

is to impute to the share of educational capital (α_E) an index of educational capital ($\frac{\dot{e}}{e}$) where the weights of the educational distribution of the labor force are not wages but educational rentals ($r_i = w_i - w_o$):

$$(21) \quad \alpha_E \frac{\dot{e}}{e} = \alpha_E \frac{\sum_i r_i \dot{a}_i}{\sum_i r_i a_i}$$

Another way of expressing (21) is to impute a rate of return to the increment of the absolute level of educational capital. This method has widespread empirical applications and has also generated some points of confusion. For this purpose we can write (21) as:

$$(22) \quad \frac{1}{Y} \sum_i b_i e_i \left[\dot{L}_i - \frac{L_i}{L} \dot{L}\right].$$

If we define $e_i L_i = E_i$, expression (22) becomes:

$$(23) \quad \frac{1}{Y} \sum_i b_i \left[\dot{E}_i - \frac{E_i}{L} \dot{L}\right].$$

At this point the main issue is to define the rate of return and educational capital in such a way that their product gives us the educational rental r_i. It is clear that there are infinitely many combinations of b_i and e_i that give us r_i.

We can define the eductional capital embodied in a person at the beginning of age J and with i years of schooling as:

(24) $$e_{iJ} = \sum_{j=J}^{\infty} r_{ij}(1+u)^{J-j-1}$$

where u is the discount rate used. The above equation can be written:

(25) $$e_{iJ} = r_{ij}\ (1+u)^{-1} + (1+u)^{-1} \sum_{j=J+1}^{\infty} r_{ij}\ (1+u)^{J-j}$$

$$= r_{iJ}(1+u)^{-1} + (1+u)^{-1}\ e_{iJ+1}$$

Therefore the rental r_{iJ} can be written as:

(26) $$r_{iJ} = (u+d_{iJ})e_{iJ} \text{ and where } d_{iJ} = \frac{e_{iJ} - e_{iJ+1}}{e_{iJ}}$$

is the percentage depreciation (or appreciation if negative) of an individual's educational capital due to change in age.

In the more general case in which we are also interested in the effect on growth of changes in the age-education mix we can rewrite (22) as:

(27) $$\frac{1}{Y} \sum_i \sum_J (u + d_{iJ})e_{iJ}\ [\dot{L}_{iJ} - \frac{L_{iJ}}{L}\ \dot{L}\ ]$$

and therefore we have to define an age specific rate of return $b_{iJ} = u+d_{iJ}$. If age is disregarded and therefore the educational rentals associated with each level of schooling (r_i) are independent of age then (27) reduces to (22) with $b_i = u + d_i$.

Most of the empirical studies that have used the educational capital approach have used for μ the internal rate of return to education, a magnitude relevant for investment decisions.

This is a particular case of equation (24) in which $\mu = \rho_i$:

$$(28) \quad e_{iJ} = \sum_{j=J}^{\infty} r_{ij} \, (1 + \rho_i)^{J-j-1} = \sum_{j=0}^{J-1} r_{ij} \, (1 + \rho_i)^{J-j-1}$$

where ρ_i is defined as the internal rate of return to i years of schooling. The last term on the right is simply the sum of outlays (less inflows after the individual enters the labor force) accumulated forward at the rate ρ_i. We will call this magnitude simply "capital at charge." Therefore $b_{iJ} = (\rho_i + d_{iJ})$ and e_{iJ} can be calculated by carrying the outflows and inflows forward to the end of age J-1 at the rate ρ_1.

A clear way of comparing the educational capital approach and the index approach in a dynamic context is to assume that relative wages do not change through time or that we have data on relative wages only for one year. To make the analysis more general we will introduce the age variable explicitly.

Under the index approach we write the contribution of improved education, for any year T, as:

$$(29) \quad \frac{\bar{w}_T \cdot L}{Y} \sum_i \sum_J \frac{w_{iJT}}{\bar{w}_T} \, \dot{a}_{iJ} = \frac{1}{Y} \sum_i \sum_J w_{iJT} \left(\dot{L}_{iJ} - \frac{L_{iJ}}{L} \, \dot{L} \right)$$

where $a_{iJ} = \frac{L_{iJ}}{L}$. If relative wages remain the same we can write (29) for the next year T_{+1} as:

$$(30)\quad \frac{1+\lambda}{1+\alpha}\ \frac{1}{Y}\sum_i\sum_J w_{iJT}\left(\dot{L}_{iJ} - \frac{L_{iJ}}{L}\dot{L}\right)$$

where λ and α are the annual growth rate of wages and output between T and T_{+1}.

The contribution of improved education, in the educational capital approach, can be written for any year T as:

$$(31)\quad \frac{1}{Y}\sum_i\sum_J b_{iJT}\, e_{iJT}\left[\dot{L}_{iJ} - \frac{L_{iJ}}{L}\dot{L}\right]$$

where $b_{iJT}\, e_{iJT} = r_{iJT}$. Under constant relative wages the contribution at the next year T_{+1} is:

$$(32)\quad \frac{1+\lambda}{1+\alpha}\ \frac{1}{Y}\sum_i\sum_J r_{iJT}\left(\dot{L}_{iJ} - \frac{L_{iJ}}{L}\dot{L}\right) = \frac{1+\lambda}{1+\alpha}\ \frac{1}{Y}\sum_i\sum_J b_{iJT}\, e_{iJT}\left(\dot{L}_{iJ} - \frac{L_{iJ}}{L}\dot{L}\right)$$

We can see that in both approaches the weights used to evaluate changes in labor's educational composition in the next year T_{+1} are $\frac{1+\lambda}{1+\alpha}$ times larger than those of period T.

The rise of rentals by λ implies also a rise of e_{iJT} by λ between T and T_{+1} so $e_{iJT+1} = (1+\lambda)e_{iJT}$.[1]

---

[1] $e_{iJT} = \sum_{j=J}^{\infty} r_{ij}\,(1+\mu)^{J-j-1}$, at year T_{+1} the person of equal characteristics has a capital value equal to:

$$e_{iJT_{+1}} = \sum_{j=J}^{\infty}(1+\lambda)(1+\mu)^{J-j-1} = (1+\lambda)e_{iJT}.$$

Thus in this case the e_{iJT} calculated from cross-sectional rentals in year T grow thereafter at the rate λ per year. In the special case in which we are using the internal rate of return to education, the value of each e_{iJT} (which is now capital at charge) in the base year grows by λ per cent if and only if the inflows and outflows carried forward to the end of age J-1 also expand by λ per cent so that the internal rate of return remains constant.[1] This will be true if all costs of education represent labor payments or if non-labor costs rise through time at the same rate as labor costs.

<u>The internal rate of return to education: its use for measuring contribution to growth and as an investment decision device.</u>

As we saw earlier we can define the internal rate of return to i years of schooling as the discount rate that makes equal the costs and benefits of acquiring this level of schooling; denoting ρ_i as this rate we know:

$$(33) \qquad \int_{j=0}^{\infty} r_{ij} e^{-j\rho i} d_j = 0$$

where r_{ij} are benefits (inflows) or costs (outflows) at age j of obtaining this level of schooling.

We will distinguish two internal rates of return to education depending on its use: one will be the relevant for measuring education's contribution to growth and we will call it cross

---

[1] For an empirical application of this case see, A.C. Harberger and M. Selowsky, "Key Factors in the Economic Growth of Chile", paper presented at the Next Decade in Latin American Development, Conference at Cornell University, April 1966; to be published by Cornell University.

section or ex-post rate. The other is the relevant for making comparisons of the social profitability of investing in education versus other investment projects; this rate is a probabilistic concept and we will call it simply ex-ante rate.

The ex-post or cross-section rate of i years of schooling for any past year T is calculated, as we saw earlier, from the rentals $r_{ij} = w_{ij} - w_{oj}$ where w_{ij} and w_{oj} are cross-section age-earnings profiles at year T of members of the labor force with i and zero years of schooling, respectively; this way of calculating the internal rate of return comes from the nature of the problem we are interested in, to explain ex-post or realized educational rentals.

For the purpose of comparing the profitability of investing <u>now</u> in education "vis-a-vis" other investment projects we need the ex-ante internal rate of return to education, one based on expected r_{iJ}'s.

How can we derive these expected r_{iJ}'s from our earlier cross section educational rentals?

The major difference between the cross section and expected r_{iJ}'s is that in the latter the rental of any particular age j is also (calendar) time specific; for investment purposes what

is relevant is the rental of a person of age J now entering the schooling system, hence we have to take into account the future behavior of relative wages.

This adjustment can be done in the following form; let us rewrite (33) as:

$$(34) \qquad \int_{j=0}^{J_1} w_{oj}\, e^{-j\rho i}\, dj + \int_{j=J_1}^{\infty} (w_{ij} - w_{oj}) e^{-j\rho i}\, dj = 0$$

where all wages are obtained cross-sectionally today and where J_1 is the age of entrance to the labor force. We assume, for mathematical simplicity, that all costs of education (represented by the first term) are foregone income and therefore equal to the wages of workers of age j with zero years of schooling.

Denoting by λ_i^e and λ_o^e the <u>expected</u> annual growth rate of wages of people with i and zero years of schooling and assuming this rate will be constant in the future we get:

$$(35) \qquad \int_{j=0}^{J_1} w_{oj}\, e^{-j\,(\rho i - \lambda_o^e)}\, dj + \int_{j=J_1}^{\infty} [w_{ij} e^{-j\,(\rho i - \lambda_i^e)} - w_{oj}\, e^{-j\,(\rho i - \lambda_o^e)}]\, dj = 0$$

There are three main additional adjustments to be made to today's labor force age-earnings profiles in order to use them to get the ex-ante rate: expected labor force participation,

expected unemployment through the lifetime and the probability of survival. We will analyze the three of them:

a) The need for adjusting for the expected participation in the labor force comes from the fact that the cross section earnings are based on the labor's force profiles while the ex-ante rate is an index of the profitability of educating individuals, not all of whom will be permanent members of the labor force in the future.

If we are interested in the effect of education on measurable output we need to adjust the cross section rentals by the probability that a typical student will become in the future a participant of the labor force.

b) If the cross section rentals were obtained from the <u>employed</u> members of the labor force then a correction for the future probability of unemployment is needed.

This correction is not needed if the cross section rentals would have been obtained including all members of the labor force; this implicitly assumes that the degree of unemployment expected in the future is the same as the one experienced by the labor force in the cross-section year.

c) The direct use of the cross-section rentals as an estimate of an individual's lifetime profile of rentals would implicitly

assume that the individual has certainty of achieving every age (probability equal to one). This is obviously not so and we should adjust every cross section r_{ij} by the probability of reaching the respective age j.

If we take into account corrections (a), (b), and (c) we could rewrite (35) as:

$$(36) \quad \int_{j=0}^{J_1} w'_{oj}\, e^{-j(\rho_i - \lambda_o^e)} dj + \int_{j=j_1}^{\infty} [w'_{ij} e^{-j(\rho_i - \lambda_i^e)} - w'_{oj}\, e^{-j(\rho_i - \lambda_o^e)}]\, dj = 0$$

where

$$w'_{oj} = P_{oj}\, U_{oj}\, S_{oj}\, w_{oj}$$

$$w'_{ij} = P_{ij}\, U_{ij}\, S_{ij}\, w_{ij}$$

where P is the expected rate of participation in the labor force, U the expected rate of unemployment and S the expected survival rate. Every rate is years of schooling and age specific and empirical evidence supports this fact.

CHAPTER III

EDUCATION AND ECONOMIC GROWTH: A QUANTITATIVE STUDY OF THREE COUNTRIES

The purpose of this chapter is to estimate the contribution of education to the growth rate of three countries: Mexico, Chile, and India. Estimates of the contribution to growth of other factors are also made in order to evaluate the relative importance of each source of economic growth.

In addition, an estimate of the growth rate of capital formation by education is made in order to compare it with physical capital formation. Special emphasis is made on disaggregating this educational capital by levels of schooling so as to determine which educational levels are principally responsible for education's contribution to growth.

Finally, an analysis of the internal rate of return by level of schooling is also made in order to compare it with the marginal productivity of physical capital. This allows us to judge whether a different past allocation of a given amount of investment resources would have resulted in a different growth rate and also in which directions adjustments in the relative investment within

education and with respect to physical capital should be made in the future.

Mexico: 1940-1964

For the purpose of estimating the contribution of improved education to the Mexican growth rate of output we will use the "index" method. The period covered is from 1940 to 1964.

As we saw in the last chapter, the index method needs through time three sets of information (see equation 7); the elasticity of output with respect to the labor input (α_L), the distribution of the labor force according to years of schooling (a_i) and relative earnings classified by years of schooling completed ($\frac{W_i}{\bar{W}}$).

Let us begin with the estimation of the distribution of the labor force by years of schooling completed.

Time series data on this kind of information do not exist in a direct way in Mexico; the main information available is the 1960 distribution of the population by years of schooling which comes from the population census.[1]

---

[1] Estados Unidos Mexicanos, VIII Censo General de Población 1960, Resumen General (Mexico, D.F., 1962). In Mexico the difference between active population and labor force is that the latter does not include the individuals who have been unemployed for more than twelve weeks. The difference between the two magnitudes are negligible (approximately .3 percent), so we will use both concepts interchangeably.

The 1960 information for the population over 15 years old was used to estimate the educational distribution of the active population of that year assuming that for any sex-age group the distribution of active and total population is the same.[1]

To obtain the distribution for other years we will use the yearly flows of entrance into and exit from the labor force distributed according to years of schooling. Those flows will be applied to the 1960 figures in order to get values for the educational distribution of the labor force through time.

For example, the members of the labor force with i years of schooling in any year 1960-T will be:

$$(37) \quad L_{i,1960-T} = L_{i,1960} - \sum_{t=0}^{T-1} En_{i,1960-t} + \sum_{t=0}^{T-1} Ex_{i,1960-t}$$

where $L_{i,1960}$ are members of the labor force in 1960 with i years of schooling obtained through the 1960 population census. $En_{i,1960-t}$ and $Ex_{i,1960-t}$ are the number of people with i years of schooling that enter and leave the labor force in any year 1960-t.

En_{it} was derived from the number of leavers or drop-outs of the school system who had completed i years of schooling. These were obtained in the following way:

$$(38) \quad D_{it} = a_{it-1} F_{i,t-1} + (1 - a_{i+1,t-1}) F_{i+1,t-1} - F_{i+1,t}$$

---

[1] See Table 28, Appendix A.

where D_{it} are leavers in i years of schooling completed in year t (see Table 2), F_{it-1} is the end-of-year enrollment of students in the ith grade in year t-1 (see Table 1)[1] and a_{it-1} is the pass rate (fraction "passing" or completing successfully) at the ith grade in year t-1.[2]

However, the leavers of any year cannot be identified with the entrants to the labor force; we cannot expect that they will become immediately members of the labor force especially if we talk about leavers with low years of schooling and with low age also. The best way of dealing with this problem is to think of a particular En_{it} as the sum of a series of fractions of <u>past</u> D_{it}'s or in another way, that a given D_{it} is distributed between future En_{it}'s. In other words, part of the leavers of year t enter the labor force in year t, some of them in t+1, t+2, etc., the marginal rate of entrance depending on the participation in the labor force by sex, the distribution of the final enrollment by sex, and age and therefore on the years of schooling completed.[3]

The entrants to the labor force in year t that have i years of schooling are:

$$(39) \qquad En_{it} = \sum_{n=0}^{N} \epsilon_{i,t-n} D_{i,t-n}$$

where $\epsilon_{i,t-n}$ is the marginal entrance ratio[4] or the proportion

---

[1] The university enrollment data are for the beginning of the year instead of the end of the year.

[2] See Appendix A, Table 29.

[3] See Appendix A, Tables 30 to 32, Figures 1 and 2 and related text (p. 83).

[4] See Appendix A, Table 32.

TABLE 1

MEXICO: END OF YEAR ENROLLMENT (in thousands)

	ELEMENTARY						SECONDARY			PRE-PARATORY		UNIVERSITY (beginning of year enrollment)				
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1931	460	200	121	72	42	33										
1932	506	220	133	79	46	36	19	13	8							
1933	503	221	133	79	47	36	21	14	8	6						
1934	436	210	127	76	45	35	21	14	8	6						
1935	510	221	134	79	47	36	20	13	8	6						
1936	544	236	143	85	50	39	21	14	8	6						
1937	629	273	165	98	58	45	23	15	9	6						
1938	671	291	176	104	62	48	26	17	10	7						
1939	704	305	185	109	65	50	28	19	11	7	5					
1940	705	306	185	110	65	50	29	19*	11	8	5	3*	3*	2*	1*	1*
1941	735	319	193	114	68	53	29	19	12	8	6	4*	4*	3*	2*	2*
1942	830	382	231	137	81	63	30	20	14	9	6	5*	4*	3*	2*	2*
1943	857	429	255	151	91	73	37	25	15	10	7	6*	4*	3*	2*	2*
1944	973	443	270	153	94	77	43	28	17	11	8	7	4.2	3.2	2.5	2
1945	1,151	455	281	165	101	80	45	30	18	12	9	8	4.8	3.6	2.8	2.2
1946	1,194	487	296	176	112	87	47	31	18	13	9	9	5.4	4.1	3.2	2.5
1947	1,154	526	327	193	126	98	51	34	20	13	10	9	5.4	4.1	3.2	2.5
1948	1,136	541	341	205	134	107	57	39	24	15	10	10	6.0	4.5	3.5	2.6
1949	1,155	560	356	213	142	122	62	43	27	17	12	10	6.0	4.5	3.5	2.8
1950	1,201	583	377	226	153	124	71	49	31	20	13	13	7.8	6.0	4.6	3.7
1951	1,228	607	400	247	168	135	72	50	32	23	16	14	8.4	6.4	6.0	4.0
1952	1,285	631	420	262	181	147	79	55	35	23	18	14	8.4	6.4	5.0	4.0
1953	1,347	666	442	282	198	159	86	60	39	25	18	15	9.1	6.9	5.3	4.2
1954	1,420	775	430	310	220	177	93	65	43	28	20	16	9.7	7.4	5.7	4.6
1955	1,455	774	520	334	239	195	103	72	48	31	22	18	10.9	8.3	6.4	5.1
1956	1,483	809	557	362	258	203	114	79	53	35	24	19	11.5	8.7	6.7	5.3
1957	1,543	835	594	395	283	227	122	85	58	39	27	21	12.7	9.7	7.5	6.0
1958	1,619	887	626	428	314	251	133	92	63	42	31	22	13.3	10.1	7.8	6.2
1959	1,763	991	670	460	343	277	152	103	73	53	33	25	15.2	11.6	9.0	7.2
1960	1,934	1,060	730	506	375	308	175	120	82	60	42	28	17.0	12.9	10.0	8.0
1961	1,972	1,143	816	562	416	340	180	126	88	64	47	31	18.8	14.3	11.0	8.8
1962	2,014	1,172	879	618	459	371	216	143	100	73	50	35	21.2	16.2	12.5	10.0
1963	2,107	1,248	951	688	520	415	241	161	116	85	57	38	23.0	17.5	13.5	10.8
1964	2,152	1,337	1,010	747	581	466	288	188	140	102	67	40	24.3	18.4	14.2	11.3

(1) to (6): Anuario Estadístico de los Estados Unidos Mexicano. Dirección General de Estadística. For 1931 to 1941 the total of elementary was distributed between the six grades according to the 1942 distribution.

(7) to (9): For 1958-1964: Banco de Mexico, Departamento Estudios.

(7) for 1932-1957 assuming that the VII_t/VI_{t-1} ratio remains at 58.5 per cent for 1937-1957 (58.5 per cent is the 1958 figure).

(8) to (9) until 1957 according to Table 40.

(10) is obtained using 78.7 per cent of IX_{t-1} to get X_t: 73 per cent is the average pass rate for 1950-1960 of secondary.

(11) is obtained using 78.7 per cent of X_{t-1} to get XI_t: 78.7 per cent is the average pass rate for preparatory for 1950-1960.

(12)-(11): From 1944 to 1949 assuming $XII_t = XI_{t-1}$ and distributing the rest of the courses according to the 1960 figures of the population census.

(12)-(16): 1950-1962: Distributing Carnoy's enrollment of total university according to the 1960 distribution that appears in the 1960 census of population. See Martin Carnoy, "The Cost and Return to Schooling in Mexico" (unpublished Ph.D. Dissertation, University of Chicago, 1963).

(12)-(16): 1962-1964: Distributing Banco de Mexico's (op. cit.) total figure according to the 1960 distribution that appears in the 1960 census of population.

Extrapolated values.

TABLE 2

MEXICO: LEAVERS OF THE EDUCATIONAL SYSTEM (in thousands)

	ELEMENTARY						SECONDARY			PRE-PARATORY		UNIVERSITY				
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI (a)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1925	105.6															
1926	105.6	46.4														
1927	105.6	46.4	29													
1928	[illegible]	46.4	29	19.1												
1929	105.5	46.4	29	19.1	2.9											
1930	105.6	46.4	29	19.1	2.9	15.9										
1931	[illegible]	46.4	29	19.1	2.9	15.9	3.2									
1932	105.6	46.4	29	19.1	2.9	15.9	3.2	3.6								
1933	137.2	64.3	38.7	24.4	6.6	15.9	3.2	3.6	1.0							
1934	145.8	71.1	42.7	26.5	8.5	16.4	5.0	4.3	1.0	1.4						
1935	122.5	54.4	34.4	21.8	5.6	16.6	6.0	4.3	1.0	1.4	0					
1936	124.8	55.1	34.5	21.5	4.5	16.2	4.9	3.6	1.0	1.4	0	1.0				
1937	112.6	45.8	29.5	19.0	1.4	17.0	4	3.3	1.0	1.4	0	1.0	.5			
1938	152.5	72.2	43.2	26.7	5.7	19.9	3.7	3.3	.7	1.4	0	1.0	.5	.2		
1939	164.2	78.1	47.9	29.2	7.4	21.4	4.4	4.0	1.6	1.4	0	1	.5	.2	0	
1940	192.1	88.7	54.9	33.7	10.2	22.8	6.4	5.7	2.3	1.4	0	1	.5	.2	0	1.0
1941	164.0	67.2	51.4	34.1	5.8	23.7	5.2	4.7	1.3	1.4	-.3	-1.0	-.2	-.2	-1.0	1.0
1942	157.6	61.6	55.8	35.6	6.4	25.5	5.0	4.5	1.2	1.4	-.2	0	.7	.8	0	2.0
1943	155.8	67.7	56.0	32.9	2.0	27.8	5.8	5.4	1.5	1.4	-.2	.8	.7	.8	0	2.0
1944	211.5	117.1	71.8	43.0	8.0	30.7	12.2	5.1	1.8	1.4	-.2	1.4	.5	.3	0	2.0
1945	247.5	134.7	75.2	38.8	8.0	35.4	8.7	6.8	2.4	1.4	-.2	1.6	.4	.2	.2	2.0
1946	300.8	133.0	75.8	40.1	5.9	38.0	9.5	6.6	2.4	2.3	-.2	1.9	.5	.2	.2	2.2
1947	296.0	115.2	72.7	36.0	5.9	41.5	8.4	7.3	2.6	2.1	0	2.9	1.0	.7	.5	2.5
1948	305.4	126.7	89.1	43.9	7.0	47.7	7.1	6.0	2.0	2.3	-.2	2.3	.6	.4	.2	2.5
1949	299.9	116.0	90.8	47.9	1.0	49.6	8.8	7.7	3.3	1.5	0	3.2	1.2	.7	.6	2.8
1950	294.8	130.6	95.1	40.8	21.0	48.9	7.5	7.4	2.8	3.0	-2.5	1.4	-.3	-.4	-.3	2.8
1951	312.3	137.1	94.3	42.7	6.0	60.4	14.7	11.8	1.5	3.3	.2	3.5	1.0	.7	.4	3.7
1952	316.2	141.3	103.2	48.2	7.2	67.4	10.0	9.3	3.4	3.6	1.8	4.4	1.6	1.1	.6	4.0
1953	328.7	144.5	106.2	47.0	7.3	74.1	11.3	9.5	5.3	3.6	.9	3.7	1.1	.8	.6	4.0
1954	344.2	144.6	97.7	42.2	6.1	77.7	13.4	11.0	7.0	3.0	-.1	4.0	1.3	.8	.5	4.2
1955	350.4	153.9	106.7	51.2	7.8	82.5	14.1	15.8	8.6	4.0	.2	3.8	.9	.6	.4	4.6
1956	365.5	166.6	117.4	56.2	11.1	91.2	15.7	12.6	5.6	5.4	2.9	5.0	1.7	1.2	.8	5.1
1957	356.9	164.3	119.1	56.1	11.6	96.6	20.6	14.7	8.6	5.7	2.0	4.7	1.5	.7	.4	5.4
1958	399.6	166.5	121.3	56.5	9.2	104.6	21.4	15.8	8.8	6.0	5.2	5.9	2.0	1.4	1.0	6.0
1959	378.7	170.1	121.9	60.1	11.7	113.7	19.4	11.6	9.3	7.0	5.1	4.9	1.1	.6	.2	6.2
1960	374.1	162.2	120.3	60.8	7.2	123.4	18.6	12.8	6.0	6.1	7.2	5.9	1.6	1.0	.6	7.2
1961	422.6	198.2	121.3	59.5	9.1	146.5	36.2	23.1	11.2	9.2	8.3	6.6	1.8	1.3	.8	8.0
1962	445.3	209.7	145.3	69.0	10.1	141.3	24.4	17.1	8.0	10.4	8.6	7.2	1.6	1.1	.6	8.5
1963	484.9	169.4	138.2	60.8	12.9	153.4	38.0	16.9	7.1	11.2	8.5	9.0	2.7	1.8	1.1	10.0
1964	395.5	185.7	147.7	66.8	17.2	153.1	34.3	10.1	5.0	12.0	13.0	10.5	2.4	2.5	1.6	10.8

Note: These figures before 1940 are needed to get the educational distribution of the 1940 labor force. The figures above the line are assumed ones and we maintained them at the 1932 level, a very low one in relation to subsequent years. The explanation of this low figure for 1932 can be the depression (a phenomenon also observed in the Chilean case) therefore we decided not to decrease those figures for the years before 1932.

(a) We assume the leavers of the XVI-th grade at year t are the enrollment figure of this level at year t-1.

of the leavers of year t-n (with i years of schooling completed) that enter into the labor force in year t, namely, n years after they leave school[1] and where the process of entrance ends at the Nth year after leaving school. The values of En_{it} for the period 1940-64 and for every level of schooling appears in Table 3.

The number of people with i years of schooling that leave the labor force in any year t, Ex_{it}, were estimated in the following way: the yearly death figures by sex and age groups[2] were multiplied by the active population to total population ratio in order to obtain the exits from the labor force by sex and age group;[3] those figures were added up and classified by age-groups only,[4] thereafter multiplied by the 1960 educational distribution of the male population also classified by age groups.[5] The result is Table 4, exits from the labor force by years of schooling.

Given the values of En_{it} and Ex_{it} (Tables 3 and 4) we can derive L_{it} according to equation (37). This is shown in Table 5: columns (2) to (10) are obtained applying En_{it} and Ex_{it} to the 1960 row; column (1) is obtained residually and it is the difference between the total active population (column 11) and the sum of columns (2) to (10).

---

[1] The fact that we begin with n=0 instead of n=1 comes from the fact that part of $D_{i,t}$ really leave school at the end of t-1; see equation (38).

[2] See Appendix A, Table 33.

[3] See Appendix A, Table 34.

[4] See Appendix A, Table 35.

[5] See Appendix A, Table 36.

TABLE 3

MEXICO: GROSS ENTRANCE TO THE LABOR FORCE BY YEARS OF SCHOOLING COMPLETED (in thousands)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 or more
1940	81.1	38.2	24.5	15.9	4.1	14.2	3.6	3.3	1.3	.8	0[a]	.4	.4	.2		.8
1941	82.7	39.6	25.2	12.6	3.5	14.9	3.4	3.0	.9	.8	0[a]	0[a]	0[a]	0[a]	0[a]	.8
1942	86.8	41.5	26.7	17.7	3.8	15.0	2.7	2.9	.8	.8	0[a]	.5	.5	.6	0[a]	1.5
1943	90.2	43.1	28.1	18.4	3.1	16.0	3.5	3.3	1.[illegible]	.8	0[a]	.6	.5	.6	0[a]	1.5
1944	96.9	47.8	31.5	20.6	4.0	17.0	6.6	3.3	2.3	.8	0[a]	1.0	.4	.2	0[a]	1.5
1945	102.7	51.1	33.8	21.1	4.0	18.5	5.2	4.1	3.7	.8	0[a]	1.2	.3	.2	.2	1.5
1946	112.5	54.1	36.2	22.1	3.7	20.0	5.8	5.1	1.5	1.3	0[a]	1.4	.4	.2	.2	1.5
1947	119.6	57.1	37.6	22.2	3.5	23.6	5.6	4.8	1.6	1.2	0[a]	2.1	.8	.5	.4	1.9
1948	127.7	61.8	41.2	23.7	4.0	24.7	4.4	4.3	1.3	1.3	0[a]	1.7	.5	.3	.2	1.9
1949	134.8	63.3	43.7	25.1	2.8	26.5	5.7	4.9	2.0	1.1	0[a]	2.3	.9	.5	.5	2.2
1950	143.7	67.3	46.7	24.9	6.4	27.5	5.2	4.9	1.8	1.7	0[a]	1.0	0[a]	0[a]	0[a]	2.2
1951	154.9	70.6	49.1	25.4	4.4	31.6	7.9	11.7	1.1	1.9	.1	2.5	.7	.5	.3	2.8
1952	162.8	73.7	52.1	26.5	4.7	35.0	6.5	6.1	2.0	2.1	1.8	3.2	1.2	.8	.6	3.1
1953	171.1	76.0	54.5	27.0	4.8	38.5	7.3	6.3	2.9	2.0	.6	2.8	.8	.6	.5	3.1
1954	177.2	78.0	55.9	26.8	4.7	41.5	11.5	6.2	4.2	1.8	0[a]	3.0	1.0	.6	.4	3.2
1955	183.4	80.6	59.1	28.2	4.8	44.9	8.6	9.3	5.2	2.3	.1	2.9	.7	.5	.3	3.5
1956	187.9	84.4	61.6	29.4	5.3	49.1	9.4	8.3	3.8	3.1	1.7	3.8	1.3	.9	.6	3.9
1957	192.5	86.9	63.5	30.3	5.6	52.5	11.6	9.3	5.4	3.3	1.2	3.6	1.0	.5	.3	4.1
1958	196.7	89.2	65.7	31.2	5.5	56.8	12.2	10.0	5.7	3.6	3.1	4.5	1.5	1.1	.8	4.6
1959	201.0	92.1	67.5	33.5	6.1	61.5	12.5	8.3	1.8	4.2	3.1	3.8	.9	.5	.2	4.8
1960	207.2	93.5	69.2	33.7	5.5	66.7	12.4	8.7	3.9	3.8	1.5	4.5	1.2	.8	.5	5.6
1961	214.8	97.6	70.7	34.6	5.8	75.7	18.9	13.3	6.7	5.6	4.9	5.2	1.4	1.0	.6	6.2
1962	220.5	101.9	74.1	36.6	7.2	77.9	17.9	11.4	5.4	6.3	5.2	5.5	1.2	.9	.5	6.8
1963	224.2	102.0	75.0	36.4	6.8	84.4	21.5	11.4	4.8	6.8	5.5	5.8	2.0	1.4	.8	7.7
1964	229.0	104.9	78.0	38.0	8.0	87.5	21.3	8.3	3.7	7.4	8.0	7.9	1.8	1.9	1.2	8.3

[a]According to Table 2 those values are negative: we will assume them equal to zero.

TABLE 4

MEXICO: EXITS FROM THE LABOR FORCE (due to death) BY YEARS OF SCHOOLING (in thousands)

	No education	Elementary					Secondary			Preparatory		University					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 or more
1940[a]	32.3	5.2	12.2	11.4	7.0	3.4	11.2	.9	1.4	1.8	.6	.7	.6	.3	.2	.2	.9
1941	32.3	5.2	12.2	11.4	7.0	3.4	11.2	.9	1.4	1.8	.6	.7	.6	.3	.2	.2	9
1942	33.6	5.4	12.6	11.7	7.1	3.5	11.6	1.0	1.5	1.8	.6	.7	.6	.3	.3	.2	1 0
1943	34.0	5.4	12.6	11.8	7.2	3.5	11.6	.9	1.5	1.9	.6	.7	.6	.3	.2	.2	.9
1944	32.4	5.2	12.1	11.2	6.8	3.3	11.0	.9	1.4	1.7	.6	.7	.6	.3	.2	.2	.9
1945	32.3	5.2	12.1	11.2	6.2	3.3	11.1	.9	1.4	1.7	.6	.7	.6	.3	.2	.2	.9
1946	30.9	4.9	11.5	10.8	6.5	3.2	10.6	.9	1.3	1.7	.5	.7	.6	.3	.2	.2	.9
1947	30.0	4.8	11.3	10.4	6.4	3.2	10.3	.8	1.3	1.7	.5	.7	.6	.2	.2	.2	.8
1948	30.1	4.8	11.3	10.4	6.4	3.1	10.2	.8	1.3	1.6	.5	.7	.6	.2	.2	.2	.8
1949	30.6	4.9	11.5	10.5	6.5	3.0	10.3	.8	1.3	1.6	.5	.7	.6	.2	.2	.2	.9
1950	30.4	4.5	11.4	10.6	6.4	3.2	10.5	.9	1.3	1.7	.6	.7	.6	.3	.2	.2	.8
1951	31.2	4.8	11.6	10.8	6.6	3.3	10.7	.9	1.3	1.7	.6	.7	.6	.3	.2	.2	.8
1952	30.4	4.7	11.4	10.6	6.4	3.2	10.5	.9	1.3	1.7	.6	.7	.6	.3	.2	.2	.8
1953	30.8	4.5	11.6	10.7	6.5	3.2	10.6	.9	1.3	1.7	.6	.6	.6	.3	.2	.2	.8
1954	28.1	4.2	10.4	9.7	5.9	2.9	9.6	.8	1.3	1.5	.5	.5	.6	.2	.2	.2	.8
1955	28.0	4.2	10.4	9.7	5.9	2.9	9.6	.8	1.3	1.5	.5	.5	.6	.2	.2	.2	.8
1956	28.4	4.2	10.6	10.0	6.1	3.0	9.7	.8	1.3	1.5	.5	.6	.6	.2	.2	.2	.8
1957	29.1	4.2	10.8	10.1	6.2	3.0	9.9	.8	1.3	1.6	.5	.6	.6	.2	.2	.2	.8
1958	29.0	4.2	10.8	10.0	6.1	3.0	9.9	.8	1.3	1.6	.5	.6	.6	.2	.2	.2	.8
1959	29.1	4.2	10.8	10.1	6.2	3.0	10.1	.8	1.3	1.6	.5	.6	.6	.2	.2	.2	.8
1960	29.5	4.1	11.0	10.3	6.2	3.0	9.7	.8	1.3	1.6	.5	.6	.6	.2	.2	.2	.8
1961	28.5	4.0	10.6	9.8	5.9	3.0	9.8	.8	1.2	1.6	.5	.6	.6	.2	.2	.2	.8
1962	29.3	4.1	10.9	10.1	6.1	3.0	9.9	8	1.2	1.6	.5	.6	.6	.2	.2	.2	.8
1963	29.3	4.1	10.9	10.1	6.1	3.0	9.9	.8	1.2	1.6	.5	.6	.6	.2	.2	.2	.8
1964[a]	29.3	4.1	10.9	10.1	6.1	3.0	9.9	.8	1.2	1.5	.5	.6	.6	.2	.2	.2	.8

[a]Extrapolated.

Source: Tables 35 and 36; the exits of the age groups 5-39 and 5-44 were multiplied by the educational distribution of the males of age 15-29; the exits of the age groups 40-74 and 45-74 were multiplied by the educational distribution of the males of age 30 and over.

TABLE 5.

MEXICO: EDUCATIONAL DISTRIBUTION OF THE ACTIVE POPULATION AT THE END OF EACH YEAR
(in Thousands)

Year	0-I	II	III	IV	V	VI	VII-IX	X-XI	XII-XIV	IV and over	Active pop.	Total pop.	Act.Pop.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1940	3562	131	431	344	317	679	171	87	68	68	5858	19653	0.298[a]
	(60.80)	(2.23)	(7.36)	(5.87)	(5.42)	(11.59)	(2.92)	(1.49)	(1.16)	(1.16)			
1945	3836	292	519	404	318	704	197	84	69	69	6492	22233	0.292[b]
	(59.09)	(4.51)	(7.99)	(6.23)	(4.89)	(10.85)	(3.03)	(1.29)	(1.06)	(1.06)			
1950	4098	539	672	490	323	774	237	91	77	75	7376	25791	0.286[b]
	(55.57)	(7.31)	(9.12)	(6.64)	(4.37)	(10.49)	(3.21)	(1.23)	(1.04)	(1.02)			
1955	4123	862	891	593	331	915	315	98	94	88	8310	29679	0.280[b]
	(49.61)	(10.38)	(10.72)	(7.13)	(3.98)	(11.01)	(3.79)	(1.18)	(1.13)	(1.06)			
1960	4162	1254	1168	720	344	1152	420	122	119	108	9569	34923	0.274[b]
	(43.49)	(13.10)	(12.22)	(4.52)	(3.59)	(12.04)	(4.39)	(1.28)	(1.24)	(1.13)			
1964	4143	1617	1426	841	360	1438	610	167	152	136	10890	40415	0.269[c]
	(38.05)	(14.86)	(13.09)	(7.72)	(3.30)	(13.20)	(5.60)	(1.53)	(1.40)	(1.25)			

[a] From 1940 Population Census

[b] Interpolated arithmetically between 1940 and 1960 and then applied to the population figures in order to get the active population

[c] Secretaría de Industria y Comercio, Dirección de Muestreo; La Población económicamente activa de Mexico, 1964-1965, Tomo VII (Mexico, D.F., November, 1965).

Note: Column (1) is obtained residually except for 1960; Col. (11) is obtained through the Anuarios Estadísticos; figures in parentheses are percentages.

The main problem is the estimation of the active population for each of the benchmark years used. The 1960 census figure for the total active population cannot be used because it is grossly overestimated.[1] To solve this problem we used two benchmark figures, the one given by the 1940 Census of Population and the one given by a sample of 25,000 families taken in 1964 by the Secretaria de Industria y Comercio;[2] the ratios of active to total population were used to interpolate the other benchmark years ratios (col. 13, Table 5) and thereafter applied to the population figures in order to get the active population (col. 11, Table 5).

Table 6 shows the resulting distribution of the labor force by years of schooling for the period 1940-64.

To get the index of labor's quality we used two alternative samples of relative wages; one is Carnoy's[3] (sample 1) and the other a combination of Carnoy's and the sample from the Direccion de Muestreo (sample 2).[4] The latter one (sample 1*) combines the relative wages from 0 to 6 years of schooling from sample 2 with the relative wages from 6 to 15 and more years of schooling from sample 1.

---

[1] We concluded this after comparing the male population and the active male population by age groups; the latter is on the average approximately 4 per cent larger than the former. See pp. 100 and 434 of The VIII Censo de Poblacion, op. cit.

[2] Secretaría de Industria y Comercio, Dirección de Muestreo; La Población económicamente activa de Mexico, 1964-1965, Tomo VII (Mexico, D.F., November, 1965).

[3] Martin Carnoy, "The Cost and Return to Schooling in Mexico" (unpublished Ph.D. Dissertation, University of Chicago, 1963).

[4] Secretaría de Industria y Comercio, Direccion de Muestreo, op. cit.

The purpose of this mix is the following; sample 2 presents data on numbers of workers in given income brackets. The brackets get wider as higher incomes are approached, subjecting our estimates of mean earnings by years of schooling to serious bias. One example of this bias is the fact that estimated mean earnings for the group with ten-eleven years of schooling are higher than those for the group with twelve-fourteen years in sample 2.

On the other hand, sample 1 presents data only for 1, 4 and 6 years of primary education while sample 2 has data by single years. The bias of sample 2 is not serious in this range, as the income brackets are narrow and sample sizes large.

We have accordingly spliced data from sample 2 to those from sample 1 to generate sample 1*. In the splicing, the average wages of all years of education up to six from sample 2 were expressed as fractions of the average wage of six years of education from the same sample. Those fractions were then multiplied by the average wage of six years of schooling from sample 1 in order to generate the series 1*.

Table 6 shows the increase in the quality index with samples 1 and 1*.

Our next step is the estimation of education's contribution to Mexican growth relative to other factors. To get education's contribution we need in addition to $\dot{Q}/Q$ the values of the elasticity of output with respect to the labor input. We have used two alternative values for the share of labor through time as an estimate of this elasticity. On the other hand, to calculate the contribution of the "maintenance" factor $(\alpha \frac{\dot{L}}{EL})$

we need

$$\alpha_E = \left(\frac{\bar{w} - w_o}{Y}\right) L.$$

For 1964 w_o is 350 pesos according to the sample of the Direccion de Muestreo. Using the alternative values of 924.1 and 890.5 for $\bar{w}$ (see Table 6) we get that 62.2 per cent and 60.7 per cent of the total 1964 labor share are payments to the educational rentals embodied in the labor force. We will use 60 per cent as the value of $\frac{\alpha_E}{\alpha_L}$ for the period studied.

Table 7 summarizes the key information necessary to estimate the sources of growth of the Mexican economy and the results are shown in Table 8 for the alternatives A and B (based on different assumed factor shares). From Table 8 we can derive the percentage contributed by each factor to the growth rate of each period. The result is Table 9. From Table 9 we can see that for 1940-64 education has probably contributed between 12.7 per cent and 15.6 per cent of the growth rate, the main contribution stemming from the maintenance factor.

Improvement in the quality of the Mexican labor force due to education (the contribution of $\dot{Q}/Q$) has not played an important role in the growth process of the period 1940-64. Nevertheless, the contribution increases from a negative value of -2.2 per cent to 10.1 per cent in the period 1960-64 (Alternative B).

TABLE 6

MEXICO: LABOR QUALITY INDEX

Years of Schooling	Monthly earnings in pesos: Carnoy 1963[a] Sample 1	Dir. de M. 1964[b] Sample 2	Sample 1*	Educational distribution of the labor force in %, Source: Table 5: 1940	1945	1950	1955	1960	1964
0-1	597 (1)	365	511	60.80	59.09	55.57	49.61	43.49	38.05
2	666[c]	451	631	2.23	4.51	7.31	10.38	13.10	14.86
3	743[c]	535	749	7.36	7.99	9.12	10.72	12.22	13.09
4	827 (4)	632	885	5.87	6.23	6.64	7.13	7.52	7.72
5	995[d]	692	969	5.42	4.89	4.37	3.98	3.59	3.30
6	1196 (6)	854	1196	11.59	10.85	10.49	11.01	12.04	13.20
7-9	1612 (8)	1202	1612	2.92	3.03	3.21	3.79	4.39	5.60
10-11	2130 (11)	2390	2130	1.49	1.29	1.23	1.18	1.28	1.53
12-14	3177 (13)	1913	3177	1.16	1.06	1.04	1.13	1.24	1.40
15 & more	6305 (16)	3861	6305	1.16	1.06	1.02	1.06	1.13	1.25
1. Index of quality (Sample 1):				862.4	848.9	847.3	864.2	888.2	924.1
Percentage change per period:					-1.59	-0.18	1.99	2.77	4.05
Percentage change per year:					-0.32	-0.04	0.40	0.55	1.01
2. Index of Quality (Sample 1 adjusted)				811.7	799.3	800.2	821	850.4	890.5
Percentage change per period:					-1.55	0.11	2.67	[illegible] 5	4.70
Percentage change per year:					-0.31	0.02	0.53	0.70	1.17

[a]Refers to earnings of urban males only; number in parentheses indicates the years of schooling to which the earnings applied. Source: Carnoy, op. cit.

[b]Refers to all wage earners. Source: Dirección de Muestreo, op. cit.

[c]Interpolated logarithmically.

*Adjusted from 0 to 6 years' earnings according to Sample 2 distribution of this tail.

TABLE 7

MEXICO: GROWTH OF OUTPUT, LABOR FORCE AND QUALITY OF LABOR INDEX, 1940-1964

	(mill. of pesos of 1960)			Average growth rate of the period (in %)				Share of Capital (in %)	
	GDP (1)	Fixed reproducible capital (2)	Labor force (thousands) (3)	GDP (4)	Capital (5)	Labor force (6)	Quality of labor force (7)	Alt. A (8)	Alt. B (9)
1940	45,411	196,676	5858						
1941	50,187	199,228							
1942	55,101	200,723		7.37	1.23	2.07	-0.31	57.8	49.2
1943	57,629	201,606							
1944	61,673	203,865							
1945	64,475	209,268	6492						
1946	67,703	218,699							
1947	69,806	230,084						64.6	56.9
1948	72,701	239,382		5.84	4.23	2.60	0.02		
1949	77,040	247,504							
1950	85,409	257,464	7376						
1951	91,847	271,446							
1952	95,811	286,189						0.610	52.2
1953	95,843	299,280		6.16	4.99	2.40	0.53		
1954	105,895	312,762							
1955	114,918	328,492	8310						
1956	123,295	348,649							
1957	132,763	369,883						0.582	48.0
1958	139,828	389,042		6.31	5.64	2.85	0.70		
1959	143,981	409,376							
1960	155,867	432,274	9569						
1961	161,498	454,986							
1962	169,503	476,508		6.22	4.99	3.29	1.17	0.560	46.3
1963	180,628[a]								
1964	198,348[a]		10,891						

[a]Provisional figures from the Departamento de Estudios, Banco de Mexico

Col. (1): Source: "El producto Bruto interno de Mexico, 1939-1963." Grupo de Hacienda. Banco de Mexico, December, 1964.

Col. (2): Source: "Alternativas de estimación de la inversión bruta fija en Mexico, 1939-1962,"

Notes to Table 7 - Continued

Departmento Estudios Económicos, Banco de Mexico, May 1965.

Col. (3): From Table 5, col. (11).

Col. (7): From Table 6, Alternative 2.

Cols. (8) and (9): From Appendix A, Table 37.

TABLE 8

MEXICO: SOURCES OF GROWTH, 1940-1964

Period	Growth rate of GDP (%) (1)	Alternative A					Alternative B				
		Contribution to Yearly Growth Rate (%)									
		Capital (2)	Brute Force	Maintenance (3)*	Improved Education (4)	Residual (5)	Capital (6)	Brute Force	Maintenance (7)*	Improved Education (8)	Residual (9)
1940-45	7.37	.71	.35	.52	-.13	5.92	.61	.42	.63	-.16	5.97
1945-50	5.84	2.73	.37	.55	.01	2.18	2.41	.45	.67	.01	2.30
1950-55	6.16	3.04	.37	.56	.21	1.98	2.60	.46	.69	.25	2.16
1955-60	6.31	3.28	.48	.71	.29	1.55	2.71	.59	.89	.36	1.76
1960-64	6.22	2.79	.58	.87	.51	1.47	2.31	.71	1.06	.63	1.51

*Labor = $\alpha_L \frac{\dot{L}}{L}$.

Col. (1): From Table 7.

Col. (2): From Table 7, col. (5) by col. (8).

Col. (3): From Table 7, col. (6) by [1 - col. (8)].

Col. (5): Col. (1) - [col. (2) + col. (3) + col. (4)].

Col. (6): From Table 7, col. (5) by col. (9).

Col. (7): From Table 7, col. (6) by 1 - col. (9).

Col. (8): From Table 7, col. (7) by 1 - col. (9).

Col. (9): Col. (1) - [col. (6) + col. (7) + col. (8)].

TABLE 9

MEXICO: PERCENTAGE CONTRIBUTION OF FACTOR GROWTH TO THE GROWTH RATE

Period	Alternative A					Alternative B				
		Labor					Labor			
	K	(1)	(2)	$\dot{Q}/Q$	Residual	K	(1)	(2)	$\dot{Q}/Q$	Residual
1940-45	9.6	4.7	7.1	-1.8	80.4	8.3	5.7	8.6	-2.2	79.6
1945-50	46.7	6.3	9.5	.2	37.3	41.3	7.7	11.5	.2	39.3
1950-55	49.4	6.0	9.1	3.4	32.1	42.2	7.5	11.2	4.1	35.0
1955-60	52.0	7.5	11.3	4.6	24.6	42.9	9.4	14.1	5.7	27.9
1960-64	44.9	9.3	14.0	8.2	23.6	37.1	11.4	17.1	10.1	24.3
	40.3	6.7	10.0	2.7	40.3	34.2	8.2	12.3	3.3	42.0

(1) Brute force. (2) Maintenance

For 1940-64 growth of capital and of labor of constant quality explain approximately 55 per cent of the growth rate under both alternatives, capital's contribution being approximately two and a half and one and two-thirds of labor's contribution, for Alternatives A and B, respectively. For the period 1945-64 growth of capital and labor of constant quality explains 66.48 per cent and 63.32 per cent of the growth rate under both alternatives, capital's contribution being approximately two and two-thirds and one and three-quarters of labor's contribution. There is no doubt that physical capital accumulation has been the main variable explaining Mexico's economic growth in this period.

The aggregate contribution of improved education which appears in Table 8 (column 8) can be disaggregated by levels of schooling and it is shown in Table 10. From Table 10 we can distinguish two periods:

For 1940 to 1955 the main source is the relative increase of people with two and three years of schooling; higher levels of education (except the range 7-9 for 1950-55) did not experience increases and most of them declined. The wage differential between 0-1 and 2-3 years of schooling plays therefore an important role in explaining education's contribution in this period[1] because it is this differential that provides the weights for the change in the distribution by years of schooling.

From 1955 to 1964 in addition to increases at 2 and 3 years of education we observe similar increases for higher levels, mainly 6 and 7-9 years of schooling.

TABLE 10.

MEXICO: CONTRIBUTION OF IMPROVEMENT IN LABOR QUALITY TO THE YEARLY GROWTH BY LEVELS OF SCHOOLING (IN PERCENTAGES PER YEAR)

Years of Schooling	1940-45	1945-50	1950-55	1955-60	1960-64
0-1	-.11	-.19	-.36	-.40	-.44
2	.18	.19	.23	.22	.18
3	.06	.09	.14	.14	.10
4	.04	.04	.05	.04	.03
5	-.06	-.05	-.04	-.05	-.05
6	-.11	-.05	.07	.16	.22
7-9	-.02	.03	.11	.12	.31
10-11	-.06	-.01	-.01	.03	.09
12-14	-.04	-.01	.03	.04	.07
15 or more	-.08	-.03	.03	.06	.12
Total	-.16	.01	.25	.36	.73

Source: Appendix A, Table 38.

[1] See Appendix A, Table 38.

Summarizing, we can say that for 1940-1955 the contribution of improved education comes principally from a quantitative improvement of the educational system, namely, an increase in the low levels of schooling at expenses of people with no schooling.[1] The wage differential between people of no schooling (some of them illiterates) and with some schooling (2-3 years) plays a key role in explaining this contribution.

For 1955-1964 the improvement of the school system reflects longer average stay in school at both the elementary and secondary levels.

The importance of each individual level of schooling can also be assessed by analyzing the per capita growth of the educational capital (embodied in the members of the labor force) of a particular level of schooling. Because what we are interested in is the growth rate, any index of educational capital at constant prices can be used; for simplicity we will use Schultz' concept, namely, the accumulated expenditure per student of a given schooling;[2] in this case no discount rate is used to accumulate the costs.[3]

In Table 11, columns (6) to (10), we see the per capita growth of the educational capital at each level of schooling. As before we can see that for 1940-55 the positive growth rates are mainly on the second and third levels; for 1955 to 1964 the growth for grades 6 to 11 also become important.

---

[1] See columns (8), (11), (14), (17), and (20) of Table 38.

[2] See T. W. Schultz, "Education and Economic Growth" in Social Forces Influencing American Education, ed., N. Henry, (Chicago: National Society for the Study of Education, 1961).

[3] See Appendix A, Table 39.

TABLE 11

MEXICO: RATES OF RETURN AND ANNUAL GROWTH RATE OF EDUCATIONAL AND PHYSICAL CAPITAL

Years of Schooling	Growth of Educational Capital = $\frac{\dot{E}_i}{E_i}$ (%)					Annual Growth of Ed. Capital per head (%) = $\frac{E_i}{E_i} - \frac{\dot{L}}{L}$					Internal rate of return	
	1940-45 (1)	1945-50 (2)	1950-55 (3)	1955-60 (4)	1960-64 (5)	1940-45 (6)	1945-50 (7)	1950-55 (8)	1955-60 (9)	1960-64 (10)	Marginal (11)	Total (12)
0-1	1.53	1.37	.13	.18	-.09	-.54	-1.23	-2.27	-2.67	-3.38		
2	24.59	16.89	11.98	9.10	5.79	22.52	14.29	9.58	6.25	2.50	17.8	
3	4.08	5.89	6.53	6.21	4.72	2.01	3.29	4.13	3.36	1.13	17.8	
4	3.49	4.26	4.21	4.28	3.36	1.42	1.66	1.81	1.43	.07	17.8	17.8
5	.06	.31	.50	.79	.93	-2.01	-2.29	-1.90	-2.06	-2.36	37.3	
6	.73	1.99	3.64	5.18	4.96	-1.34	-.61	1.24	2.33	1.67	37.3	24.3
7-9	3.04	4.06	6.58	4.67	9.05	.97	1.46	4.18	1.82	5.76	24.0[a]	
10-11	-.71	1.67	1.54	4.89	7.37	-2.78	-.93	-.86	2.04	4.08	15.1[b]	22.5
12-14	.29	2.32	4.41	5.32	5.55	-1.78	-.28	2.01	2.47	2.26	14.4[c]	
15 or more	.30	1.74	3.46	4.55	5.18	-1.77	-.86	1.06	1.70	1.89	29.9[d]	21.4
Total	1.21	2.71	4.00	4.99	6.77	-.86	.11	1.60	2.14	3.48		
PHYSICAL CAPITAL	1.23	4.23	4.99	5.64	4.99						20.0	

[a] Corresponds to 7-8 years of schooling

[b] Corresponds to 9-11 years of schooling

[c] Corresponds to 12-13 years of schooling

[d] Corresponds to 14-16 years of schooling.

Col. (1) and (12) from Carnoy, op. cit., Table 62, column A.
Source: Appendix A. Table 39.

Table 11 gives some clues to explain the low contribution of improved education to growth in the earlier years, mainly 1940 to 1950. The main reason is the negative growth of the educational capital per head at the levels of higher internal rates of return, namely, 5-6 years and 15 and more years of schooling. On the other hand, those levels showed a substantial increase for the period 1950-1964 (including the 7-9 level with also a higher rate of return than the 2-4 level) and are part of the explanation of the increase in the contribution of improved education to Mexico's growth rate.[1]

The comparison of the growth rate of each kind of educational capital with physical capital together with their respective rates of return gives some light on the degree of optimality of Mexico's resource allocation in the past.

We have estimated at 20 per cent the gross return to Mexico's physical capital[2] in order to compare it with the internal rate of return to the different levels of schooling.

---

[1] We will analyze more rigorously this problem in Chapter IV.

[2] Interviews with officials of different trust funds in Mexico City convinced me that a portfolio of Mexican stocks of moderate risk yield a real return of 15 per cent. This is the net return or the relevant for private investors, meanwhile what we are interested in is the gross return or the contribution of investment to domestic gross product. We have to adjust therefore the above figure by capital's depreciation allowances, direct taxation on income from capital and indirect taxation. From the Departamento de Estudios of the Bank of Mexico we have obtained the following figures for the period 1950-64: a) Indirect taxation as a percentage of GNP: 4.6 per cent; b) Taxation on income from capital as a percentage of GDP: 2.6 per cent; c) Depreciation allowances as a percentage of the capital stock: 2.5 per cent per year. Assuming a capital share in GDP equal to .55 we get a gross return equal to

$$.19 = [.15 + .025]\,[1 + .046 + .026/.55]$$

We will use .20 as our estimate.

From Table 11 we can see that the rates of returns to completing each educational level (except the eleventh grade or preparatory) are larger than physical capital overall productivity. An appropriate policy of investment would try to increase capital formation on those levels (sixth, ninth, and fifteenth) at expenses of a lower rate of capital formation at other levels and of physical capital.

We can see that for 1940-55 the higher rate of capital formation (educational and physical) was at the 2-4 years of schooling level, one of relatively low rate of return.[1] This means that Mexico's growth rate would have been higher for this period if the composition of investment had been different, namely, emphasis on physical capital and on the completion of educational degrees.

For the period 1955-64 educational capital accumulation at the high rate of return levels increases and becomes higher than the growth rate of physical capital for the period 1960-64. At the same time the growth rate of capital in the less productive years of schooling declines, even though some of them still have a higher rate than physical capital formation.

There is no doubt that future educational policy in Mexico needs to rely on qualitative improvement, the main effort being on the completion of the educational degrees.

---

[1] See Table 11, columns (1) to (5).

Chile: 1940-1964

The purpose of this section is to repeat for Chile the analysis we did in the last section for Mexico. The methodology used to obtain the educational distribution of the labor force through time is the same except for some slight changes resulting from data differences.

For Chile we do not have data on year-end enrollment of students so we have worked instead with average yearly attendance.[1] The difference between the two measures is not significant as can be seen in years in which information for both were available. Given the above change, we have to substitute average attendance for F (in equation (38)) and "a" by the fraction that complete successfully.[2] This way we obtain the drop-outs or leavers by years of schooling completed.[3]

The entrants to the labor force by years of schooling completed are obtained again through equation (39) and are shown in Table 12. Exits of the labor force by level of schooling are shown in Table 13.

Through equation (37) we are able to obtain, for every year, the members of the labor force with specified amounts of schooling. These were estimated by applying the flows of entrants and leavers to the 1960 distribution of the labor force by years of schooling which was obtained from the 1960 population census.

---

[1] See Appendix B, Table 41.

[2] See Appendix B, Table 42.

[3] See Appendix B, Table 43.

TABLE 12

CHILE: ENTRANTS TO THE LABOR FORCE BY YEARS OF SCHOOLING (in thousands)

	Elementary						Secondary						University				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17 or more
1940	38.7	16.4	15.5	12.1	0	8.5	2.2	1.1	1.9	1.3	.8	1.9	0	.2	0	.2	.5
1941	39.6	16.6	16.2	13.5	.7	10.1	2.3	1.7	2.2	.9	.3	2.0	0	.1	-.1	.2	.7
1942	40.4	15.7	15.8	13.5	.6	10.1	1.0	1.0	1.5	.7	.1	1.7	.1	0	-.1	.2	.7
1943	40.5	16.8	17.0	15.3	1.8	11.1	1.6	1.3	1.9	-.1	-.1	2.2	.1	.1	0	.2	.6
1944	40.5	16.6	16.8	14.8	1.2	11.3	1.7	1.8	2.2	.6	.2	2.6	-.1	.2	-.1	.1	.7
1945	40.1	16.5	17.3	16.3	2.7	12.7	1.8	1.1	2.0	.9	.2	2.7	-.2	.2	-.2	-.1	.7
1946	39.5	16.6	16.8	14.7	- .1	11.9	2.0	1.6	2.6	.8	.1	3.5	.1	.2	.1	.8	.7
1947	38.4	16.8	16.2	16.3	4.6	16.3	2.4	1.8	3.1	1.1	.3	3.4	-.2	0	0	0	.7
1948	38.1	17.3	15.7	15.7	3.4	14.2	2.1	1.7	3.1	1.0	.3	4.3	.1	0	.2	0	.7
1949	37.9	17.3	14.4	15.6	2.5	15.7	2.6	2.3	3.3	.9	.5	3.9	.2	0	.1	0	.7
1950	38.4	17.6	14.6	16.4	4.4	16.5	1.9	1.6	2.9	.5	.3	4.0	-.3	.2	-.2	0	1.0
1951	39.2	17.0	12.8	13.8	1.8	15.7	2.2	1.4	2.8	.5	.2	4.6	0	.3	-.2	0	1.1
1952	38.1	17.4	14.0	18.4	5.6	17.5	5.0	3.1	4.9	1.1	.9	5.3	.1	.2	.1	.4	.9
1953	41.1	17.1	12.6	15.7	3.3	18.7	5.6	.5	1.7	.4	.7	4.2	0	.2	-.2	.2	1.1
1954	42.1	16.8	12.2	15.7	1.4	19.3	3.4	- .5	3.4	.8	.3	4.3	-.2	-.2	-.3	.2	1.1
1955	43.0	15.7	12.6	16.4	.8	22.2	3.4	- .6	3.9	1.8	1.8	5.2	-.1	-.1	-.2	.2	1.3
1956	43.6	15.5	12.3	18.2	.04	21.4	2.2	-2.5	3.9	- .9	.1	4.9	0	.3	0	.2	1.5
1957	44.6	14.9	13.3	19.2	1.4	24.3	5.3	2.7	6.5	.6	.6	5.5	-.3	-.2	-.3	.2	1.5
1958	45.3	14.7	13.0	18.8	2.9	21.8	5.6	3.3	4.5	1.1	1.0	6.6	.2	.2	.2	.4	1.7
1959	45.9	14.4	12.4	18.9	4.1	23.2	6.0	2.4	6.6	1.1	1.2	6.5	.2	-.1	0	.4	1.7
1960	46.0	13.9	12.0	18.5	4.9	25.1	6.4	2.7	5.0	1.3	1.4	6.8	.1	.2	.2	.7	1.7
1961	45.9	13.3	11.0	18.0	5.5	27.2	6.7	2.8	5.2	1.3	1.5	6.9	.2	.4	.6	.7	1.8
1962	46.0	13.0	10.9	21.1	8.6	29.8	7.4	3.4	5.5	2.5	2.6	7.8	.4	.4	-.4	.4	2.0
1963	45.1	12.3	8.6	19.5	4.9	28.6	7.1	2.6	5.0	2.2	1.7	6.0	.1	.2	.3	.9	1.9
1964	43.7	12.2	8.5	22.2	6.6	32.6	9.3	3.9	6.5	3.1	2.3	7.1	.4	.3	.4	.6	2.3

Source: Tables 43 and 44.

TABLE 13

CHILE: EXIT FROM THE LABOR FORCE BY YEARS OF SCHOOLING (in thousands)

	ELEMENTARY							SECONDARY						UNIVERSITY				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1941	5.09	.69	1.91	3.13	3.21	1.75	4.74	.97	1.10	1.18	1.05	.60	1.16	.10	.06	.06	.12	.36
1942	5.32	.72	1.99	3.28	3.36	1.83	4.96	1.01	1.15	1.24	1.09	.62	1.22	.11	.06	.07	.12	.37
1943	5.21	.71	1.96	3.21	3.29	1.79	4.85	.99	1.13	1.21	1.07	.61	1.19	.11	.06	.06	.12	.36
1944	5.57	.76	2.09	3.43	3.51	1.91	5.18	1.06	1.21	1.30	1.15	.65	1.27	.11	.06	.07	.13	.39
1945	5.91	.80	2.22	3.64	3.71	2.02	5.48	1.12	1.28	1.57	1.20	.69	1.34	.12	.06	.07	.13	.41
1946	5.35	.72	2.01	3.30	3.37	1.84	4.96	1.01	1.16	1.24	1.09	.62	1.21	.11	.06	.07	.12	.38
1947	5.07	.69	1.91	3.12	3.20	1.74	4.72	.96	1.10	1.18	1.04	.59	1.16	.10	.06	.06	.12	.36
1948	5.41	.74	2.03	3.33	3.41	1.85	5.03	1.03	1.17	1.26	1.11	.63	1.24	.11	.06	.07	.12	.38
1949	5.70	.78	2.14	3.51	3.59	1.95	5.39	1.08	1.24	1.39	1.16	.67	1.29	.12	.06	.07	.13	.40
1950	5.27	.72	1.99	3.24	3.31	1.80	4.87	.99	1.13	1.22	1.07	.61	1.19	.11	.06	.07	.11	.37
1951	5.37	.73	2.02	3.30	3.38	1.83	4.98	1.02	1.16	1.25	1.10	.62	1.22	.11	.06	.07	.12	.37
1952	4.59	.62	1.72	2.82	2.89	1.57	4.26	.87	.99	1.06	.94	.54	1.05	.10	.05	.06	.10	.32
1953	4.56	.62	1.71	2.81	2.87	1.56	4.23	.87	.99	1.05	.93	.53	1.04	.10	.05	.06	.10	.32
1954	4.69	.64	1.77	2.89	2.95	1.60	4.34	.89	1.01	1.08	.95	.54	1.06	.10	.05	.06	.10	.32
1955	4.73	.65	1.79	2.92	2.97	1.62	4.38	.90	1.03	1.09	.96	.55	1.06	.10	.05	.05	.11	.33
1956	4.81	.66	1.81	2.96	3.03	1.64	4.45	.91	1.04	1.11	.98	.56	1.09	.10	.05	.05	.11	.33
1957	4.81	.65	1.81	2.96	3.02	1.64	4.45	.91	1.04	1.11	.98	.56	1.09	.10	.05	.06	.11	.34
1958	4.75	.65	1.79	2.92	2.99	1.62	4.39	.90	1.02	1.09	.96	.56	1.08	.10	.05	.05	.11	.34
1959	5.30	.73	1.99	3.27	3.34	1.80	4.90	1.01	1.14	1.23	1.08	.61	1.19	.11	.06	.07	.11	.37
1960	5.01	.68	1.89	3.09	3.15	1.70	4.44	.95	1.09	1.15	1.02	.58	1.13	.11	.06	.06	.11	.35
1961	5.14	.70	1.94	3.16	3.23	1.75	4.74	.97	1.11	1.19	1.04	.60	1.15	.11	.06	.07	.11	.36
1962	5.36	.73	2.03	3.30	3.37	1.82	4.95	1.01	1.16	1.28	1.08	.62	1.19	.11	.06	.07	.12	.38
1963	5.86	.80	2.21	3.61	3.68	1.99	5.41	1.11	1.27	1.35	1.19	.68	1.32	.12	.07	.07	.12	.41
1964	5.42	.73	2.05	3.33	3.40	1.84	5.00	1.02	1.17	1.25	1.09	.63	1.21	.11	.06	.07	.12	.38

Source: Multiplying exits from the labor force by sex (col. (15) and (16) of Table 49) by the education distribution of the labor force by sex (Table 50).

TABLE 14

CHILE: LABOR'S QUALITY INDEX

Years of Schooling	Monthly earnings by years of schooling: Sample 1 (esc.1964) (1)	Sample 2 (esc.1965) (2)	Educational distribution of the labor force (in %): 1940 (3)	1945 (4)	1950 (5)	1955 (6)	1960 (7)	1964 (8)
0	54.9	E°258.3						
1	61.2	228.0	53.49	48.86	43.29	37.00	28.08	20.64
2	68.7	237.2						
3	74.0	270.5	2.79	6.05	8.49	10.04	11.46	11.73
4	88.1	272.1	1.14	4.00	6.64	9.01	11.76	13.65
5	87.0	255.5	7.81	7.26	6.92	6.60	6.43	6.74
6	101.4	286.3	9.85	10.59	12.08	14.32	17.40	20.15
7	110.6	263.7	2.34	2.26	2.35	2.84	3.55	4.36
8	141.1	357.7	5.25	4.86	4.60	4.19	4.04	4.10
9	148.8	492.7	3.45	3.33	3.47	3.69	4.36	4.79
10	151.7	529.2	5.64	5.02	4.54	4.17	3.85	3.79
11	194.0	657.9	3.10	2.71	2.40	2.27	2.19	2.27
12	268.4	730.0	2.42	2.47	2.89	3.47	4.30	4.93
13								
14	900.6[b]	1523.5[c]	1.72	1.58	1.34	1.29	1.26	1.36
15								
16								
17 & more	1532.9[a]	2317[a]	1.01	1.00	1.00	1.10	1.31	1.49
Index of quality: sample 1:			119.7	118.3	117.8	121.3	128.5	135.8
Index of quality: sample 2:			340.2	336.9	336.2	342.0	354.3	366.8

[a]This figure is the simple average of the mean income of agronomists and commercial engineers obtained by two studies: (a) Jorge Matetic, "Educación agropecuaria en Chile," Escuela de Agronomía, Universidad Católica de Chile, 1966. (6) Hermán Ovalle, "Ingresos de Ingenieros Comerciales"; Escuela de Economía, Universidad Católica de Chile, 1967; it excludes those that work in family-owned enterprises.

[b]The midpoint between 268.4 and 1532.9.

[c]The midpoint between 730.3 and 2317.0.

Table 14 shows the educational distribution of the Chilean labor force for 6 years of the period 1940-1964. It also shows two alternative sets of wages according to years of schooling. Sample 1 (column (1)) is based on a set of 2020 observations of urban male wage earners of five southern provinces, Curico, Colchagua, Talca, Linares and Maule. This sample was carried out in 1964 by the Centro de Planificacion Economica of the Universidad de Chile.[1]

Sample 2 was carried out by the Centro de Investigaciones Economicas of the Universidad Catolica de Chile and covers 2540 workers and employees (except self-employed workers) of both sexes from the city of Santiago.[2]

Table 15 shows the annual increase in labor's quality due to education with both sets of wage data:

TABLE 15

YEARLY INCREASE IN LABOR's QUALITY DUE TO EDUCATION
(in percentages)

	1940-45	1945-50	1950-55	1955-60	1960-64
(1) Sample 1	-.24	-.08	.59	1.19	1.42
(2) Sample 2	-.20	-.04	.35	.72	.88

Source: Table 14.

[1] "Encuesta Nivel de Vida," Centro de Planificación Económica, Universidad de Chile, 1964. I have to thank Mr. Abraham Nahmias who kindly made available to me this information.

[2] There are significant differences in the overall level of wages of both samples. However, for our purpose we are interested only in the relative wages by level of schooling, therefore no explanation for this difference is made in this study.

Sample 1 gives a larger estimate for all periods and the main reason is the larger wage variance it has for the first 6 years of schooling, levels for which the distribution of the labor force had important changes.

We will use the sample 1 estimate for the change in labor's quality having in mind that it is a reasonable upper limit of this value.[1]

For estimating the contribution of the "maintenance" factor ($\alpha_E \frac{\dot{L}}{L}$) we need to know the relative wage of individuals with no schooling ($w_o/\bar{w}$).

I have chosen sample 1 in order to obtain this figure. The reason is that sample 2 probably overstate the value of w_o. If we look at Table 14 [column (2)] we can see that there is almost no wage differential between w_o and the wages of the consecutive 5 years of schooling. One reason may be the higher degree of unionization and the bigger effectiveness of minimum wage legislation in the city of Santiago than in the other provinces.

w_o is E^o 54.9 for 1964 and the average wage in the labor force, according to sample 1, for 1964, is E^o 135.8. $\frac{w_o}{\bar{w}}$ is therefore 40 per cent almost exactly equal to the value obtained for Mexico.

Table 16 shows the contribution of each productive factor to the growth rate.

---

[1] We did not make any "sample mix" as in the case of Mexico. The reason is that the upper tail of both wage distribution have more or less the same variance so the use of sample 1 is a good approximation to such a mix.

The most interesting feature of the Chilean figure is that the total contribution of education ($\alpha_E \frac{\dot{L}}{L} + \alpha_L \frac{\dot{Q}}{Q}$) for the period 1940-1964 (20.59 per cent) is higher than that of any of the other factors specifically identified, and almost double that of physical capital. For the same period approximately two-thirds of education's contribution is represented by the "maintenance" factor.

TABLE 16

CHILE: SOURCES OF GROWTH, 1940-1964. (FIGURES IN PARENTHESES REPRESENT THE PERCENTAGE CONTRIBUTION OF EACH FACTOR TO THE GROWTH RATE)

Period	Growth rate of output (1)	Capital (2)	Labor: Brute force (3)	Labor: Maintenance (3)	Improved education (4)	Residual (5)
1940-45	3.20	.12 (3.75)	.36 (11.25)	.54 (16.88)	-.12 (-3.75)	2.30 (71.87)
1945-50	3.58	.55 (15.36)	.36 (10.06)	.54 (15.08)	-.04 (-1.12)	2.17 (60.62)
1950-55	3.76	.33 (8.78)	.32 (8.51)	.48 (12.77)	.30 (7.98)	2.33 (61.96)
1955-60	3.78	.31 (9.45)	.29 (8.90)	.44 (13.36)	.60 (18.29)	1.64 (50.00)
1960-64	5.15[a]	.95[b] (18.44)	.33[c] (6.37)	.49[c] (9.55)	.71 (13.79)	2.67 (51.85)
	3.73	.43 (11.53)	.33 (8.90)	.50 (13.35)	.27 (7.24)	2.20 (58.98)

Source: A. C. Harberger and M. Selowsky, "Key Factors in the Economic Growth of Chile", paper presented at the Next Decade in Latin American Development, Conference at Cornell University, April 1966; to be published by Cornell University.

(continued on page 53)

Capital's contribution has been half of the contribution of labor of constant quality even though it becomes almost 20 per cent larger for the period 1960-64 (18.44 per cent for capital and 15.92 per cent for labor of constant quality).

Capital and labor of constant quality never explain more than 40 per cent of the growth rate (only 40.50 per cent for 1945-50) and for the entire period their contribution is 33.78 per cent.

The overall contribution of improved education which appears in column (4) can be disaggregated by levels of schooling: this is shown in Table 17. The pattern is very similar to Mexico's namely, that for the earlier periods (1940-50) the positive contribution comes mainly from increases in the low levels of schooling (3 and 4 years) at expenses of the group 0-2; again the wage differential between those levels (literates and illiterates?) is crucial in explaining the magnitude of the contribution.[1]

---

[a] "Cuentas Nacionales de Chile, 1960-65" Oficina de Planificacion Nacional.

[b] From the gross investment-GDP ratio we subtract .8 to get the net ratio; this ratio was multiplied by .15 or the marginal productivity of capital. Both values were obtained from Harberger and Selowsky, op. cit.

[c] We used .015, .016, .017, and .018 for the growth rate of labor for 1960, 1961, 1962, and 1963; see Appendix B, Table 51.

Column (4) $= \frac{\dot{Q}}{Q}\ \alpha_L$: $\frac{\dot{Q}}{Q}$ is obtained from Table 15: α_L is .5 according to Harberger and Selowsky, op. cit.

[1] It is interesting to analyze the error in $\dot{Q}/Q$ of adding individuals with 0, 1, and 2 years of schooling into a single group to which an overall wage w_1 is imputed.

The true contribution of this group to $\dot{Q}/Q$ is

For later periods higher levels become dominant in a stronger way than in Mexico's case and they get particularly important at years of schooling that reflect end-of-school levels. Increases in the sixth, twelfth, and seventeenth grades account for almost all of the contribution of $\frac{\dot{Q}}{Q}$ to growth.

Table 18 shows the growth rate of educational and physical capital[1] and their respective rates of return. The internal rate of return to education was obtained with the help of two studies, one by Raul Yver on costs of education in Chile[2] and the other through the age-earnings profiles of urban males given by the "Encuesta Nivel de Vida" (see Appendix B, section "Estimation of the Internal Rate of Return to Education.")

$\frac{w_o}{\bar{w}} \dot{a}_o + \frac{w_1}{\bar{w}} \dot{a}_1 + \frac{w_2}{\bar{w}} \dot{a}_2$ and the estimated is $\frac{w_1}{\bar{w}} [\dot{a}_o + \dot{a}_1 + \dot{a}_2]$ so the difference between the estimated and the true one is:

$$\frac{w_1 - w_o}{\bar{w}} \dot{a}_o - \frac{w_2 - w_1}{\bar{w}} \dot{a}_2 .$$

[1] There are no direct data for the growth rate of physical capital in Chile so we estimated it through the identity $\dot{K}/K = \dot{K}/Y \cdot Y/K$; data for $\dot{K}/Y$ comes from Harberger and Selowsky, op. cit. and we assumed for K/Y a value equal to 4 which is an upper limit for it [in Harberger and Selowsky this estimate was 3.3].

[2] Raul Yver, "The Costs of Education in Chile" (Universidad Catolica de Chile, 1959). (mimeographed)

We can see again that for 1940-55 the educational capital (per head) embodied in the third and fourth level of schooling is the one of the highest growth; the low contribution to growth of those levels in relation to the huge growth of their embodied capital (25.62 per cent and 55.05 per cent for 1940-55) and also relatively high internal rate of return is explained by the low proportion of this capital in total educational capital (1.8 per cent for 1940).[1]

For later years the growth rates of the capital embodied in the sixth, twelfth and seventeenth levels become the most important ones, these being the ones with the highest (marginal) rate of return (except the seventeenth year for which we do not have data). This accounts for the increase in education's contribution in the period 1955-64.

One of the most interesting characteristics of the Chilean case is the fact that total educational capital has been growing at a faster rate than physical capital including all the levels of education with higher marginal rates than physical capital's. From this point of view allocation of investment between both kinds of capital has been successful.

From the point of view of future policy we can say that the only investments in education which clearly appear better than the ones in physical capital are those that tend to complete

---

[1] See Appendix B, Table 43.

TABLE 17

CHILE: CONTRIBUTION OF IMPROVED EDUCATION TO THE YEARLY GROWTH BY LEVELS OF SCHOOLING
(in % per year)

Years of Schooling	1940-45	1945-50	1950-55	1955-60	1960-64
0-2	-.25	-.29	-.33	-.45	-.44
3	.20	.15	.10	.09	.02
4	.21	.20	.18	.20	.16
5	-.04	-.03	-.02	-.01	.03
6	.06	.13	.19	.26	.27
7	-.01	.01	.05	.07	.08
8	-.04	-.03	-.05	-.02	.01
9	-.01	.02	.03	.08	.06
10	-.08	-.06	-.05	-.04	-.01
11	-.06	-.05	-.02	-.01	.02
12	.01	.09	.13	.18	.16
13-16	-.10	-.18	-.04	-.02	.08
17 or more	-.01	0	.13	.27	.27
Total	-.12	-.04	.30	.60	.72

Source: Appendix B, Table 42.

TABLE 18

CHILE: RATES OF RETURN AND ANNUAL GROWTH RATE OF EDUCATIONAL AND PHYSICAL CAPITAL

Years of Schooling	Growth of education capital = $\frac{\dot{E}_i}{E_i}$ (in %)					Growth of educational capital = $\frac{\dot{e}}{e}$ (per head (in %)					Internal rate of return (1964)	
	1940-45	1945-50	1950-55	1955-60	1960-64	1940-45	1945-50	1950-55	1955-60	1960-64	Marginal	Total
0-2	-.03	-.65	-1.61	-4.90	-5.48	-1.83	-2.45	-3.21	-6.36	-7.12	7.7[a]	7.7[a]
3	27.42	10.67	5.62	4.23	1.87	25.62	8.87	4.02	2.77	.23		
4	56.86	16.24	9.40	7.71	4.78	55.06	14.44	7.80	6.25	3.14	19.1	13.4
5	.16	.86	.65	.67	2.38	-1.64	-.94	-.95	-.79	.74		
6	3.52	4.94	5.67	5.80	4.73	1.72	3.14	4.07	4.34	3.09	24.8	17.2
7	1.08	2.75	6.15	6.55	6.23	-.62	.95	4.55	5.09	4.59		
8	1.80	.69	-.27	.51	1.64	0	-1.11	-1.87	-.95	0	12.4	16.0
9	1.10	2.81	3.04	5.03	3.48	-.79	1.01	1.44	3.57	1.84		
10	-.52	-.25	-.11	-.41	1.02	-2.32	-2.05	-1.71	-1.87	-.62		
11	-.98	-.64	.52	.51	2.14	-2.78	-2.44	-2.12	-.95	.50		
12	2.38	5.53	6.03	6.33	4.46	.58	3.73	4.43	4.87	2.82	22.9[c]	15.25
13-16	.07	-1.58	.94	.76	2.88	-1.73	-3.33	-.66	-.70	1.24		
17 or more	.47	1.90	3.75	5.18	4.37	-1.33	.10	2.15	3.72	2.73		
Physical Capital[b]	.64	1.32	.84	.92	2.8						.15	

Source: Appendix B, Table 43.

[a]Corresponds to the rate of return to two years of schooling.

[b]From Harberger and Selowsky, op. cit.

[c]Corresponds to the rate of return of 12 years of schooling over 10 years.

the fourth year and the elementary and secondary level. In other words, what is desirable is the completion of those grades by people that are already in the school system.

If the choice is an overall increase in investment in education (which includes new entrants to school) relative to physical capital the answer is not clear; for answering this question the total internal rates of return to education are relevant and those are not much different from the marginal productivity of physical capital.

India: 1950-1960

For the purpose of estimating education's contribution to the growth rate of India we have constructed the labor quality index, Q, in the following way:

study by Nalla Gounden provides for 1961 age-earnings profiles for male workers by educational attainment.[1] The 1961 census provides the age distribution of the population by educational attainment. These two pieces of information allow us to get the average wages of persons with different amounts of schooling (w_i).

Table 19 shows the earnings of males by age and educational level. Table 20 shows the distribution of the male population by age-group and educational level; we have used the male distribution instead of the population distribution because we think it is a better index of the labor force distribution.

---

[1] Nalla Gounden, "Education and Economic Development" (unpublished Ph.D. Dissertation, Kurukshetra University, India, November, 1965).

From Tables 19 and 20 we get the following average earnings in Rs. of 1961:

Illiterates	Rs.	767
Literates	Rs.	1037
Primary	Rs.	1102
Metric	Rs.	2247
Bachelor's Degree	Rs.	3988
Engineering Degree	Rs.	8257

The next information we need to construct the labor quality index is the distribution of the labor force by educational levels. This is shown in Table 21 for 1950-51 and 1960-61.

From the earlier information on average wages (w_i) and from Table 21 we get Q for 1950-51 and 1960-61.

	1950-51	1960-61
$Q = \sum_i w_i a_i$	886.6	890.8

The value of $\dot{Q}/Q$ for the decade is .47 per cent.

For estimating the contribution of the "maintenance" factor we need to know what fraction of the observed share of labor represents the rent of the educational inputs embodied in the labor force. This fraction, as we saw in the cases of Mexico and Chile, is $\frac{\alpha E}{\alpha_L} = [\, 1 - \frac{w_o}{\bar{w}} \,]$.

TABLE 19

INDIA: AVERAGE ANNUAL INCOME OF MALES BY LEVEL OF EDUCATION AND AGE, 1961 (in Rupees)

Age	Illiterates	Literates[a]	Primary	Metric	Bachelor's Degree	Engineering Degree
17	355	359	410			
22	475	645	824	1453		
27	782	900	1390	1987	2803	4346
32	850	1203	1500	2565	4049	5806
40	1200	1750	1850	2977	4757	8856
50	744	1133	1466	3170	5386	12564
60	650	800	964	2069	2154	15192

Source: Nalla Gounden, "Education and Economic Development," (unpublished Ph.D. Dissertation, Kurukshetra University, India, November, 1965).

[a]Without formal education.

TABLE 20

INDIA: DISTRIBUTION OF THE MALE POPULATION BY EDUCATIONAL LEVEL AND AGE GROUPS (in percentage)

Age	Illiterates (1)	Literates (2)	Primary (3)	Metric[a] (4)[b]	Bachelor's Degree[b] (5)	Technical Degree[b] (6)
15-19	11.41	13.19	26.74			
20-24	11.69	13.70	17.50	30.46		
25-29	13.69	14.25	13.68	19.45	28.49	26.43
30-34	12.02	17.55	10.69	13.63	20.93	21.61
35-44	20.08	20.18	15.45	18.53	25.16	23.33
45-59	20.21	17.86	11.66	13.30	18.50	21.37
60 +	11.20	8.27	4.28	4.63	6.92	7.26

Source: Census of India, 1961, Vol. I, Part II-C (i)

[a] Metric plus Technical and Non-technical Degree

[b] Columns (4) to (6) refer to the urban sector

TABLE 21

INDIA: ACTIVE POPULATION BY YEARS OF SCHOOLING
(in thousands)

Degree	1950-61[a]	1960-61[b]
Illiterates	101319 (71.85)%	136797 (72.76)%
Literates	27408 (19.44)%	32290 (17.17)%
Primary	8950 (6.35)%	13750 (7.31)%
Metric	2647 (1.88)%	4130 (2.19)%
Technical diploma	60 (0.04)%	74 (0.04)%
Non-technical diploma	84 (0.06)%	122 (0.06)%
Degree holder	391 (0.28)%	636 (0.34)%
Technical degree holder	141 (0.10)%	201 (0.11)%
	141000	188000

[a]Calculated back from the 1961 Census througn inflows and outflows; Gounden, op. cit.

[b]From the 1961 Census.

We will use the 1961 earnings of illiterates (Rs. 767) for w_o. For $\bar{w}$ we will also use the 1961 figures (Rs. 890.8). This gives us $\frac{w_o}{\bar{w}} = .86$ which means that only 14 per cent of labor's share represents payments to educational inputs. (Recall that this figure was approximately 40 per cent for Mexico and Chile.)

Our next step is the estimation of the share of labor and capital: the ratio of total tangible wealth (including land) to output is 3.7 and 3.6 for 1950 and 1960 respectively.[1] Harberger's estimates for the gross marginal productivity of capital in the corporate sector in India suggest that values of less than 15 per cent are rather implausible.[2] Using 3.7 and 15 per cent for the capital-output ratio and capital's rate of return we get a share of capital on output equal to 55 per cent.

On the other hand, separate studies suggest that wages and salaries represent 30 per cent, and that the incomes of self-employed (mainly agriculture) account for 46 per cent of national income.[3] Having in mind that Indian agriculture

---

[1] "Estimates of Tangible Wealth in India," Reserve Bank of India Bulletin, January, 1963.

[2] Arnold C. Harberger, "Investment in Man vs. Investment in Machines: The Case of India," paper presented at the Conference on Education and Economic Development, University of Chicago, April, 1963.

[3] M. Mukherjee, "On the Available Estimates of the Breakdown of National Income by Distributive Shares in India," in Papers on National Income and Allied Topics, ed. V. K. Rao, (London: Asia Publishing House, 1962).

is quite labor intensive we will assume that between one-half and two-thirds of this self-employed income is labor payments. This procedure gives us 53 per cent to 61 per cent as a plausible range for the share of labor in output.

We will use our earlier estimate of 55 per cent for our calculations. Table 22 shows the sources of growth of the Indian economy for the period 1950-1960.

TABLE 22

INDIA: SOURCES OF GROWTH, 1950-1960.
(Figures in parentheses represent the percentage contribution of each factor to the growth rate.)

	Output	Capital	Labor		Improved education	Residual
			Brute force	Maint.		
	(1)	(2)	(3)		(4)	(5)
Growth rate	44.3[a]	34.1[b]	33.3[c]			
Contribution to growth		15.34 (34.6)	15.75 (35.5)	2.56 (5.8)	.26 (.6)	10.39 (23.5)

[a] M. Mukherjee, "Estimates of Tangible Wealth," in Papers on National Income and Allied Topics, ed. V.K. Rao, (London: Asia Publishing House, 1962).

[b] Ibid.

[c] Gounden, op. cit.

From Table 22 we can see that almost three-quarters of the Indian growth is explained by the growth of physical capital and brute force, the total contribution of education being small and concentrated almost completely in the "maintenance" factor. In other words, most of the growth of India is explained by conventional inputs, the residual being relatively small.

To appreciate more fully the role of education in India we have constructed Table 23 which shows the growth rate of the educational capital embodied in the members of the labor force of different schooling.

For the same purpose we have recalculated Gounden's internal rates of return to education. The reason is that Gounden makes the assumption that half of the wage differential between workers of different years of schooling (given age and sex) is due to the effect of education itself, the rest due to other non-specified factors. There is no doubt that there can be other elements influencing this differential (I.Q., father's occupation, etc.,), but to make an "a priori" judgment on their order of magnitude does not give us any better information; on the other hand, most studies relating to other countries attribute all the differential to the effect of education. For comparability, we have recalculated Gounden's rates of return under this last assumption.

Given the age-earnings profiles[1] (including costs) we

---

[1] See Gounden, op. cit., and Appendix C, Figure 9.

have obtained the marginal and total internal rates of return to education [1] (Table 24).

The low contribution of education in India can be explained in several ways. From Table 21 we can see that the change in the educational distribution of the labor force is almost negligible. This can also be seen in a capital accumulation framework: the increment in the educational capital embodied in the labor force was only Cr. 1349.9 (see Table 23), as against approximately Cr. 13. 000 for physical capital during the period 1950-1960. In other words, the net investment in physical capital has been ten times that in educational capital.

An important reason is also the composition of the investment in education. The educational capital embodied in literates (with 2 years of schooling) has one of the highest rates of return but nevertheless exhibits the lowest growth rate. Furthermore, the growth rate of this educational capital is lower than the growth rate of the labor force (33.3 per cent) so on a per capita basis has a negative contribution to growth.

We can conclude that future investment policy of India has to emphasize investment in low levels of schooling (the ones enough to become a literate) even if it comes at the expense of investment of physical capital or investment at higher levels of schooling, both with lower rates of return.

---

[1] By total we mean the return to reaching any level of schooling in relation to 0 years of schooling.

TABLE 23

INDIA: EDUCATIONAL CAPITAL EMBODIED IN THE LABOR FORCE
(in Rupees of 1960)

Degree	Years of schooling	1950-51	1960-61	Growth rate (%)
Literates	2[a]	361.8	426.2	17.80
Primary	7	823.4	1265.0	53.63
Metric	11	819.2	1278.2	56.03
Technical diploma	11	25.0	9	23.60
Non-techical diploma	11	23.0	33.4	45.21
Degree holder	15	402.1	654.1	62.67
Technical degree holder	17	274.1	390.7	42.53
Total		2728.6	4078.5	49.47

Source: Gounden, op. cit.

[a]For the members of the labor force that were classified as "literates" without information on formal schooling, Gounden imputed two years of schooling.

TABLE 24

INDIA: MARGINAL AND TOTAL (SOCIAL) INTERNAL RATES OF RETURN TO EDUCATION

Years of Schooling	Internal Rates of Return: Marginal (1)	Internal Rates of Return: Total (2)
2	23.5	23.5
5	23.5	21.2[a]
8	17.7	19.9
11	16.4	18.9
15	11.6	16.2
17	14.7	16.0

[a]This figure is not equal to the weighted average of the marginals because we assumed that people with 5 years of schooling enter the labor force at the same age of those with 2 years. The reason was that no earnings were observed for individuals with less than 11 years of age.

CHAPTER IV

INTERNATIONAL COMPARISON AND CONCLUSIONS

a) One of the purposes of this chapter is an attempt to compare cross-country differences both in the magnitude and in the trend of education's contribution to the growth rate.

Earlier works on these comparisons have been made only for more developed countries and have dealt with only the $\frac{\dot{Q}}{Q}$ component, neglecting the contribution of $\alpha_E \frac{\dot{L}}{L}$ or the "maintenance" factor. The question now is how does education's contribution differ between countries of sharply different per capita incomes, and how does the relative importance of the "maintenance" factor vary among them.

Table 25 summarizes this information for eight European countries, the U.S. and the three countries studied.

We have calculated $\alpha_E \frac{\dot{L}}{L}$ for the U.S. in the following way. We have used for w_o the average earnings of individuals of the

group 0-4 years of schooling.[1] The value of $\frac{w_o}{\bar{w}}$ calculated in this way comes from the study by Griliches and Jorgenson on the sources of productivity change for the U.S. economy.[2] This value is .50, .52, .45, .41, and .50 for the years 1939, 1949, 1956, 1958, and 1959. Given that the estimated w_o is an overstatement of the true w_o we will use .4 as the value of $\frac{w_o}{\bar{w}}$.

According to the Bureau of Labor Statistics the growth rate of the private man-hours index for 1940-1962 was .9 per cent per year. Using a labor share equal to 72 per cent, we get $\alpha_E \frac{\dot{L}}{L} = \alpha_L \left(1 - \frac{w_o}{\bar{w}}\right) \frac{\dot{L}}{L} = .004$.

In other words, .4 per cent per year is the contribution of education to growth that comes from the "maintenance" factor and it represents approximately 10 per cent of the yearly growth rate (3.9 per cent) of that period.

---

[1] Earnings data for persons reporting zero years of schooling are available, but the reported demographic characteristics of this group differ so much from those of the general population that the reported earnings figure is of dubious quality for present purposes.

[2] Dale Jorgenson and Zvi Griliches, "The Explanation of Productivity Changes," Report 6715 (University of Chicago: Center for Mathematical Studies in Business and Economics, 1967), Table 7.

TABLE 25

GROWTH CONTRIBUTIONS EXPRESSED AS A FRACTION OF THE OBSERVED GROWTH RATE

		Source		
		$\alpha_L \frac{\dot{Q}}{Q}$	$\alpha_E \frac{\dot{L}}{L}$	Total
(1)	United States	.15	.10[a]	.25
(2)	Belgium	.13		
(3)	Denmark	.04		
(4)	France	.06		
(5)	Germany	.02		
(6)	Netherlands	.05		
(7)	Norway	.07		
(8)	United Kingdom	.13		
(9)	Italy	.07		
(10)	Greece (1951-1961)	.03		
(11)	Mexico (1950-1964)	.06	.14	.20
(12)	Chile (1950-1964)	.13	.12	.25
(13)	India (1950-1960)	.006	.058	.06

[a] See text of this study, pp. 67-70.

(1) to (9): E. Denison and J. P. Poullier, Why Growth Rates Differ: Postwar Experience in Nine Western Countries. (Forthcoming). Data refer to the period 1950-1962.

(10): Samuel Bowles, Sources of Growth in the Greek Economy, 1951-1961. Economic Development Series, Memorandum No. 27, Center for International Affairs, Harvard University.

(11): From Table 9, Alternative B.

(12): From Table 16.

(13): From Table 22.

From Table 25 we can see that for the U.S. (1950-62) and Chile (1950-64) education explains 25 per cent of the growth rate. For Mexico the corresponding value is 20 per cent and for India 6 per cent.

We can now see the magnitude of the bias in using $\alpha_L \frac{\dot{Q}}{Q}$ as the measurement of the contribution of education to growth: the true contribution of education ranges from one and two-thirds time (U.S.) to ten times (India) the contribution measured by the $\frac{\dot{Q}}{Q}$ index. Obviously the bias tends to be bigger, the bigger the growth rate of the labor force and one of the main characteristics of the Indian economy was a high rate of growth of the labor force.

From Table 25 it is not clear whether the degree of development is related to the magnitude of education's contribution to growth; further information is needed, mainly the movement of the contribution through time.

A more complete study of the role of improvements in labor quality due to education on the U.S. growth rate through time is the one by Jorgenson and Griliches.[1]

Table 26 shows the contribution of the Q index or improved education to growth by periods for the U.S., Mexico, and Chile.

---

[1] Jorgenson and Griliches, op. cit.

TABLE 26

ANNUAL INCREASE IN LABOR QUALITY DUE TO EDUCATION ($\dot{Q}/Q$) AND ITS CONTRIBUTION TO GROWTH: UNITED STATES, MEXICO AND CHILE

		UNITED STATES					
		1940-1948	1948-1952	1952-1957	1957-1959	1959-1962	1962-1965
(1)	$\dot{Q}/Q$	.78	.62	.59	1.20	.79	.62
(2)	Labor's share	.68	.72	.72	.72	.74	.74
(3)	(1)x(2)	.53	.45	.42	.86	.58	.53
(4)	Growth rate	4.50	5.10	2.80	2.60	3.60	5.10
(5)	(3)/(4)	11.77	8.82	15.00	33.07	16.11	10.39

		MEXICO				
		1940-1945	1945-1950	1950-1955	1955-1960	1960-1964
(1)	$\dot{Q}/Q$	-.31	.02	.53	.70	1.17
(2)	Labor's share	.51	.43	.48	.52	.54
(3)	(1)x(2)	-.16	.01	.25	.36	.63
(4)	Growth rate	7.37	5.84	6.16	6.31	6.22
(5)	(3)/(4)	-2.17	.17	4.06	5.71	10.13

		CHILE				
		1940-1945	1945-1960	1950-1955	1955-1960	1960-1964
(1)	$\dot{Q}/Q$	-.24	-.08	.59	1.19	1.42
(2)	Labor's share	.50	.50	.50	.50	.50
(3)	(1)x(2)	-.12	-.04	.30	.60	.71
(4)	Growth rate	3.20	3.58	3.76	3.28	5.15
(5)	(3)/(4)	-3.75	-1.12	7.08	18.29	13.79

Source: For the United States, Row (1): Dale Jorgenson and Zvi Griliches, "The Explanation of Productivity Changes," Report 6715 (University of Chicago: Center for Mathematical Studies in Business and Economics, 1967). Rows (2) and (4): U.S. Department of Commerce, Long Term Economic Growth, 1860-1965, (Washington, Government P.D., 1966).
For Mexico, Tables 6 and 8, alternative B.
For Chile, Table 15 and 16.

Row (3) shows the contribution of improved education to the growth rate and row (5) shows this contribution as a percentage of the growth rate. The most interesting feature is that this contribution has remained roughly constant for the United States (except for 1957-1959), the percentage contribution having varied only because of different growth rates of output. On the other hand, the main characteristic of the Mexican and Chilean case is the rising trend of the role of improved education, both starting from a negative contribution in 1940-1945 and surpassing the United States value for 1960-1964. In the case of Chile this contribution, also as a percentage of output, is already higher than the United States in 1955-1960.

We can explain the differences in the contribution of improved education by analyzing the equation $\alpha_L \sum_i (w_i/\bar{w})\dot{a}_i$, where $\sum_i (w_i/\bar{w})\dot{a}_i = \dot{Q}/Q$; therefore those differences can be explained by differences among the countries in labor's share and in the increase in the quality index [row (1)], the latter depending on relative wages and the changes in the distribution of the labor force by years of schooling.

The share or participation of labor in output gives the weight to the change in the quality index due to the fact that the quality index and the index of man-hours are perfect substitutes. In other words, the "product of education" (or $\dot{Q}/Q$) is evaluated according to labor's participation in output. In the U.S. the share of labor is approximately 40 per cent higher than in Chile and Mexico; this fact alone, therefore, would account for a 40 per cent higher contribution of education. The other factors explaining the difference between the U.S. on the one hand and Mexico and Chile on the other are differences in relative wages and in different changes in the educational distribution of the labor force.

Relative wages affect $\dot{Q}/Q$ according to the variance of wages by years of schooling, $\dot{Q}/Q$ being greater (for a given change in the educational distribution of the labor force) the bigger this variance. Examining Mexico's and Chile's data (Table 6, column (1) and Table 14, column (1)) we found a bigger variance than in the United States.[1]

---

[1] Ibid., Table 12.

This suggests that the higher values for $\dot{Q}/Q$ in the United States for the period 1940-1957 come from bigger changes in the educational distribution at all years of schooling and/or changes concentrated not between marginal years but between levels (i.e., elementary, high school, etc.) as a whole.

It seems that this last explanation is the most plausible one in view of the United States data.[1] The United States case indicates that the main changes in the educational distribution occur in a wider spectrum than in Chile and Mexico, namely, changes from people with elementary school to high school and college as a whole. On the other hand, in the period 1940-1950, for Mexico and Chile the changes are between marginal years of schooling mainly at very low levels (between 0-1 and 2-4 years), higher levels having only negative changes.[2]

For later years $\dot{Q}/Q$ increases sharply and reaches levels substantially higher in Mexico and Chile than in the United States. This rising trend in the index of labor quality in relation to a rather constant value for the United

---

[1] Ibid, Table 7.

[2] See Tables 38 and 52.

States is one of the most interesting features of this cross-country comparison and is mainly due to the rate of acceleration of the number of people with different years of schooling with respect to the total labor force. This can be seen by differentiating $\dot{Q}/Q$ with respect to time. We know:

$$(50) \qquad \frac{\dot{Q}}{Q} = \sum_i \frac{w_i}{\bar{w}} \mathring{a}_i \qquad \text{where } a_i = \frac{L_i}{L}$$

denoting Q/Q by q, $w_i/\bar{w}$ by v_i and differentiating with respect to time we get:

$$(51) \qquad \dot{q} = \sum_i \dot{v}_i \mathring{a}_i + \Sigma\, v_i \mathring{a}_i^{\bullet}$$

Denoting $\dot{L}_i/L_i$ by n_i and $\dot{L}/L$ by n we can write (51) as:

$$(52) \qquad \dot{q} = \sum_i \dot{v}_i (n_i - n)\, a_i + \sum_i v_i (\dot{n}_i - \dot{n})\, a_i + \sum_i v_i (n_i - n)^2\, a_i$$

The first term of the right hand side of (51) shows the effect of changes in relative wages and the second one the rate of acceleration of the percentage distribution of the labor force by years of schooling.

From (51), Tables 38 (Appendix A) and 52 (Appendix B), we can evaluate the sources of a positive $\dot{q}$ for Mexico and Chile.

For both countries we can see that $\sum_i \dot{v}_i \mathring{a}_i$ is rather small given the rough constances of relative wages. On the other hand, $\sum_i v_i \mathring{a}_i^{\bullet}$ is positive and relatively substantial indicating the rapid acceleration of higher levels of schooling with respect to the labor force.

For Mexico $\mathring{a}_i^{\circ}$ is positive for almost all levels of schooling except the first year in the 1940-1955 period. For 1955-1964, the positive $\mathring{a}_i^{\circ}$'s are fewer but are concentrated in higher levels of schooling so they get a bigger weight from the v_i's.

For Chile the positive $\dot{q}$ since 1940 comes from an acceleration at all the levels of schooling beginning with the fifth grade and especially from the sixth grade (completion of elementary). For 1960-1964, the $\mathring{a}_i^{\circ}$'s become negative for several grades and this explains the small increase in the contribution of $\frac{\dot{Q}}{Q}$ from 1956-1960 to 1960-1964.

b) One of the most important conclusions obtained from Chapter III is the wide differences in the endowment of educational capital in relation to other factors of production. To make an international comparison of relative factor endowment we have constructed Table 27.

The concept of educational capital used is Schultz's and the purpose is to make this value independent of international differences in the discount rate.

The most interesting conclusion is that the biggest differences in factor endowment ratios between countries are on the amounts of educational capital per worker (E/L). For 1950 this value in the United States is 142 times that of India, ten times that of Chile and seventeen times that of Mexico.

TABLE 27

INTERNATIONAL COMPARISONS OF FACTOR ENDOWMENT

	Educational Capital Per Worker (Dollars of 1956)				Ratio of Educational Capital (in the labor force) to reproducible physical capital				Reproducible Physical Capital Per Worker (dollars of 1956)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	U.S.A.	Chile	Mexico	India	U.S.A.	Chile	Mexico	India	U.S.A.	Chile	Mexico	India
1909	2,946				.22				10,190			
1910	2,626				.23				11.415			
1920	3,068				.24				12,781			
1930	3,696				.24				15,397			
1940	4,697	581	378		.33	.13	.12		14,091	4,467	3,149	
1945		572	353			.13	.12			4,399	2,940	
1950	5,973	575	363	42	.37	.14	.11	.13(.08)	16,145	4,106	3,206	323 (525)
1955		604	374			.15	.11			4,022	3,400	
1957	7,556				.42				17,983			
1960		655	410	48		.17	.10	.13(.08)		3,840	4,100	369 (600)
1964		712	466			.18				3,952		

Column (1): T. W. Schultz, "Education and Economic Growth" in Social Forces Influencing American Education, ed., N. Henry, (Chicago: National Society for the Study of Education, 1961).

Column (2): Table 43; The Brokers Exchange Rate of January 1964 (E° 3106) was used.

Column (3): Table 39; An exchange rate of 12.5 per dollar was used.

Column (4): Gounden, op. cit. We used the 1960 official exchange rate (Rs. 4.77 per dollar)

Column (5): Schultz, op. cit.

Column (6): Obtained assuming a capital output ratio equal to 3.33 for 1950 and then applying the growth rate of K/Y of Table 16.

Column (7): From Table 7.

Column (8): The reproducible physical capital figures were obtained from "Estimates of Tangible Wealth;" value in parenthesis is obtained when we use total tangible-capital namely including land.

Columns (9) to (12): From the earlier columns through the identity: $K/L = E/L \cdot K/E$. Values of parenthesis in column (12) indicate total tangible wealth (including land) per worker.

Furthermore, within the less developed countries we can also observe this phenomena though in a lesser degree. If we take land into account in India (which represents half the value of tangible capital) we get that Chile and Mexico, respectively, have fourteen and nine times more educational capital per worker than India in relation to six and seven times for physical capital per worker. Those values refer to 1960.

We can compare these figures with the following per capita incomes of those countries for 1960 (in dollars).[1]

United States	2,569
Chile	406
Mexico	357
India	69

We can see that the differences in E/L are much bigger than the differences in per capita income. There is no doubt that, irrespective of differences in the internal rate of return to education between countries, the differences in E/L explain a big part of those per capita income differentials.[2]

---

[1] Sources: For the United States, Long term economic growth, 1960-1965. For Chile, Cuentas Nacionales de Chile: An exchange rate of E° 1316 was used for 1960, and it is obtained applying to the 1959 figure (E° 1053) the increase in the price index of home-goods. For Mexico, Departamento Estudios, Banco de Mexico. An exchange rate of 12.5 pesos per dollar was used. For India, International Monetary Fund, International Financial Statistics, 1966. An exchange rate of Rs. 4.77 per dollar was used.

[2] The data suggest that for all the countries analyzed the average internal rate of return to education lies in the range of 10 per cent to 25 per cent so the maximum difference could be 2.5 time. For data for the United States, see L. Hansen, "Total and Private Rates of Return to Investment in Schooling," Journal of Political Economy (April, 1963).