Education's Contribution to Economic Growth in Cuba

by

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This paper has been published in Cuba in Transition 10, Association for the Study of the Cuban Economy (ASCE), Washington D.C., 2000.

[*] I would like to express my deepest appreciation to Rodrigo Garcia for his helpful research assistance. The views expressed, opinions and conclusions reached in this paper are those of the author, and do not necessarily reflect those of the institutions with which the author is affiliated.

INTRODUCTION

The main problem faced by government is allocating scarce resources across competing activities and sectors. The choice between alternative investment such as investment in education versus investment in physical infrastructure depends on society's objectives which are represented by governmental decisions, and on the analysis between cost of the investment versus the future benefit to be derived from that investment. Since, education is seen as an investment by economist, therefore it is important to estimate its contribution to economic growth and/or its rate of return.[1]

Education represents both consumption and investment. Education is valued for its immediate as well as for its future benefits. This means that the distribution of educational investment affects future income distribution, thus, equity plays an important role in educational investment decisions. Different societies give different weight between the objectives of efficiency and equity in defining an educational investment. In general, centrally planned economies placed a higher weight on equity grounds in defining their educational policy investment than capitalist economies.

This paper is a follow up to and complements my previous publications related with sources of economic growth in Cuba (Madrid-Aris, 1997, 1998), in the sense that the growth accounting or sources of growth analysis is extended by creating a labor quality index to determine the contribution of education to economic growth. This paper has two goals. The first one is to provide a very brief descriptive analysis of the historical pattern of factor accumulation (physical investment and human capital creation), social investment, and human capital creation. The second goal is to determine the education's contribution to economic growth.

This paper is organized as follows. The next section provides a brief review of the historical patterns of Cuban growth, factor accumulation, and human capital for the period 1962-1988. The third section contains a brief review about different methodologies normally applied to estimate education's contribution to economic growth. The fourth section contains the estimation of education’s contribution to economic growth by using Denison-type of growth accounting methodology. The final section contains the conclusions.

[1] For an excellent review about international rates of return to education, see Psacharopoulus (1972, 1985, 1994).

2. REVIEW OF THE CUBAN FACTOR ACCUMULATION, AND LABOR FORCE STRUCTURE

2.1 Cuban Growth and Investment Indicators

Table 1 shows a summary of Cuba's main macroeconomic indicators and the Soviet assistance received by Cuba during the period 1960-1988.

TABLE 1: Macroeconomic Indicators

Period	Economic Growth (%)	Income Per capita Growth	Investment as share of GMP	Total Soviet Assistance as share of GMP*	Exports as share of GMP	Imports as share of GMP
1960-1964	1.9	-0.2	0.14	0.08	0.15	0.19
1965-1969	3.6	1.7	0.19	0.07	0.14	0.21
1970-1974	10.0	8.2	0.17	0.07	0.18	0.23
1975-1979	3.4	2.2	0.28	0.18	0.34	0.40
1980-1984	5.7	5.1	0.30	0.33	0.44	0.52
1985-1988	1.3	0.3	0.31	n.a.	0.40	0.60
AVERAGE	**4.4**	**3.2**	**0.23**	**0.15**	**0.28**	**0.36**

Notes: Economic growth has been estimated with Gross Material Product (GMP) since statistics of Gross Social Product (GSP) are not as accurate as GMP (See Mesa-Lago and Perez-Lopez, *World Bank Staff Working Paper Number 770*, 1985).
*Total Soviet Assistance includes Soviet trade subsidies (sugar, petroleum and nickel) plus development aid (for further details, see, Central Intelligence Agency (CIA), Directorate of Intelligence, 1984, p. 40 and 1989, p. 39).
Source: Rodríguez (1990), Brundenius (1984), Mesa-Lago and Pérez-López (1985), CIA-Directorate of Intelligence (1984, 1989), Comité Estadístico Estatal (CEE)-Anuario Estadísticos de Cuba, several years, and author's estimations.

Cuba's gross material product (GMP)[2] was able to grow at a steady rate of 4.4% and per-capita income increased at an average rate of 3.2% during this period. Cuba greatly increased the rate of investment, which went from 15% in 1960 to 30% in 1988. Data from Table 1 shows that between 1960 and 1964, there was no increase in income per capita. On the other hand, during the period 1965-1988 income per capita increased at a considerable rate. Data show the Soviet assistance increased considerably over this time. During the period 1960-64, soviet assistance was on average only 7% of GMP, but it increased to a level of 33% of GMP for the period 1980-1984. The amount of Soviet assistance was larger than the investments realized by the Cuban government for the period 1980-1984. In other words, during this period, it could be assumed that most of the investments realized by the Cuban government were realized by using capital received from Soviet assistance.[3] Therefore, it could be inferred that the Cuban economy was losing its saving capacity.

[2] The Cuban accounting system is different from the western concept of Gross National Product (GNP). Cuba uses the Soviet system of Global Social Product (GSP) and Gross Material Product (GMP), which is also called "gross product." For further explanation of the Cuban Accounting System, see Brundenius (1984), pp. 19-40, Mesa-Lago and Perez-Lopez (1985).

[3] Note that in a centrally planned economy like Cuba, the investment is mainly realized by the government since there are no opportunities for private enterprises or for private investment. Therefore, private income is spent mostly in consumption.

Note that the highest rate of economic growth (10%) was achieved in the period 1970-1974. Ironically, during this period the Cuban investment rate was low (17%) and even decreased in this period from a level of 19% to a level of 17%. Additionally, the lowest rate of economic growth (1.3%) was during the period 1985-1988, when the highest rate of investment (31%) was observed. Looking at these figures, it seems that the Cuban economy was not able to absorb an efficient way such a high level of investment.[4] If the rate of investment exceeds the country's technical, human and institutional capacity to allocate it in an efficient way, most of the investment goes to poorly managed projects. Hence, investment is not very productive and depreciates. In sum, it can be concluded that during the 1980s, investment was not allocated as efficiently as during the 1970s.

2.2 National Income and Social Investment

Table 2 shows that investment in education increased considerable. In 1960, it was only 3.2% of total national income, and increased to a level of 13.1% in 1987. Investment in health also increased considerably during this period. In 1960, investment in health represented only 2.0% of national income, and it increased to a level of 6.6% of national income by 1987**.**

TABLE 2: National Income and Social Investment (Education and Health)

	In Millions of Current Pesos (C$)			In Percentage (%)		
Year	Value of National Income	Investment in Education	Investment in Health	Investment in Education as % of National Income (%)	Investment in Education as % of GMP* (%)	Investment in Health as % of National Income
1960	2,625.5	83.7	51.3	3.2	3.3	2.0
1965	3,888.2	260.4	148.9	6.7	7.0	3.8
1970	3,517.6	351.1	216.4	10.0	10.4	6.2
1975	8,112.6	808.5	304.2	10.0	10.4	3.8
1980	9,853.1	1,340.8	440.2	13.6	14.1	4.5
1987	12,202.2	1,600.0	810.2	13.1	13.6	6.6

**Note: ***figures estimated by the author considering an aggregated depreciation rate of 4%.
Source: Rodriguez, José. *Estrategia del Desarollo Económico de Cuba.* La Habana: Cuba, 1990, p. 218 and p. 293.

2.3 Labor Force, and Human Capital [5]

Table 3 contains data on enrollment per 1,000 habitants by educational levels in Cuba between 1958 and 1985.

TABLE 3: Student Enrollment by Level of Education (per 1,000 habitants)

[4] Miguel Figueras, the former Director of Planning of the Cuban Ministry of Industry, supports this view. Fir further details, see Figueras, 1994.

[5] Human capital investment is a concept widely used by economists, meaning the process of improving of the quality of the labor force. Thus, human capital is referred to as the level of education of the labor force. This improvement of the labor force quality is basically achieved by education and training (Becker, 1963).

Year	Primary Education	Secondary Education	Higher Education	Other Education	**TOTAL ENROLLMENT**
1958	104.9	11.8	3.8	0	120.5
1970	193.4	24.9	4.1	32.4	254.8
1975	205.2	57.1	9.0	31.3	302.6
1980	164.2	110.0	15.7	6.8	296.7
1985	116.8	110.0	23.2	2.0	252.0

Note: For Cuba, secondary education includes technical schools. Other types of education include the worker farm educational program developed after the revolution.
Source: Madrid-Aris (1998).

Cuba considerably increased the rate of enrollment during the period 1959-1988. The data show that human capital accumulation has been quite rapid in Cuba during the last 35 years. Without looking at economic variables, such as the amount invested in education and the return on human capital creation, it could be concluded that the Cuban government was successful in achieving a very high rate of enrollment during this period.

TABLE 4: Labor Force Composition by Educational Level in Selected Years as Percentage of Total labor Force (%)

COUNTRY	**YEAR**	**Illiteracy**	**Primary Education**	**Secondary Education**	**University Education**	**Unspecified**
	1950	37.7	54.8	5.4	1.1	1.0
Colombia	1960	27.1	63.7	6.1	.8	2.3
	1970	4.5	56.6	30.6	8.6	0.0
	1950	n.a	77.4	20.2	2.3	.1
Chile	1960	n.a	75.1	22.3	2.6	0.0
	1970	8.3	52.2	31.5	3.3	4.7
	1950	48.3	44.0	6.6	1.1	0.0
Brazil	1960	41.5	50.5	6.8	1.2	0.0
	1970	28.3	58.1	11.7	1.9	0.0
	1960		63.7*	34.3	2.1	0.0
Cuba	1970		56.3*	40.7	3.0	0.0
	1980		37.6*	57.5	4.9	0.0
	1982		36.4*	57.7	5.9	0.0
	1986		24.3*	67.7	8.0	0.0
	1996		17.3*	70.0	12.7	0.0

Notes: *this figure includes illiteracy and primary education.
Source: Cuban figures estimated by the author. Figures from other Latin American countries, from Elias (1992, page 92).

As the previous Table shows, the share of those with only primary education was large initially, but it decreased considerable between 1960 and 1986. In addition, there was an uniform increase in university-educated workers, which will have an important effect on the calculation of the growth of the labor quality component.

2.4 Summary of Factors Contribution to Economic Growth

Table 5 shows the factors' contribution to economic growth for the period 1963-1998 estimated without considering quality adjustment factor for the labor force.

TABLE 5: Factors' Contributing to Aggregated and Sectoral Economic Growth (%)

PERIOD	CONTRIBUTION OF FACTORS (as % of economic growth)								
	All Productive Sectors			Agriculture			Industry		
	Labor	Capital	TFP	Labor	Capital	TFP	Labor	Capital	TFP
1963-1970	25	53	22 (1.0)	30	120	-50 (-1.9)	18	56	26 (1.4)
1971-1980	17	70	13 (0.8)	12	132	-44 (-1.2)	19	67	14 (0.7)
1981-1988	38	99	-37 (-1.2)	27	158	-85 (-1.5)	36	73	-9 (-0.4)
AVERAGE	**26**	**70**	**4 (0.2)**	**23**	**133**	**-56 (-1.5)**	**23**	**65**	**12 (0.6)**

Note: Value of TFP growth is in parenthesis. .
Source: Madrid-Aris (2000).

Previous tables show that for the agricultural sector, the average TFP growth is negative (-1.5%), and its contribution of TFP to output is negative (-56%) during the period of 1963-1988. In the industrial sector, at least the average TFP growth is positive, but it was moderate (0.6%), and its contribution to economic growth was very low (12%). In sum, the Cuban government's interventionist policy during 1975-1988 was accompanied by very low TFP performance. Previous results show that the industrial sector, which had a lower rate of investment, had the higher TFP growth and contribution to economic growth. TFP analysis results show that Cuba's growth during 1963-1988 was almost entirely the result of capital accumulation rather than productivity gains. Decreasing TFP growth through the 1970s and 1980s, with increasing amount of subsidies received from Soviet Union during the same period, seem to suggest that Soviet dependency created inefficiency in Cuba.

This seems ironic, because Cuba's centrally planned development strategy was oriented toward getting resources from agriculture to develop an industrial economy. But, reality shows that agriculture has been a big consumer of resources especially capital, without any positive result. Results show that governmental creation of institutional mechanisms to deal with inefficiencies may not always be an efficient way to force technological change. The Cuban decreasing TFP growth under factor accumulation is a confirmation of the low level of technical and allocative efficiency of a centrally planning system. Result from this research and other analysis of centrally planned economies (Nishimizu and Robinson, 1984) confirm that the lack of allocative and technical efficiency is a common pattern of centrally planned economies as result of lack of competition and incentives.

3. MEASURING EDUCATION'S CONTRIBUTION TO ECONOMIC GROWTH

The concept of investment in human capital and its relationship with productivity and economic growth dates back to the time of Adam Smith and the early classical economists. The empirical literature on education's contribution to economic growth was initiated in 1960. This was mainly triggered by the need of understanding the role of education in economic growth. The most often cited works in this field are Schultz (1961), Denison (1962, 1967), Psacharopoulos (1972) and Nadiri (1972). By the 80s, there was a renewed interest in this field. Thus, in this period the most influential works are those developed by Hicks (1980), Wheeler (1980), and Pscharopoulus (1984).

With respect to methodologies to estimate education's contribution to economic growth, some researchers have used growth accounting or productivity index (Denison, 1967, Selowsky, 1969), production functions (Grichiles, 1970), and other growth equations (Harberger and Selowsky, 1966).

The first attempt to measure the contribution of education to economic growth was developed by Denison and Schultz. Traditionally different methodologies have been applied to estimate education's contribution to economic growth, but the two methodologies[6] commonly applied are: (i) the labor quality adjustment growth accounting or Denison-type of growth accounting (Denison, 1967); (ii) the rate of return to human capital (Schultz-type of growth accounting). With respect to the specification of the education variables, the number of years of schooling of the labor force in relation to the wage differentials of the labor force by different levels of education is frequently used (Denison), or the amount of capital invested in education in conjunction with the rate of return on that capital (Schultz).

The starting point of the Denison estimation is the Solow (1957) methodology for growth accounting, which aggregated production function implicitly considering the neutrality of technical progress. Thus:

$$Y_t = A(t) f(K_t, L_t) \qquad (1)$$

The Denison-type of growth accounting methodology normally applied to estimate labor contribution to economic growth is based on analyzing the effect of quality of the labor force due to education. In other words, in the Denison's methodology not only gross capital and labor are considered as in Solow (1957) methodology, but factors (labor and capital) are adjusted by quality. Normally, different factors for estimating the quality of labor can be considered, such as education, age and gender of labor force, hours of work, and unemployment. Thus, the contribution is based on how much the quality of the labor force contribute to the "residual" or to the total factor of productivity growth. The Denison-type of growth accounting can also distinguish between different kind of educated labor within the production function. Normally, the

[6] For a more detailed review of these two methodologies, see Psacharopoulos (1973), pp. 111-118.

disaggregation is done into different categories, no education, primary, secondary and higher education.[7]

Denison used the wage differentials of labor with different schooling levels as weight in order to measure the labor quality. Thus, the Denison type of growth accounting production function with labor quality adjustment factor takes the form:

$$Y_t = f(K_t, L_{t,} \sum_s L_s * (W_s - W_{s-1})) \qquad (2)$$

In equation (2) the index *s* represent the different schooling levels of the labor force and W represents the average wage of the educational category. Denison (1967) estimated that 23% of the rate of growth of output in the USA between 1930 and 1960 is due to the increased of education of labor force. Denison also estimates that the figure for 1950-1962 is equal to 15%.

It is important to note that Denison-type of growth accounting as commonly applied without considering the maintenance component[8] of a growing labor force could result in an underestimation of the contribution of education to economic growth (Selowsky, 1969). Selowsky (1969) using a Denison type of growth accounting, considering the maintenance component, determines that contribution of education to economic growth in the USA for the period 1940-1965 is 21%, in Mexico approximately 11% and in Chile approximately 24%.

Schultz introduced the concept of rental value of education in growth accounting. In this methodology, the investment in education is entered into the traditional methodology by distinguishing two kind of capital, the human capital and physical capital. Another way is by distinguishing several non-homogenous inputs based on educational levels.[9] Thus, the Schultz type of production function is:

$$Y_t = f(K_t, L_t, r * K_{edu}) \qquad (3)$$

Where *Kedu* is the educational capital stock in the economy and *r* is the rate of return on the educational capital. Thus, the product *r*Kedu*, is the measure of the educational factor of production that contributes to output. Thus, the Schultz-type of calculation about the contribution of education to economic growth is made by estimating the factor rentals (rate of return to human capital times educational investment). The difficulty of this approach is that it requires the estimation of the stock of educational capital in the economy and the rate of return on that capital. Obviously, the estimation of these two elements is an extensive task, which in most cases is impossible to estimate them as result of the lack of data, especially in less developed countries (LDCs).

[7] For an empirical application to Latin American countries, see Elias (1992), pages 71-99.
[8] Maintenance component is the effort entailed in maintaining constant the relative distribution of the labor force by years of schooling. For further details, see Selowsky (1969).
[9] For further details, see Schultz (1963), Psacharopoulus and Hinchliffe (1973, pages 20-34)

It is known that growth accounting and residuals are not a good toll for explaining the process of economic growth as result of the exogenity of the technical progress. The important issue is to determine what are the variables that could explain the residuals. Although the residuals lost ground, especially with the development of the new growth theory, economists have not yet agreed on what is the proper way to measure the contribution of education to economic growth.

4. ESTIMATING EDUCATION'S CONTRIBUTION TO ECONOMIC GROWTH FOR THE CUBAN ECONOMY

For the purpose of estimating education's contribution to economic growth in Cuba, the traditional Denison-type method of calculation will be applied.

4.1 Denison Methodology

As explained before, Denison methodology considers the estimation of a labor quality index. According to the Denison-type of growth-accounting methodology, the rate of change of the quality component of the labor force as result of education captures the effect of the education's` contribution to economic growth. According to this methodology, the rate of change of the quality component is equal to the weighted average of the changes in the share of each kind of labor with respect to the average wage for the whole labor force. The weights are represented by the wages structure of different educational level of the labor with respect to the average wage of the total labor force.[10] Thus, the basic aggregated production function with quality adjustment factor can be expressed as follows:

$$Y_t = f(K_t, L_{t,} Q_t) \qquad (4)$$

Where *Qt* is the quality of labor force. The growth accounting equation (discrete approximation) can be expressed as follows:

$$\frac{\Delta Y}{Y} = a_k * \frac{\Delta K}{K} + a_l * \frac{\Delta L}{L} + a_l * \frac{\Delta Q}{Q} + TFP \qquad (5)$$

where the relative change in an index of the quality of the labor force due to education is defined as follows:

$$\frac{\Delta Q}{Q} = \sum_i \frac{w_i}{W} * \frac{L_i}{L} \qquad (6)$$

[10] If there is no change in the level of education of the labor force, the rate of change of the quality of the labor force will be zero. If there are changes in favor of the groups with higher relative wages (university graduates), the quality of the labor will increase.

In equation (6), the index *i* represents the different years of schooling of the labor force or educational level. In our specific case, the index *i* represents the educational level attained by the labor force.

For the purpose of estimating the index of the quality of labor force, each component of labor corresponds to a well-defined educational category (primary, secondary and university) as shown in Table 4. In other words, it is assumed that education is one of the most important elements of labor income. The educational component could be defined in a way that covers formal schooling and informal education (e.g. in the job training), however, only the formal component is considered for our case.

4.2 Results

One can argue that growth accounting implicitly assumes perfect competition that the marginal product of labor equals wages, therefore, labor markets are competitive. If labor markets are not competitive as the case of Cuba,[11] then relative wages across different levels of education are not necessarily a good measure of the relative productivity at different level of education of workers, unless government sets the wages according to some productivity rule. If the wages are not a reliable measure of productivity, it may be preferable to measure the effect of education as physical measure of output, rather than the use of wage differentials. Another alternative is to use shadow wage rates, instead of actual wage to estimate the labor quality index for the growth accounting estimation. In the analysis presented in this section, a sensitivity analysis is conducted using shadow wage rates from Brazil. Table 6 shows the relative wages by level of education in Cuba and other Latin American countries.

TABLE 6: Relative Wages by Level of Education (*wi/W*)

		RELATIVE WAGES BY EDUCATIONAL LEVEL ATTAINED		
COUNTRY	**YEAR**	**Primary Education**	**Secondary Education**	**University Education**
Colombia	1965	0.916	1.394	1.455
	1967	0.560	1.120	n.a
Chile	1960	0.598	1.862	4.717
	1965	0.708	1.376	5.233
Brazil	1960	1.088	2.020	3.960
	1969	0.814	1.340	3.545
Cuba*	1970-1980	0.80	1.25	1.70

Notes: *estimated based on employment categories (workers, administrative, manager o dirigentes).
Source: Cuban figures estimated by the author, other Latin Countries from Elias (1992, p. 92)

Computing the labor quality component requires the data on labor force composition presented in Table 4, as well as data on relative wages by level of education (Table 6). The quality of labor force is due to education and is obtained by multiplying the rate of change of different educational categories or change in the labor composition by the relative wage of that category. Normally, it has been common to adjust the earnings differentials by a common factor

[11] In Cuba wages are set by central planners instead of define by labor market competitive forces.

that varies between 0.4 to 0.6. This adjustment tries to reflect that only a small part of the higher income should be attributed to schooling, the rest being due to others socioeconomic factors. In our case, no adjustment factor has been considered.

In many cases, in this type of studies when applied to LDCs there is only one year of wage earning differentials or relative wages by categories (data presented in Table 6). One way to solve this problem is simply to use these one-year figures for all other years. This has been the method used in all the country studies in which such information on relative wages is missing (Denison, 1967, Selowsky, 1969, Elias, 1992). Thus, using the data from Table 4 and 6, three different indexes for rate of change in quality of the labor force have been estimated, which results are presented in Table 7.

TABLE 7: Annual Growth Rate of the Labor Quality Index due to Education (ΔQ/Q)

PERIOD	Results based on Cuban Relative Wages (%)	Results based on Relative Wages from Colombia (%)	Results based on Relative Wages from Brazil (%)
1963-1970	0.37	0.35	0.58
1971-1980	1.16	1.13	1.75
1981-1988	0.83	0.71	1.63
1963-1988	**0.75**	**0.70**	**1.26**

Source: Cuba's estimations based on data from Tables 5 and 6.

As shown in the previous Table, labor quality index using shadow wages differential from Colombia and Brazil have been estimated for comparative purposes. Using shadow wages from Colombia, the labor quality index estimated is lower than the one using the Cuban wages. In the case of applying the factor estimated with the Colombian wages to Cuba, the contribution of education to economic growth will be lower than using the index based on Cuban wages. Hence, the contribution of education to growth will be estimated with the Cuban index and the index estimated using shadow wages from Brazil. The annual growth rate of the labor quality index due to education estimated is increasing over time until 1980 as result of changes in favor of the groups with higher relative wages (university graduates). The rate of growth of the Cuban quality index increases from 0.37% for 1963-1970 to 1.16% for 1970-1980, then it decreases to 0.83% for the period 1980-1988.

Table 8 shows the contribution of education to economic growth estimated for the all productive sector as well as for the agricultural and industrial sector. Estimated figures presented in Table 8 assume that the quality of labor has increased at the sectoral level at the same rate as the overall economy.

TABLE 8: Education's Contribution to Economic Growth (as % of GMP)

	ALL PRODUCTIVE SECTORS	AGRICULTURAL SECTOR	INDUSTRIAL SECTOR
1963-1970	3.8 (5.9)	4.4 (6.8)	2.8 (4.4)

1971-1980	8.6 (12.5)	16.9 (23.6)	8.6 (12.5)
1981-1988	10.7 (19.1)	18.9 (31.3)	8.0 (13.1)
AVERAGE (63-88)	**7.3 (11.6)**	**11.4 (17.7)**	**5.7 (9.7)**

Note: figures in parenthesis are the contribution of education to growth based on quality index with Brazilian shadow wage differentials.

The percentage contribution varies in part because of the different growth rates of output in the different period and different sectors (see Table 1). On the other hand, the main characteristic is the rising trend of this contribution. The important features of these increases with regard to the education's contribution to economic growth over the years is the increased index of the quality of the labor force (<Q/Q) complemented with the decreasing TFP growth. The increase in the rate of growth of the quality factor is mainly due to the rate of acceleration of the number of workers with a high level of education as percentage of the total labor force (see Table 4). Obviously, this acceleration can not be expected in the future since most of the illiteracy has been eliminated, as well Cuba has already achieved a very high rate of primary and secondary education.

5. CONCLUSIONS

Results show that education's contribution to economic growth overall has increased over the years from 1963 to 1988. The increases in regard to the education's contribution to economic growth over the years resulted from the increased index of the quality of the labor force (<Q/Q) due to a more educated labor force and the decrease of TFP growth.

The highest contribution of education to economic growth can be found in the agricultural sector (11.4%). This high contribution is due to the lower productivity that this sector presents (see Table 5). The lowest contribution of education to economic growth can be found in the industrial sector (5.7%). This low contribution is the result that this sector has grown based on more productivity gains rather than labor gains. In other words, due to the assumption of neutrality of technical progress (exogenity) common in the growth accounting production function, the higher the technological change the lower the expected contribution of education to economic growth.

In general, Cuba's education contribution to economic growth can be considered low compared with other studies applied to less developed countries (Selowsky, 1969). This low level of contribution can be explained based on factors contributions to growth (Table 5), which show that Cuba’s growth during 1963-1988 was almost entirely the result of capital accumulation which contributed 70% to economic growth rather than productivity and labor gains.

Cuba’s low contribution of education to economic growth resulting from this empirical research complemented with the investment pattern observed on education (see Table 2) seem to

suggest that the educational resource allocation policies adopted by the Cuba's centrally planned system seemed to have aimed more for equity goals rather than efficiency goals.

REFERENCES

Barro, Robert, "Economic Growth in a Cross Section of Countries," *Quarterly Journal of Economics*, pp. 407-1991.

Barro, R., and Xavier Sala-i-Martin. *Economic Growth.* New York: McGraw Hill Press, 1995.

Becker, Gary. *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education.* NBER: The University of Chicago Press, 1963.

Central Intelligence Agency (CIA), Directorate of Intelligence. *The Cuban Economy: A Statistical Review*. Washington D.C., 1984, 1989.

Comité Estadístico Estatal (CEE), Anuario Estadístico de Cuba, several years

Denison, E. "United States Economic Growth," *Journal of Business*, 35, 357-394, 1962.

Denison, E. *Why Growth Rates Differ: Post-War Experience in Nine Countries*. Washington, D.C., Brookings Institutions, 1967.

Denison, E. *Trends in American Economic Growth, 1929-1982.* Washington, D.C.: Brookings Institution Press, 1985.

Elias, Victor. *Sources of Growth: A Study of Seven Latin American Economies.* San Francisco: ICS Press, 1992.

Figueras, Miguel. *Aspectos Estructurales de la Economía Cubana*. Editorial de Ciencias Sociales, La Habana, Cuba, 1994.

Harberger, Arnold. "A Vision of the Growth Process," *American Economic Review*, Vol 88, No 1, pp. 1-31, March 1998.

Hicks, N. "Economic Growth and Human Resources," World Bank Staff Working Paper No 408, Washington D.C., 1982.

Jimenez, Georgina. *Hablemos de Educación, Recopilación de Artículos, Comentarios y Reportajes sobre Educación*. La Habana: Editorial Pueblo y Educación, 1985.

Jorgenson, Dale, Frank M. Gollop, and Barbara M. Fraumeni. *Productivity and U.S. Economic Growth.* Cambridge: Harvard University Press, 1987.

Kim, J.I., and Lawrence Lau. "Economic Growth of the East Asian Newly Industrializing Countries," *Journal of the Japanese and International Economics*, 235-271, 1994.

Krugman, Paul. "The Myth of Asia's Miracle," *Foreign Affairs*, Nov/Dec, pp. 62-78, 1994.

Madrid-Aris, Manuel, "Growth and Technological Change in Cuba," in *Cuba in Transition*, Volume 7, published by the Association for the Study of the Cuban Economy, Washington D.C., 1997.

Madrid-Aris, Manuel, "Investment, Human Capital, and Technological Change: Evidence from Cuba and its Implications for Growth Models," in *Cuba in Transition*, Volume 8, published by the Association for the Study of the Cuban Economy, Washington D.C., pp. 465-481,1998.

Madrid-Aris, Manuel, "The Tyranny of Numbers, Linear Models or Investment Planning: Confronting the Cuban and Singaporean Factor Accumulation and Technological Change," working paper, 2000.

Mesa-Lago, Carmelo. *The Economy of Socialist Cuba: A Two Decade Appraisal.* Albuquerque: University of New Mexico Press, 1981.

Mesa-Lago, Carmelo y Jorge Perez-Lopez, "A Study of Cuba's Material Product System, its Conversion to the System of National Accounts, and Estimation of GDP per Capita and Growth Rates," *World Bank Staff Working Papers*, Number 770, 1985.

Mincer, Jacob. *Schooling, Experience and Earnings*. New York: Columbia University Press, 1974.

Perez-Lopez, Jorge. *Measuring Cuban Economic Performance*. Austin: University of Texas Press, 1987.

Poznanski, K. "The Environment for Technological Change in Centrally Planned Economies," *World Bank Staff Working Papers*, #718, Washington D.C., 1985.

Psacharopoulos, George, "Returns to Investment in Education: A Global Update," *World Development,* 22(9):1325-134, 1994.

Psacharopoulos, George. *Economics of Education: Research and Studies.* New York: Pergamon Press, 1987.

Psacharopoulos, George and Maureen Woodhall. *Education for Developmet: An Analysis of Investment Choices.* New York: Oxford University Press, 1985.

Psacharopoulos, George. *Returns on Education.* San Francisco: Jossy Bass-Elsevier, 1973.

Psacharopoulos, George, "Measuring the Marginal Contribution of Education to Economic Growth," Economic Development and Cultural Change, Vol 20, No 4, pp. 641-658, July 1972.

Schultz, T. W. "Investing in Human Capital," *American Economic Review*, March 1961.

Schultz, T. W. *The Economic Value of Education*. New York: Columbia University Press, 1963.

Schultz, T. Paul. "Education Investment and Return." In *Handbook of Development Economics*, eds. H. Chenery and T.N. Srinivasan, eds, Chapter 13. New York: North Holland, 1988.

Solow, Robert. "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics*, 70, 65-94, 1956.

Solow, Robert. "Technical Change and the Aggregate Production Function," *Review of Economic and Statistics*, 39, 312-320, 1957.

Solow, Robert. "Investment and Technical Progress." In *Mathematical Methods in the Social Sciences*. Edited by Kenneth J. Arrow, Samuel Karbin and Patrick Suppes. Stanford University Press, 1959.

Wheeler, D. "Human Resource Development and Economic Growth in LDC's: A Simulation Model," World Bank Staff Working Paper No 407, Washington D.C: World Bank, 1980.

World Bank. *World Development Report*. Oxford University Press, 1990

Zimbalist, Andrew. "Cuban Industrial Growth, 1965-1984," *World Development*, Vol 15, No 1, 83-93, 1987b.