THE INFLUENCE OF EDUCATION ON MANUFACTURING PRODUCTIVITY: THE PHILIPPINES

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I. INTRODUCTION

THERE SEEMS A growing consensus among empirical growth economists that the educational background of workers significantly affects labor productivity. Education has been suggested in several studies to be an important component of the quality of labor. In a recent survey Nadiri observes that "about one-third to one-half of labor's contribution to the growth of output and from 0.11 to 0.50 percentage points to the growth of income" [7, p. 140] have been attributed to education in a wide cross-section of countries for which such studies were undertaken. Interestingly enough, the contribution of education is found generally to be smaller in less developed countries than in developed countries. This would seem not inconsistent with the lower rate of return to education compared to physical capital that has been observed in a number of developing countries, "possibly created by the government policy of overinvesting in education regardless of demand and by the type of education that is emphasized" [7, p. 141].

According to A. Maddison, "the most remarkable thing about manufacturing productivity in developing countries is that it is generally so high" [6, p. 180]. The average productivity level in the twenty-two countries considered (cf. Table I) is about 60 per cent of that in the United Kingdom. He attributes this to the nature of technology, most modern techniques being developed in countries where wages are high. This does not mean of course that less developed countries actually adopt the most modern techniques. It does point out the rather limited choice in techniques effectively available given the existing technology.

Factor proportions and productivities in the developing countries would differ according to the degree of substitutability between capital and labor and the variation in relative factor prices across countries. It is possible, moreover, that labor productivity would be influenced also by the educational attainment of workers—an intuitively plausible hypothesis that is not borne out by a simple international comparison of the two variables, as may be discerned from Table I. (The correlation coefficient is 0.336, implying lack of significance at even the 10 per cent level.) The Philippines is shown to have the second highest educational attainment of

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workers among the twenty-two developing countries but belongs to the bottom one-third in the ranking by labor productivity. Similarly, Ceylon has the lowest productivity while ranking third in education level.

TABLE I
LABOR PRODUCTIVITY AND EDUCATIONAL QUALIFICATION IN TWENTY-TWO DEVELOPING COUNTRIES, 1965

Country	Level of Output per Man in Manufacturing, U.S. $ 1965 Prices	Average Number of Years of Primary and Secondary Education per Laborer
Argentina	3,157	6.9
Brazil	2,630	3.9
Ceylon	284	7.5
Chile	4,233	6.9
Colombia	1,588	3.8
Egypt	1,593	3.2
Ghana	295	3.3
Greece	2,893	7.4
India	437	3.2
Israel	3,911	8.5
Malaya	4,496	5.1
Mexico	2,380	4.9
Pakistan	590	2.5
Peru	1,430	4.9
Philippines	935	7.8
South Korea	849	6.5
Spain	3,984	5.9
Taiwan	2,589	5.7
Thailand	464	5.5
Turkey	1,208	3.7
Venezuela	6,254	5.4
Yugoslavia	4,148	6.0

Source: [6, Tables II-6, VI-7, pp. 46, 181].

In this paper we attempt to examine more systematically the role of education in explaining differences in manufacturing productivity in the Philippines, using cross-section data by province from the *1961 Economic Census for Manufacturing* [10]. Two analytical approaches to the problem will be employed, consistency between them to be demonstrated. One is based on a behavioral relation derived from the demand for labor, assuming that the production function is of the constant-elasticity-of-substitution (CES) type and labor is paid its marginal product. The other involves direct estimation of a Cobb-Douglas production function with the education variable explicitly included as an argument.

Using either of the two approaches (and either of two measures of the education variable to be defined below), it is shown that the educational attainment of the work force bears little relationship with labor productivity in manufacturing. This clashes with the findings of other investigators in developed countries, e.g., Griliches [4, pp. 275–321] and Brown and Conrad [2, pp. 341–71] and would seem to suggest that closer attention be given to the implicit connection assumed between formal education and quality of the labor force in the context of less developed countries. Our finding gives cause for skepticism on the reliability of estimates on the contribution of education to the growth of output in developing countries based on such assumed relationship.[1] The temporal implication is that increasing educational expenditures to raise the average number of years of formal schooling or the proportion of the labor force completing at least secondary education will not lead automatically to an increase in industrial productivity.

II. EVIDENCE BASED ON LABOR DEMAND FORM THE CES PRODUCTION FUNCTION

There are available in the economic literature a number of analytical models that may be used to explain differences in industrial labor productivity. One possibility is to assume a CES production function with constant returns to scale and equate the marginal product of labor to the prevailing wage rate under the assumption of profit maximization and perfect competition in the demand for labor. As originally specified by Arrow, Chenery, Minhas, and Solow [1, pp. 225–50], this involves the estimation of a linear equation relating the logarithms of labor productivity and the real wage rate. In the present study we are also interested in examining how variations in technology and educational attainment of the workers affect manufacturing productivity across provincial areas in the Philippines, in which case the behavioral relationship may be postulated as follows:

$$\log q_i = a_0 + a_1 \log W_i + a_2 \log X_i + a_3 \log Z_i + u_i, \tag{1}$$

where for each province i (= 1,..., 52),

q_i = ratio of value added in manufacturing to the amount of labor employed,

W_i = wage income per unit of labor,

X_i = education variable,

Z_i = technology variable,

u_i = error term.

The term $q_i/X_i^{a_2}Z_i^{a_3}$ may be considered as an adjusted labor productivity variable (i.e., allowing for differences in educational background of the labor force and technology among different provinces), which is seen to be influenced solely by the wage rate. Given such interpretation, the coefficient a_1 in (1) represents the elasticity of substitution between the two factors, capital and labor, as in the ACMS specification.

Brown and Conrad [2, pp. 341–71] have provided a highly plausible rationale for the presence of the education variable in eqth. (1). They argue that the parameters of the CES production function as conventionally specified could vary across industries and regions but such variation simply reflects the influences of "fundamental" variables, e.g., education and research, which differ in degree among in-

[1] For the Philippine case, see [14].

dustries and regions. In the present study education can be considered initially as a fundamental variable.[2] The test of such assumption is a necessary task to which our attention will be directed later.

In regard to the technology variable, the model of technology diffusion suggested by Nelson [8, pp. 1219–48] may be interpreted to apply across provinces in the Philippines, any new technology from the advanced countries being assumed to be adopted first in areas most open to foreign influence, namely, in Manila and the regional centers, before it is taken up with a time lag by manufacturing firms in the outlying provinces.

Two measures of labor input are used, viz.: (1) the number of production and related workers,[3] and (2) the number of man-hours worked by production and related laborers. The latter appears more appropriate although the reported figures might be less accurate. The wage rate variable is likewise defined in two ways, corresponding to the ratio of total wage earnings of production and related workers to the two measures of labor input for this class of workers. The source of basic data for q_i and W_i is the *1961 Economic Census* [10] which provided information for "all" manufacturing in each of the fifty-two provinces.[4]

Two measures of the education variable are computed from data on the number of persons ten years old and over completing each year of formal education in each provinces as obtained from the population census of 1960. (No such information is available for 1961.) The first measure is the average number of years of formal education of the labor force; this conforms to fairly standard practice which views the contribution to labor productivity of the various levels of education on time-proportional basis. Our second measure of educational attainment is the fraction of the labor force that has completed at least the secondary education (typically, ten years). The latter measure places greater weight on later years of schooling and might be more relevant on the ground that work adaptability and skills are perhaps acquired more easily with, and sometimes require, at least the secondary level of education.

We follow Hildebrand and Liu [5] in representing the technology variable by the ratio of professional and technical workers to the total number of paid employees. The underlying assumption is that differences in technology, as well as in industry structure among provinces, would be captured by the variation in the relative composition of the work force across provinces. It may be noted that sources-of-growth studies à la Denison [3] explicitly take into account the composition of the labor force (not necessarily as defined above) as another component of labor quality.

To account for region-specific influences on labor productivity, i.e., affecting only the intercept of the function, nine regional dummy variables were introduced in

2 Manufacturing establishments in the Philippines, as in most less developed countries, do not undertake research activities to any significant extent.

3 This is the employment measure more frequently used in previous studies; see, for example, [15] [14].

4 By "all" manufacturing is meant here all organized manufacturing establishments employing ten cr more workers, for which data required in this study are available.

eqth. (1).[5] However, none of the coefficients of the regional dummies turned out to be significantly different from zero. In fact, the inclusion of these variables hardly affected the coefficient estimates of the explanatory variables appearing in (1) and the corresponding t-values, frequently yielding lower values of the coefficient of determination when adjusted for degrees of freedom. We are reporting in Table II therefore only the regression results in which the regional dummy variables are

TABLE II
GOODNESS OF FIT STATISTICS
DEPENDENT VARIABLE: AVERAGE LABOR PRODUCTIVITY

Specification	Coefficient of log:					$\bar{R}^2$	s
	$W1$	$W2$	$X1$	$X2$	Z		
A-1	1.157 (4.57)	—	−.291 (−.83)	—	.628 (3.15)	.550	.311
A-2	1.136 (4.23)	—	—	−.071 (−.30)	.642 (3.22)	.545	.313
A-3	1.585 (6.83)	—	−.394 (−1.04)	—	—	.469	.339
A-4	1.568 (6.18)	—	—	−.094 (−.05)	—	.342	.342
A-5	1.044 (4.52)	—	—	—	.643 (3.26)	.553	.310
A-6	1.527 (6.77)	—	—	—	—	.468	.339
B-1	—	.785 (3.81)	−.362 (−.97)	—	.758 (3.81)	.483	.334
B-2	—	.828 (3.57)	—	−.214 (−.79)	.767 (3.85)	.480	.335
B-3	—	1.121 (5.32)	−.452 (−1.07)	—	—	.341	.376
B-4	—	1.164 (4.79)	—	−.234 (−.76)	—	.333	.379
B-5	—	.945 (3.69)	—	—	.770 (3.88)	.484	.333
B-6	—	1.065 (5.21)	—	—	—	.339	.337

Note: Numbers in parentheses are t-values of the coefficients. See text for meaning of symbols used.

not included. They pertain to the various combination of the alternative measures of the explanatory variables, where

$W1$ = ratio of wage earnings of production workers to man-hours,
$W2$ = ratio of wage earnings of production workers to the number of production workers,
$X1$ = average number of years of formal education of labor force,
$X2$ = percentage of labor force completing at least secondary education.

The values of the (adjusted) coefficient of determination are fairly respectable

[5] These variables take on values as follows: $d_1 = 1$ for provinces in the Ilocos region and zero for Manila and provinces in the remaining eight regions; $d_2 = 1$ for provinces in the Cagayan Valley region and zero for Manila and other provinces; etc.

for regressions using cross-section data. About one-half of the variation of labor productivity across provinces is explained in equations where the wage rate and the technology variable are included. The remainder may be attributed to differences in prices, rates of capital utilization, and market imperfections among provinces.[6]

The most striking result from Table II is the lack of significance of the education variable, however measured. The negative sign of the estimated coefficient of course does not make economic sense since a higher value of the variable would be associated with improved quality of labor and hence higher productivity.

In contrast the wage rate, whether measured in terms of the number of production workers or by man-hours, as well as technology variable, are highly significant in whatever specification they appear. Dropping the technology variable in the regression tends to reduce the value of the coefficient of determination drastically, whether the education variable is included or excluded in the remaining explanatory variables. The higher values of the standard error of estimate are also noticeable. The lack of correlation between the technology and education variables (simple correlation coefficient = 0.214 with $X1$ and 0.051 with $X2$) is consistent with these results.

Consider now what happens when the education variable is omitted while keeping the technology variable in the regression. These cases are shown in specifications A-5 and B-5, which are seen to exhibit the highest values of the coefficient of determination and the lowest standard error of estimate in their respective categories. One could make the inference therefore that differences in educational attainment of the labor force, defined in terms of either the number of years of formal schooling or the percentage completing at least secondary education, has little to do with the variation in labor productivity across provinces in the Philippines. The latter can be explained in good part by the technological differences and interprovincial variation in wage rates from a labor demand model using the CES production function.

The interpretation of the estimated coefficients of the significant explanatory variable is straightforward. In the "best" specifications A-5 and B-5, a 1 per cent change in the technology variable would be associated with a 0.643 or 0.770 per cent change in labor productivity, depending on whether the labor input is measured in man-hours or number of workers. (Notice that greater responsiveness is suggested by the latter measure, which seems credible in view of the likelihood of a slack embodied in an employment measure defined by the number of laborers.) Introduction of the education variable defined in either measure changes but little the coefficient estimates of the technology variable (cf. A-1, A-2, B-1, and B-2).

As already mentioned, the coefficient of log W represents the elasticity of substitution in the CES production function. In specification A-5, which measures labor in man-hours, the estimate is 1.044; where the labor input is defined in terms of the number of workers (B-5), it is 0.945. The two estimates therefore lie on both sides of unity. Are they significantly different from one? Application of the standard

6 These influences on labor productivity are not considered in the present study due to lack of relevant information on provincial basis.

t-test at the 5 per cent level of significance indicates that they are not. Hence we conclude that the production function for Philippine manufacturing in 1961 can be characterized by unitary elasticity of substitution.[7]

III. EVIDENCE BASED ON THE COBB-DOUGLAS PRODUCTION FUNCTION

The foregoing characterization of the production function as having unitary elasticity of substitution permits us to investigate further the variation of labor productivity across provinces, using now a Cobb-Douglas function of the following unrestricted form:

$$q_i = B(K_i/L_i)^{b_1} L_i^{b_2} X_i^{b_3} Z_i^{b_4}, \tag{2}$$

where K is the depreciated value of machinery and other production equipment (obtained from the *1961 Economic Census* [10]) and the rest of the variables are as defined in the preceding section.

The initial hypothesis is that both education and technology variables are significant influences on labor productivity, allowing shifts in the production function with constant elasticities of output with respect to capital and labor. We make use as before of the two measures of educational attainment but consider only as our measure of labor input the man-hours worked by production and related laborers. The latter decision was made on the basis of theoretical relevance and the higher value of the coefficient of determination observed earlier for specification A-5 compared with that for B-5 (cf. Table II).

Regional dummy variables were introduced as before but again appeared to affect neither the coefficient estimates nor the statistical goodness of fit. Table III presents

TABLE III
GOODNESS OF FIT STATISTICS
DEPENDENT VARIABLE: AVERAGE LABOR PRODUCTIVITY

Specification	Coefficient of log:					$\bar{R}^2$	s
	K/L	L	$X1$	$X2$	Z		
C-1	.399 (2.78)	.093 (1.15)	.082 (.20)	—	.558 (2.35)	.489	.332
C-2	.423 (3.01)	.053 (.59)	—	.258 (.89)	.530 (2.24)	.497	.329
C-3	.596 (4.87)	.103 (1.21)	.177 (.41)	—	—	.441	.347
C-4	.610 (5.19)	.052 (.56)	—	.357 (1.20)	—	.456	.343
C-5	.390 (2.88)	.101 (1.82)	—	—	.563 (2.41)	.560	.320
C-6	.580 (5.03)	.119 (1.61)	—	—	—	.451	.344

Note: Numbers in parentheses are t-values of the coefficients.
See text for meaning of symbols used.

[7] This is an agreement with the general findings for Philippine manufacturing in previous years (1956–60) by G. P. Sicat [11, pp. 107–31] [12].

the regression results of the loglinear specification suggested in eqth. (2). If anything, they reinforce the findings in the preceding section on the lack of significant influence of education on industrial productivity.

The estimated coefficient of the education variable, expressed in either measure and in whatever specification it appears, is seen from the t-statistic to be not significantly different from zero. In fact, deleting the education variable has the effect of improving the goodness of fit of the regression. This is shown by the higher values of the (adjusted) coefficient of determination, lower standard errors of estimate and higher t-values of the coefficient estimates for log L and log Z (but the t-value for log K/L is diminished).

The technology variable on the other hand is shown to affect labor productivity significantly, noting the high t-value of the coefficient estimate in each specification where log Z appears. Dropping the technology variable causes a decrease in the coefficient of determination by nearly 0.10 percentage points and also lowers the t-value of the labor coefficient. In the "best" specification C-5 the coefficient estimate for log Z is seen to be 0.563, which is not significantly different at the 5 per cent level from the corresponding estimate (0.643) observed in the preceding section.

Direct estimation of the Cobb-Douglas production function also provides us with estimates of capital and labor elasticities of output and hence also of returns to scale. The capital elasticity estimate is the coefficient of log K/L, which is 0.390 in C-5; the labor elasticity is equal to $b_2 - b_1 + 1$ from eqth. (2), yielding an estimate in C-5 of 0.711. The two elasticity values sum up to 1.101, which is not significantly different from unity at the 5 per cent level. Therefore, constant returns to scale can be accepted.

To recapitulate, we have shown that the production function in Philippine manufacturing can be characterized by (a) unitary elasticity of substitution and (b) constant returns to scale.[8] The two analytical models employed in the present study are therefore not inconsistent.

IV. CONCLUDING REMARKS

The main objective of this paper has been to present some evidence that there is no significant relationship between industrial productivity and the amount of formal education of the labor force in the Philippines. While there are obvious limitations in the data used, our empirical finding tends to support the widely held view that Philippine schools and colleges do not offer the kind of education necessary for productive employment in local industries.[9] This is reflected in the unusually high level of unemployment among the educated members of the labor force [13]. To the extent that other less developed countries are similarly placed, development economists should look more to the quality of education being provided than merely

[8] P. Zaremba [16] has similarly concluded from a study of production functions in U.S. manufacturing that for empirical purposes it would be acceptable to use the Cobb-Douglas function with constant returns to scale rather than the CES function.

[9] See, for example, the recent assessment of the Philippine educational system by the Presidential Commission to Survey Education [9].

the amount of formal schooling made available to the labor force in evaluating the contribution of labor to economic growth.

Considering that educational systems in present-day less developed countries have been patterned arbitrarily after those of the former colonizing countries, human resource development may not be achieved in the economic sense by simply raising the educational attainment of the labor force. What would seem necessary is a purposeful reshaping of educational goals and investment that will alter the content of education to make it fit the contemporary needs of the developing economy.

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