# OCCUPATIONAL AND EDUCATIONAL STRUCTURES OF THE LABOUR FORCE AND LEVELS OF ECONOMIC DEVELOPMENT

## SOME INTERNATIONAL EVIDENCE

by

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This article presents certain results of a large scale study undertaken by the author, in collaboration with J. P. JALLADE and C. CRONER, at the Organisation for Economic Co-operation and Development (OECD). The full Report is available in mimeographed form under the title : *Occupational and Educational Structures of the Labour Force and Levels of Economic Development - Possibilities and Limitations of an International Comparison Approach* (OECD, 1969, ref. no. DAS/EID/69.16). The final version will be published by the OECD in 1970.

## 1. INTRODUCTION

The purpose of this study can be described as follows : within the limitations inherent in international comparisons, to attempt to identify the forces which govern the evolution of the skill structure of the labour force and to quantify the impact of each of these forces. Relevant information was obtained for up to fifty countries drawn from the latest rounds of Censuses, i.e. for the years 1960 or 1961. The amount of detail in which the data is available varies according to the country. The number of observations (the units of observation are the countries) differs, therefore, according tot he level of aggregation of the analysis.

The interested reader is referred to the following publications which also deal, in varying degree of detail and sophistication, with some of the aspects touched upon in the present article :

1 — P. R. G. Layard and J. C. Saigal : „Educational and Occupational Characteristics of Manpower : an International Comparison", *British Journal of Industrial Relations*, Vol. IV, July 1966.

2 — M. A. Horowitz, M. Zymelman, I. L. Herrnstadt: *Manpower Requirements for Planning: an International Comparison Approach*, Northeastern University, Boston, December 1966 (2 volumes) (1).

3 — *The Educational Structure of the Labour Force: a Statistical Analysis*, Netherlands Economic Institute, Rotterdam, March 1966 (mimeo. pub. No. 37/66).

4 — J. G. Scoville : *The Occupational Structure of Employment, 1960-1980*, I.L.O., Geneva, August 1966 (mimeographed).

## 2. SCOPE OF THE STUDY

The bulk of the analysis undertaken in the framework of the present article concentrates on an attempt to explain changes in occupational and educational structures of the labour force as observed in the various countries under review (2). In trying to explain the *observed* situation, explanatory variables have frequently been brought in which are themselves extremely difficult, if not impossible, to forecast. A distinction has, therefore, to be made between an attempt to explain the observed situation, and the usefulness of the established relationships for forecasting purposes.

The three following sections of this paper deal successively with the occupational structure; with the educational profile of occupational categories; and finally with the educational structure of the labour force directly.

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(1) Mr. Zymelman has produced two other documents using the same data : „Productivity, Skills and Education in Manufacturing Industries", UNIDO, May 1967 (restricted), and „The Relationship between Productivity and the Formal Education of the Labour Force in Manufacturing Industries", Center for Studies in Education and Development, Harvard University, prepared for UNIDO, November 1967 (Preliminary, mimeographed).

(2) For a listing of the countries used in the different parts of the analysis, see Annex 1.

(i) *The occupational structure*

In the first instance, the type of relationship examined is of the following general firm :

$$L_j/L = F(Z) \qquad [2.1]$$

The dependent variable is, therefore, the percentage of a given occupation j in the whole economy or in a sector of economic activity; Z stands for any of the explanatory variables selected to reflect levels of economic and technological development, again both on the level of the whole economy as well as on the sector level. This variable Z will in the following pages take the form of output per worker (X/L), of gross capital formation per worker ($\Sigma$ I/L); of a non-monetary indicator of the level of economic development (In); of energy consumption per worker (En/L), etc. The variable Z should reflect as much as possible the different factors that determine the economic and technological „requirements" for the various occupational categories.

(ii) *Occupation/education relationships*

An analogous pattern of analysis as the one outlined above has also been adopted for the investigation into the observed differences in the educational profiles of occupational categories. The first general type of relationship tested is :

$$L_{jk}/L_j = F(Z) \qquad [2.2]$$

The number of persons with an educational level k in occupation j as a percentage of the total number of persons in occupation j, is made a function of the same kind of explanatory variables as mentioned under (i) above. The second type of relationship examined is :

$$L_{jk}/L = F(Z) \qquad [2.3]$$

This time the number of persons with educational level k in occupation j is taken as a proportion of the total labour force. The first relationship [2.2.] follows the so-called manpower approach which—in its methodological chain—first forecasts the occupational structure and then translates each of the occupational categories into educational equivalents. The second [2.3] can best be considered as a weighted occupational category and—while giving the same information as [2.2]—will serve to test the hypothesis that when only certain educational categories within the occupational groups are taken into account, measurement errors will tend to diminish and the chances to obtain better relationships will consequently improve.

Next to the above types of "demand" equations, an attempt was also made to examine whether the educational supply pattern can, to any extent, add to the explanation of the observed educational profiles of the different occupational categories. This is done by introducing the total stock of people in the labour force with a level of education (k) which normally corresponds to the occupational category in question. This variable ($L_k/L$) has been examined alone and in combination with the economic and technological indicators :

$$L_{jk}/L_j = F\ (L_k/L) \qquad [2.4]$$

$$L_{jk}/L_j = F\ (Z, L_k/L) \qquad [2.5]$$

The analysis of the occupation/education relationship is possible for the whole economy only.

(iii) *The educational structure*

The educational structure of the labour force has been examined with the aid of the following relationships which, in the light of the above description, need no further elaboration:

$$L_k/L = F\ (Z) \qquad [2.6]$$

$$L_k/X = F\ (Z) \qquad [2.7]$$

This analysis was possible both at the level of the whole economy and for certain sectors.

In the following sections a few examples will be presented of some of the results obtained during the investigation of each of the three broad areas outlined in this section.

## 3. OCCUPATIONAL STRUCTURES AND ECONOMIC DEVELOPMENT

In this section attention will be mainly focused around relationship [2.1] : $L_j/L = F\ (Z)$. This relationship has been tested for the whole economy, for the eight one-digit sectors of economic activity, as well as for certain manufacturing branches (at the two-digit level of I.S.I.C.). The unit of observation is the country; in other words, the occupational categories have been examined for *one economic sector* at a time across the countries for which observations on $L_j$ and Z were available. In this section some results will be presented of the correlation and regression analyses carried out for the whole economy, for Manufacturing and for Services (tables 1, 2 and 3). It is in those two latter sectors that the bulk of highly qualified manpower (HLM) can be found, and they therefore deserve special attention.

(i) *The variables*

The dependent variables (occupational categories—the $L_j$'s) which are presented here are the following (1) : 0: professional and technical workers; 1: executive and managerial personnel; 2: clerical workers; 3: salesworkers; 0-0: engineers, architects and surveyors; 0-1: chemists, physicists, etc.; 0-2: agronomists, biologists; 0-X: draughtsmen, and science and engineering technicians; 1-1: directors, managers and working proprietors; 0-02: engineers alone.

Moreover, at the level of the major occupational groups 0 + 1 together has also been tested (called here HLM category) as well as 0 + 1 + 2 + 3 (the non-manual workers). At the level of the minor groups, 0-0, 0-1, 0-2 and 0-X have been grouped into an STP (scientific and technical personnel) category.

The different explanatory variables (Z) adopted and presented in this paper are : output per man (X/L for the whole economy; $X_m/L_m$ for manufacturing) or GDP per capita (X/P) for Services; a non-monetary indicator of development (In) (2); energy consumption per capita ($E_n/P$); gross capital formation per worker

(1) The codes refer to those used for the major groups, the minor groups and the unit groups in I.S.C.O. — *International Standard Classification* of Occupations, I.L.O. Geneva, 1958. In the following pages we will frequently only refer to these codes, without always giving anew the full name of the occupational category.

(2) The index used here is the one published by D. H. Niewiaroski : "The level of living of nations : meaning and measurement", in *Estadistica*, Interamerican Statistical Institute, Washington, March 1965. For a critical review, see W. Beckerman : *International Comparisons of Real Incomes*, O.E.C.D., 1966, p. 22.

($\Sigma$ I/L) over a period of seven to eight years preceding the Census year, and the sector share of employment for Manufacturing ($L_m/L$) and Services ($L_s/L$).

This article is not the place to go into a detailed discussion of the difficulties of measurement, nor of a justification of the inclusion of the above variables, which moreover would appear to be rather obvious. A few words on the NIEZWIAROSKI non-monetary indicator may be in order, however. The object of this "level of living" approach is to avoid the purchasing power problem, and its fundamental postulate is that well-being is reflected by certain key items in a given nation's economy. By selecting appropriate items and giving them suitable weights, an index can be constructed that provides a direct measure of well-being. Since the items chosen are expressed in physical quantities rather than money values, conversion at dubious exchange rates is unnecessary, and the troublesome purchasing power problem is avoided. The basic items selected by Niewiaroski for the construction of his index are the following : (i) proportion of labour force engaged in non-agricultural activities; (ii) number of telephones per capita; (iii) energy consumption per capita; (iv) steel consumption per capita; (v) cement production per capita; (vi) motor vehicles per capita; (vii) per capita fibre consumption; (viii) proportion of protein in diet.

It was considered to be of interest to include this indicator in the study in order to examine how its influence compared with that of the productivity variable (X/L), in the measurement of which the exchange rate problem may play a distorting role. Clearly, for forecasting purposes, the In (non-monetary indicator) is useless, and from that point of view one can therefore only hope that X/L will turn out to be at least as important an explanatory variable as In.

(ii) *Simple regression analysis - log-linear form*

The equation which was used at this stage of the analysis had the following general form :

$$\log L_j/L = a + b \log (Z) \qquad [3.1]$$

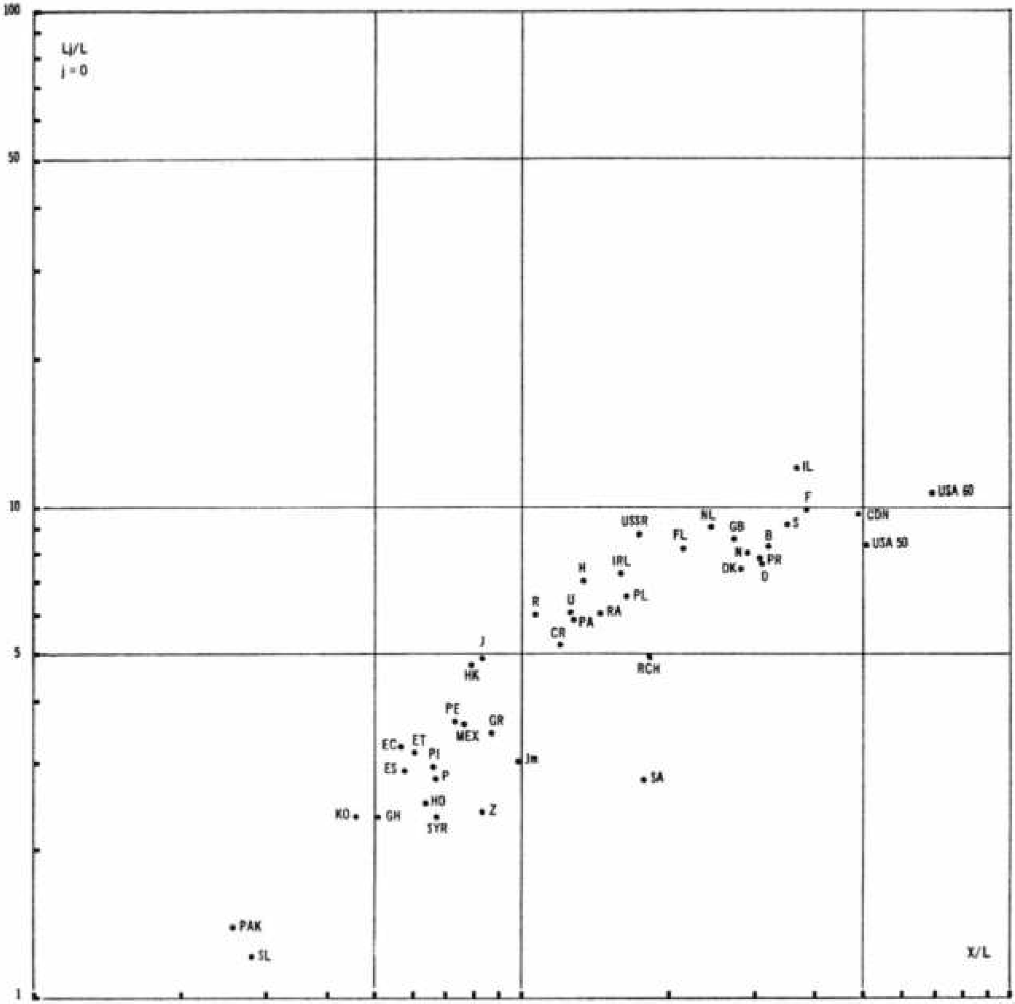
where j stands successively for the occupational categories enumerated above and which can be found back at the left-hand

TABLE I : Whole Economy : Occupational Categories (major and minor groups) and Indicators of Economic and Technological Development : Correlation (r) and Regression Coefficients (b) and Number of Observations (n).

| | (1) Output per worker X/L | | | (2) Non-Mon. Index In | | | (3) Energy Input En/P | | | (4) Gross Capit. Form Σ I/L | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | r | b | n | r | b | n | r | b | n | r | b |
| *Major Groups* | | | | | | | | | | | | |
| 0 | 43 | 0.91 | 0.66(0.05) | 43 | 0.89 | 0.84(0.07) | 42 | 0,86 | 0.38(0.04) | 28 | 0.92 | 0.51(0.04) |
| 1 | 42 | 0.83 | 0.92(0.10) | 42 | 0.76 | 1.09(015) | 41 | 0.78 | 0.52(0.07) | 27 | 0.74 | 0.60(0.11) |
| 2 | 42 | 0.82 | 0.71(0.08) | 42 | 0.85 | 0.96(0.09) | 41 | 0.81 | — | 27 | 0.75 | — |
| 3 | 42 | 0.20 | 0.14(0.11) | 42 | 0.23 | 0.22(0.15) | 41 | 0.09 | — | 27 | 0.32 | — |
| 0+1 | 42 | 0.93 | 0.73(0.05) | 42 | 0.88 | 0.90(0.08) | 42 | 0.85 | 0.41(0.04) | 27 | 0.93 | 0.54(0.04) |
| 0+1+2+3 | 42 | 0.79 | 0.48(0.06) | 42 | 0.79 | 0.62(0.09) | 41 | 0.60 | — | 27 | 0.83 | — |
| *Minor Groups* | | | | | | | | | | | | |
| 0–0 | 24 | 0.87 | 1.06(0.13) | 24 | 0.82 | 1.29(0.19) | 23 | 0.87 | 0.66(0.08) | 15 | 0.70 | 0.78(0.22)) |
| 0–1 | 22 | 0.79 | 1.21(0.21) | 22 | 0.70 | 1.36(0.31) | 22 | 0.81 | 0.83(0.13) | 15 | 0.62 | 0.67(0.24) |
| 0–2 | 26 | 0.53 | 0.89(0.29) | 26 | 0.52 | 1.14(0.39) | — | — | — | — | — | — |
| 0–X | 23 | 0.53 | 0.64(0.22) | 23 | 0.60 | 0.98(0.29) | 22 | 0.74 | 0.55(0.11) | 15 | 0.63 | 0.73(0.26) |
| STP | 31 | 0.78 | 0.98(0.14) | 31 | 0.82 | 1.33(0.18) | 30 | 0.86 | 0.66(0.07) | 15 | 0.76 | 0.84(0.18) |
| 0–02 | 16 | 0.85 | 1.03(0.16) | 16 | 0.82 | 1.39(0.26) | 15 | 0.87 | 0.69(0.11) | 10 | 0.75 | 0.81(0.25) |
| 1–1 | 25 | 0.73 | 0.92(0.18) | 25 | 0.66 | 1.04(0.25) | 24 | 0.68 | 0.52(0.12) | 17 | 0.62 | 0.57(0.19) |

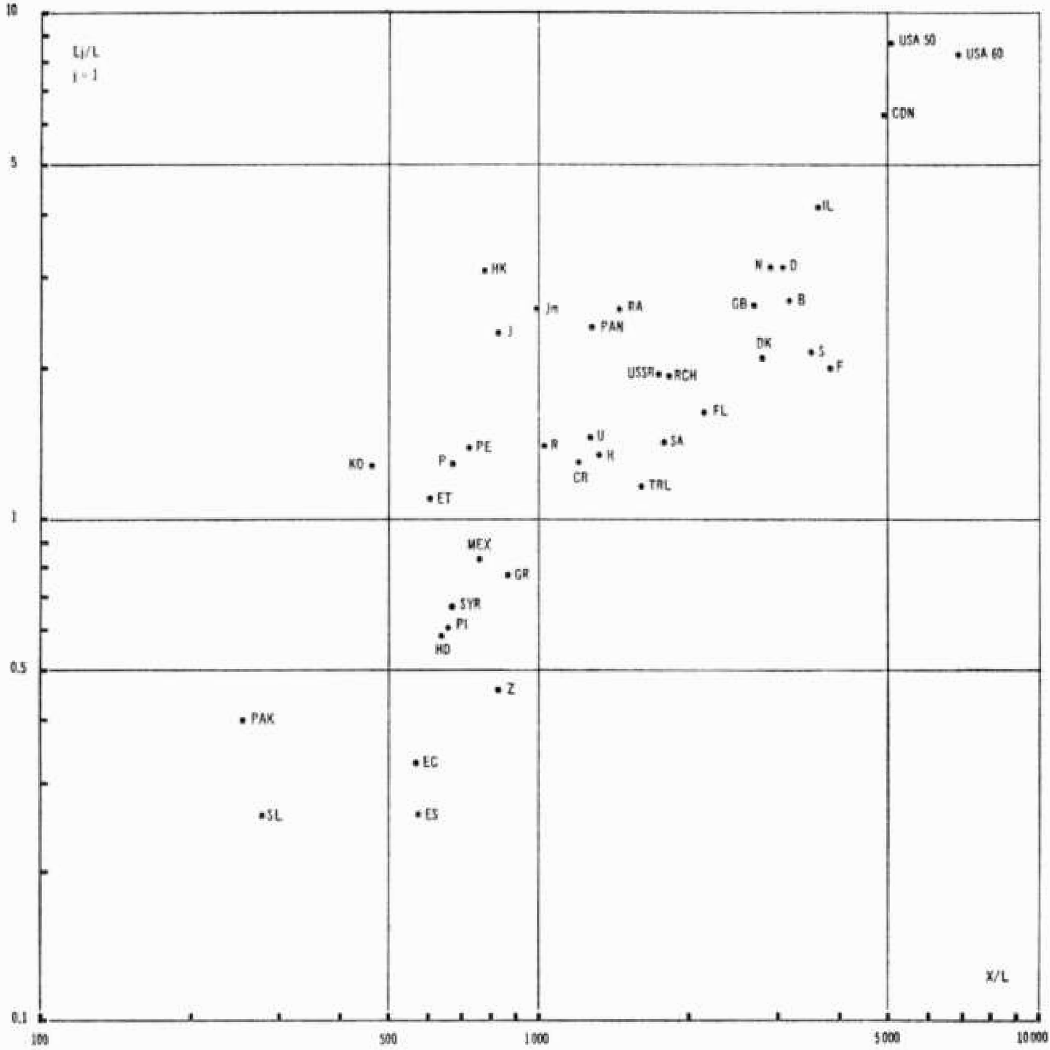
*Note :* The complete results of the regression analysis are presented in the full OECD Report mentioned above. This remark applies also to all subsequent tables in this article.

GRAPH 1 : Whole economy : Professional and Technical workers ($L_i/L$) and output per worker ($X/L$)




column of tables 1, 2 and 3; and Z for $X/L$, In, En/P, $\sum I/L$ and $L_1/L$. These explanatory variables have also been presented above and can be found back, horizontally, in the top row of the tables. Table 1 presents some of the results for the whole economy; table 2 is concerned with Manufacturing, and table 3 with Services. Graphic presentations are shown for occupations 0 and 1

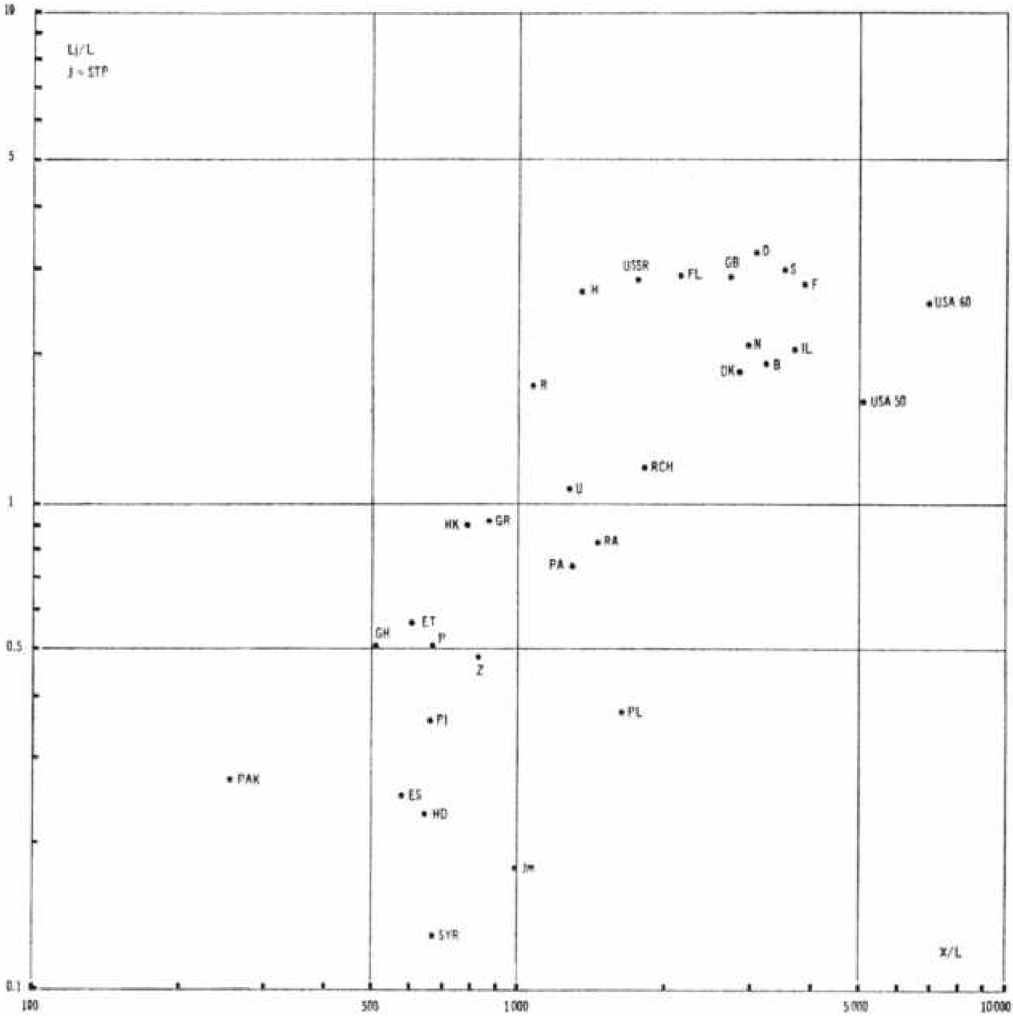
GRAPH 2 : Whole economy : Administrative, executive and managerial workers ($L_i/L$) and output per worker (X/L)




and STP for the whole economy; o for Services, and o-o for Manufacturing; in all cases these occupations have been shown in relacion to X/L (X/P in the case of Services).

Looking first at the correlation coefficients (r) for the whole economy, as presented in table 1, it becomes clear that the best

GRAPH 3 : Whole economy: Scientific and Technical personnel ($L_i/L$) and output per worker (X/L)




overall results are obtained with the productivity variable (X/L), although the r's obtained with the other explanatory variables are quite respectable as well. Thus, the correlations between occupational categories and X/L on the one hand, and In on the other, can be considered for all intents and purposes as equal. It may, therefore, be concluded that avoiding the exchange rate and the

TABLE 2 : Manufacturing : Occupational Categories (major and minor groups) and Indicators of Economic and Technological Development : Correlation (r) and Regression Coefficients (b) and Number of Observations (n)

| | (1) Output per worker Xm/Lm | | | (2) Non-Mon. Index In | | | (3) Gross Capt. Form Σ Im/Lm | | | (4) Sector Share Lm/L | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | r | b | n | r | b | n | r | b | n | r | b |
| *Major Groups* | | | | | | | | | | | | |
| 0 | 30 | 0.80 | 1.00(0.14) | 35 | 0.82 | 1.51(0.19) | 11 | 0.70 | — | 40 | 0.67 | 1.35(0.24) |
| 1 | 30 | 0.67 | 0.59(0.12) | 35 | 0.73 | 0.99(0.16) | 11 | 0.48 | — | 40 | 0.52 | 0.80(0.21) |
| 2 | 30 | 0.79 | 0.65(0.10) | 35 | 0.85 | 1.04(0.11) | 11 | 0.69 | — | 40 | 0.72 | 0.97(0.15) |
| 3 | 30 | 0.74 | 0.96(0.17) | 35 | 0.57 | 0.99(0.25) | 11 | 0.12 | — | 40 | 0.44 | — |
| 0+1 | 30 | 0.80 | 0.72(0.10) | 35 | 0.84 | 1.22(0.14) | 11 | 0.80 | 0.51(0.14) | 40 | 0.66 | 1.05(0.19) |
| 0+1+2+3 | 30 | 0.82 | 0.69(0.09) | 35 | 0.85 | 1.08(0.12) | 11 | 0.65 | — | 40 | 0.71 | — |
| *Minor Groups* | | | | | | | | | | | | |
| 0–0 | 14 | 0.75 | 1.39(0.36) | 14 | 0.75 | 1.74(0.43) | — | — | — | 14 | 0.73 | — |
| 0–1 | 18 | 0.13 | n.s. | 18 | 0.06 | n.s. | — | — | — | 20 | 0.07 | — |
| 0–2 | — | — | — | — | — | — | — | — | — | — | — | — |
| 0–X | 16 | 0.50 | 1.17(0.54) | 15 | 0.48 | 1.19(0.61) | — | — | — | 18 | 0.66 | 2.31(0.66) |
| STP | 20 | 0.65 | 1.03(0.43) | 22 | 0.50 | 1.02(0.39) | — | — | — | 25 | 0.63 | 1.68(0.43) |
| 0–02 | 10 | 0.80 | 0.96(0.25) | 12 | 0.86 | 1.46(0.31) | — | — | — | 12 | 0.75 | 1.76(0.42) |
| 1–1 | — | — | — | — | — | — | — | — | — | — | — | — |

purchasing power problem through the introduction of a non-monetary index of development, has *not* resulted in a better fit and additional explanatory power. This is important for those interested in manpower forecasting; although the future development of labour productivity is not easy to predict, "In" is of course next to impossible to forecast. Attention must also be drawn to the excellent performance of the Energy variable (En/P) with respect to the minor groups, and in particular the STP category. It also becomes clear that salesworkers (3) are in no way related to any of the explanatory variables selected. This problem will be taken up again in the next section, where a possible explanation of this "outstanding" result will be advanced. Interestingly enough, the r's for the minor group 0-0 and for the quite narrowly defined unit group 0.02 (engineering) are also quite high (0.87 and 0.85 respectively, with X/L). The STP group as a whole has a correlation coefficient between 0.79 and 0.86 with X/L and En/L respectively, which is not unsatisfactory. It has to be kept in mind, however, that the number of observations available for the minor occupational groups is less than for the major groups. Moreover, the data constraints were also very severe as far as the proxy variable for the capital stock is concerned ($\sum$ I/L).

For the problems under examination, the regression coefficients (the b's) and their standard deviations are more important than the correlation coefficients. Given the log-linear function adopted, these b's are of course readily interpretable elasticity coefficients of the $L_j/L$'s with respect to the different explanatory variables. As to the different major groups, the striking aspect is the higher b-coefficient for the managerial group (1) as compared to all the other major groups. In other words, with rising levels of development the managerial category would have a tendency to increase relatively faster than the other major groups, including the professional and technical workers. A glance at graph 2 could suggest that this high elasticity *might* be due to a few "suspicious" countries. This problem of "devient cases" will be dealt with below. All the b-coefficients of the major groups are statistically significant, except the one for salesworkers (3) which, decidedly, is our "bête noire".

An examination of the b-coefficients of the minor groups indicate that on the whole the STP categories have higher elasticities than the major groups, including managerial personnel. This is in particular the case for the engineering categories (0-0 and 0-02). It would, therefore, appear as if indeed scientific and technical personnel grows much faster than other HLM as development proceeds. However, again a note of caution has to be sounded. Not only is the number of observations different, but the standard deviations attached to the b-coefficients of the minor groups are much more important than for the major groups, so that careful interpretation is required. All this indicates that one will still find importantly different values for the occupational categories within the same development range. This is corroborated by the graphic presentations. At the end of this section this question will be taken up again.

Turning now to Manufacturing (table 2), it will be noted that in general the correlation coefficients are lower in this case as compared to those found at the level of the whole economy. Two striking features : first of all, the salesworkers this time are rather well correlated with the explanatory variables and particularly so with X/L and In. This occupational group appears to be better and more narrowly defined in this sector and appears to play an important role in the production process of the Manufacturing industries. The share of this type of labour which can be found in Manufacturing is small, however; the bulk is employed in Commerce. It is largely this fact—and the definitional problem of salesworkers in Commerce and in Services—that makes for the low and statistically non-significant correlation found for the whole economy (1). Secondly, the non-monetary indicator (In) is about as well, or better, correlated with the major groups and with the engineering categories as is output per worker. It is important to underline the fact that, whereas the technologists (0-0 and 0-02) do show a definite and significant relationship with economic and technological development in

(1) The correlation coefficient in Commerce between salesworkers and sector productivity is -0.52, and is significant at the 5 per cent level. With growing levels of development the number of salesworkers in Commerce diminishes, which is a consequence of the growing concentration of retail trade. The pattern is, however, very heterogeneous across countries, and it is no doubt because of the large proportion of shopkeepers in the total number of salesworkers that the results for the whole economy are what they are.

this sector, this is not at all the case with the so-called pure scientists (0-1).

The b-coefficients in this sector are, this time, much higher for the professional and technical workers (0) than for any other major group; it is exactly unity with respect to the productivity variable : a one per cent change in $X_m/L_m$ will tend to be accom-

GRAPH 4 : Manufacturing : Engineers, Architects and Surveyors ($L_{ij}/L_i$) and sector output per worker ($X_i/L_i$)

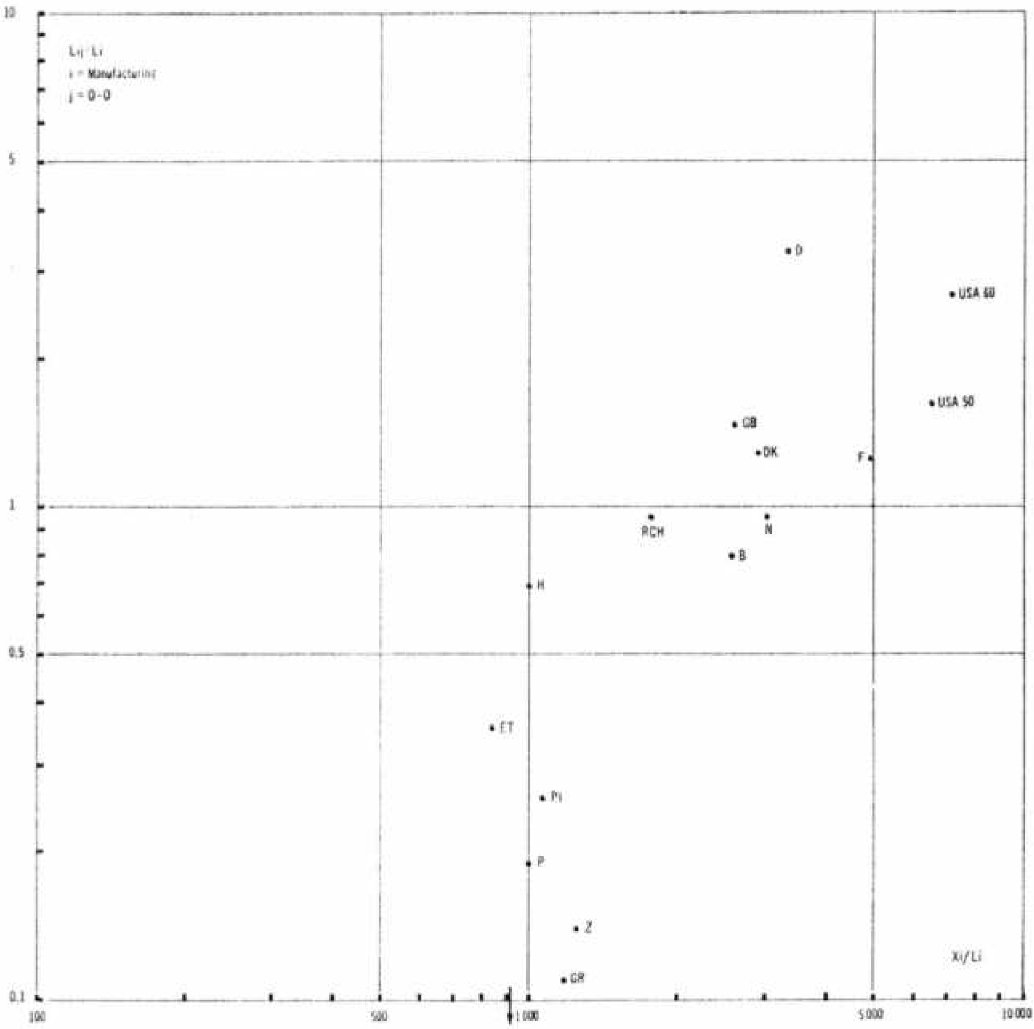


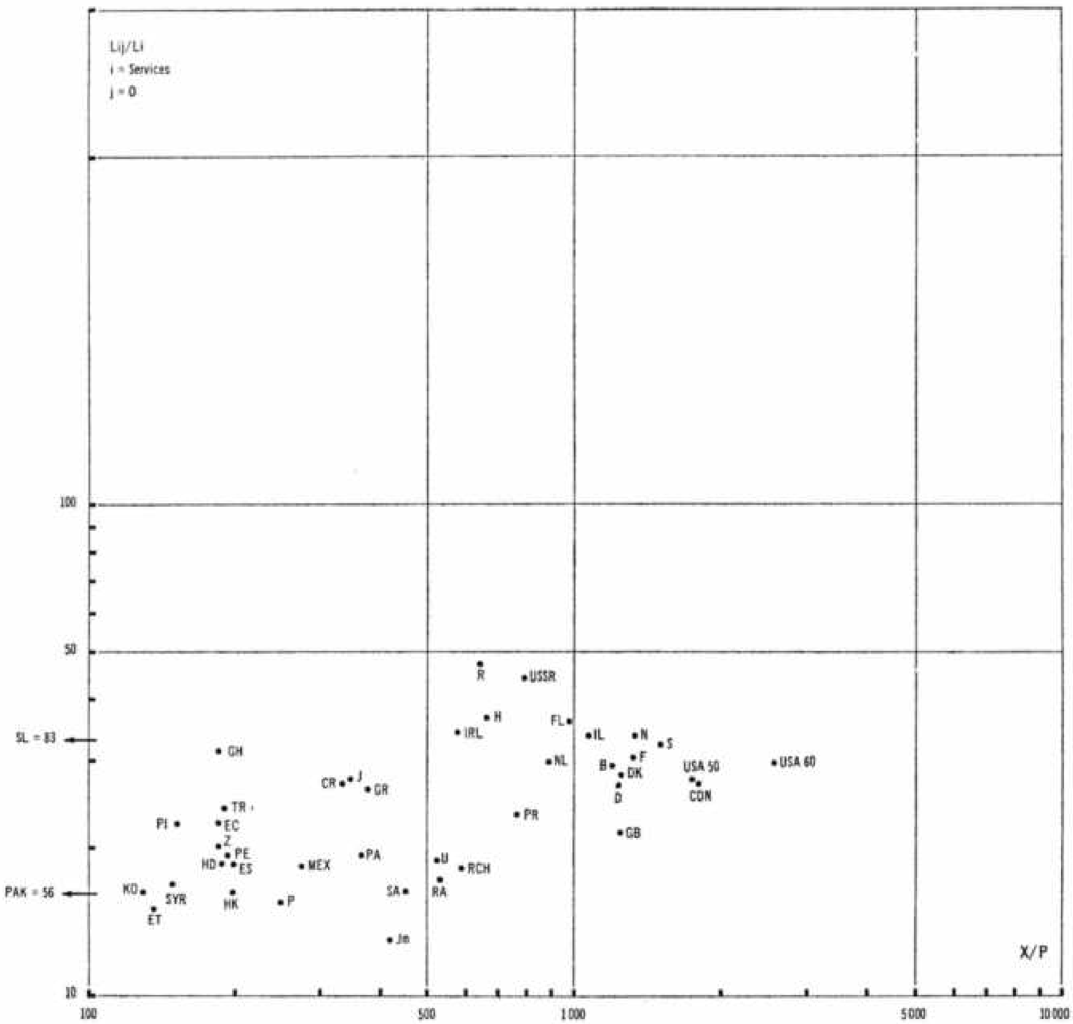
TABLE 3 : Services : Occupational Categories (major and minor groups and Indicators of Economic and Technological Development: Correlation (r) and Regression Coefficients (b) and Number of Observations (n)

| | (1) GDP per capita X/P | | | (2) Non-Mon. Index In | | | (3) Sector Share Ls/L | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | r | b | n | r | b | n | r | b |
| *Major Groups* | | | | | | | | | |
| 0 | 43 | 0.53 | 0.18(0.05) | 39 | 0.41 | 0.18(0.06) | 42 | 0.04 | n.s. |
| 1 | 42 | 0.43 | 0.28(0.09) | 38 | 0.26 | n.s. | 41 | 0.16 | n.s. |
| 2 | 42 | 0.26 | n.s. | 38 | 0.29 | n.s. | 41 | 0.31 | 0.23(0.11) |
| 3 | 43 | 0.13 | n.s. | 39 | 0.28 | n.s. | 42 | 0.25 | n.s. |
| 0+1 | 42 | 0.57 | 0.19(0.05) | 38 | 0.44 | 0.18(0.06) | 42 | 0.01 | n.s. |
| 0+1+2+3 | 42 | 0.58 | 0.16(0.04) | 38 | 0.51 | 0.16(0.05) | 41 | 0.13 | n.s. |
| *Minor Groups* | | | | | | | | | |
| 0–0 | 20 | 0.63 | 0.61(0.18) | 17 | 0.62 | 0.85(0.28) | 19 | 0.30 | n.s. |
| 0–1 | 20 | 0.41 | 0.47(0.24) | 18 | 0.46 | 0.77(0.37) | 19 | 0.11 | — |
| 0–2 | 23 | 0.25 | n.s. | 21 | 0.33 | n.s. | 22 | 0.34 | — |
| 0–X | 20 | 0.32 | n.s. | 17 | 0.40 | n.s. | 19 | 0.35 | — |
| STP | 27 | 0.56 | 0.42(0.12) | 24 | 0.59 | 0.62(0.18) | 26 | 0.05 | — |
| 0–02 | 15 | 0.64 | 0.49(0.16) | 12 | 0.40 | n.s. | 14 | 0.44 | — |
| 1–1 | 22 | 0.39 | n.s. | 19 | 0.29 | n.s. | 22 | 0.59 | 1.62(0.50) |

panied by a one per cent change in the *proportion* of professional and technical workers in the sector, almost twice as high as the change in the proportion of managerial workers. This is intuitively acceptable if it is remembered that, according to I.S.C.O., working proprietors are also classified under the managerial category, and that these tend to decrease with rising levels of economic development and the growing industrial concentration with which this is accompanied (1). In general, however, the standard deviations are higher than for the whole economy; this is particularly striking for the regression coefficients of the minor groups. For these latter groups, the relationships definitely cannot be used for forecasting purposes (see also graph 4).

(1) This seems to point to the fact that the high elasticity for this occupational category observed in the whole economy, may be due again to some specific sector like commerce. This will be examined in the full report.

GRAPH 5 : Services : Professional and Technical workers ($L_{ij}/L_i$) and GDP per Capita (X/P)




Finally, table 3 shows that for the Services sector (sector 8 of I.S.I.C.) both the correlation and the regression coefficients are relatively low, and that many of them are not significant. GDP per capita comes out on top, whereas sector share of labour is not related to the occupational structure at all, which could be expected. Interestingly enough, the engineering categories show again the most respectable correlation coefficients, although the standard errors of the b-coefficients are rather formidable. Graph 5 which relates the per capita GDP to the percentage of professional and technical workers in this sector indicates an irregular pattern with countries at the same level of development showing quite different proportions of professional and technical workers and vice versa. This may be due to an important extent to the different educational supply patterns. This will also be taken up again at the end of this section.

(iii) *A multiple regression analysis*

The above examples of the quantification of relationships between the occupational structure and indicators of development are based on simple correlation and regression analysis. It would appear of interest to examine if the introduction of more than one explanatory variable increases the results so far obtained in any significant manner. In this respect, it is especially X/L and Σ I/L which are worth considering. However, the results are disappointing, and this seems to be mainly due to the high inter-correlation between X/L and Σ I/L. This causes the resulting regression coefficients to become non-significant. One example wille suffice. For minor group o-o, at the level of the whole economy, the following simple regression equation was calculated with Σ I/L as the explanatory variable (cf. table 1) :

$$\log L_{0\text{-}0}/L = -2.78 + \underset{(0.22)}{0.78} \log (\Sigma\ I/L) \quad t = 0.70 \quad n = 15 \qquad [3.2]$$

Adding X/L to the equation and using the same country observations, the results are as follows :

$$\log L_{0\text{-}0}/L = -4.04 + \underset{(0.62}{1.44} \log X/L - \underset{(0.49)}{0.29} \log \Sigma I/L \quad R = 0.80 \quad n = 15 \qquad [3.3]$$

The correlation coefficient has gone up from 0.7 to 0.8 by adding X/L. This, however, has been obtained at the expense of a severe loss in significance of the regression coefficients. Moreover, table 1 reminds us of the fact that the results with X/L alone were much better in alle respects as compared to the outcome of equations [3.2] and [3.3] (1). The only interesting aspect of

(1) r = 0.87, b = 1.06 (0.13), with 24 observations.

equation [3.3] is the suggestion of the possibility of substitution between capital and engineers (cf. the negative regression coefficient for $\Sigma I/L$). But the huge standard error attached to the regression coefficient makes even this aspect highly dubious.

The above example illustrates a general phenomenon : the different explanatory variables selected cannot fruitfully be combined in a multiple regression equation. Simple regression analysis, has to be adhered to.

(iv) *Correcting for "deviant cases"*

In the preceding calculations use has been made of the maximum number of available observations. An attempt will now be made to identify those observations which can be considered to disturb the "true" relationship between the variables for any one—or a combination—of the following reasons : classification errors; errors in measurements; observations which clearly deviate from the basic pattern because of certain atypical events. Moreover, in certain cases observations were also taken out because of their extreme values, which might bias the regression results by their extreme position in relation to other observations, resulting in "stretching out" the spread of observation points. A few examples for the whole economy and for Manufacturing will be rapidly presented. It would lead too far—in the limits of the present article—to name and to justify the countries excluded. Details on that score can be found in the full report.

At the level of the whole economy and in the cases of major group 0 and major group 1, seven and six countries were taken out respectively. Neither the correlation nor the regression coefficients changed to any significant extent when the equations were re-calculated in this way. This is, therefore, against our expectations as far as the managerial category is concerned [cf. graph 2 and the relevant discussion in paragraph (ii) above]. The situation becomes different when the minor groups are considered, still for the whole economy. The log-linear relationship between minor group 0-0 and $X/L$—and taking out six countries—now give a correlation coefficient of 0.95 instead of 0.87 as shown in Table 1; the b-coefficient becomes 0.96 (0.08) instead of 1.06 (0.13). For the STP group the correlation coefficient increases from 0.79 to 0.88 (with $n = 24$), whereas the regression coefficient does not change significantly : 0.91 (0.11) instead of 0.98 (0.14).

In the case of Manufacturing, the exclusion of "deviant cases" confirms the unitary elasticity for professional and technical workers with respect to sector productivity, as presented in table 2. The b-coefficient now becomes 1.06 (0.11) and r increases from 0.80 to 0.89 (for n = 27). For salesworkers, it will be recalled, a relatively high r was found, but the b-coefficient looked suspiciously high (0.96). In the "corrected" version, the regression coefficient becomes 0.64 (0.16), and r also decreases, from 0.74 to 0.61 (for n = 27). As to the STP group, eliminating two deviant countries (n = 18), raises r (with respect to productivity) from 0.65 to 0.85, whereas the b-coefficient becomes more precise : 1.15 (0.17).

It is, therefore, beyond doubt that the correction for so-called deviant cases has been successful—and particularly so for the minor groups—in improving the precision of the estimate, both for the whole economy and for the Manufacturing industries.

### (v) *An attempt at sector disaggregation: Manufacturing branches*

One of the results of the analysis presented so far has been that the relationships found between the occupational structure on the one hand, and the economic indicators on the other are more systematic and more reliable at the macro-economic level than on the sector level. In other words, sector disaggregation actually made for poorer results (1). An attempt has been made to examine whether this trend is confirmed at the sub-sector level. The data available did not permit covering more than two two-digit branches in Manufacturing : chemical industries (I.S.I.C. 31-32) and basic metals and metal products (I.S.I.C. 34-38). The number of observations available at this level of analysis is 13 only, and graphic analysis indicates that the relationship between the various occupational categories and labour productivity of the branches is very erratic indeed. Any estimates drawn from such data would, therefore, yield very poor results.

(1) Although account has to be taken of the improved results when correcting for deviant cases, as shown in the previous paragraph.

### (vi) *Functions with variable elasticity*

The preceding analysis has been based entirely on an assumption of constant elasticities implicit in the adoption of a log-linear relationship between the variables. It may be argued that it is unrealistic to assume such an unchanging geometric relationship, particularly over longer periods of time, and that, for example, a *semi-logarithmic* function would be more appropriate to depict the true relative development between the variables. A non-linear trend may also be caught by fitting a *parabolic* function. When it is felt that some upper limit exists in the growth of certain occupations, an *asymptote* would take account of that. The plain *linear* arithmetic function might, of course, also be tried, if one sees any reason for doing so.

Without exception, these "refinements", when tried in those instances considered appropriate, did not give significantly better results than the log-linear relationship. In actual fact, in most cases the results obtained were worse in terms of the value of the correlation coefficients and the significance of the regression coefficients.

### (vii) *Tentative and preliminary conclusions*

The preceding overview of certain results of the occupational analysis suggest the following tentative conclusions :

— Output per worker and per capita product are, across the board, the best explanatory variables of those included in the analysis. In particular, the non-monetary indicator is, on the whole, *not* better related to the occupational structure than X/L.

— The introduction of additional explanatory variables into the regression equation, although frequently improving the correlation coefficient, makes the estimate higly indeterminate because of the high standard errors, caused by the high intercorrelation between most of the independent variables.

— The best results were obtained for the whole economy, both in terms of correlation coefficients and of the significance of the regression coefficients. These results can even be improved upon by a careful correction for "deviant" countries. As a minimum, therefore, the international comparison approach could serve as a useful macro-economic checking device of national manpower estimates.

— The results in Manufacturing, and particularly after correcting for "deviant" cases, are hopeful as well, although the problem of the high standard errors of the regression coefficients begins to loom large. In the other economic sectors the results are less encouraging, although always interesting.

— Within the range of levels of development of the countries under review, it would appear as if the log-linear (constant elasticity) function performs best.

— There is no doubt, however, than even if the regression results are fairly respectable, one can still observe different values for the occupational categories within rather narrow productivity ranges (cf. graph 1). This is, of course, even clearer in other cases, like the one depicted in graph 4 and 5. The final report goes into the possible explanations for this phenomenon: from classification and definitional problems, via differences in the production structure of the sectors in the various countries to the more interesting cases of differences in the utilisation pattern of highly qualified personnel. For example, it may legitimately be asked, in how far the situation in the Services sector, as shown in graph 5, has been caused by educational supply effects in different industrial development contexts. Quite clearly, at the level of aggregation of this study and with the kind of data used, any interpretation has to be attempted with extreme care.

## 4. OCCUPATIONS, EDUCATION AND ECONOMIC DEVELOPMENT

The previous section was concerned with changes in occupational percentages and coefficients according to levels of economic and technological development. The present section introduces a new dimension into the analysis in the form of the various levels of educational attainment associated with the different occupational categories. This analysis is only possible for *the whole economy*, because three-way classifications—occupations by education by economic sector—are still very rare. However, one of the conclusions of the previous section was that the international data under review—and with regard to the occupational distribution of the labour force—appeared to be most useful at the macro-economic level (Table 1). This finding enhances, therefore, the interest of going into more depth precisely at that level of aggregation.

The number of observations available for this kind of analysis is less than that at our disposal for the occupational analysis. Nevertheless for most calculations 17 to 25 countries could be included.

The levels of education alattainment distinguished had to be few, as will be readily understood. Moreover, they are taken as cumulative groups : A : university degree; B : complete secondary education and beyond; C : more than eight years of schooling; D : eight years of schooling and less. Some results are also presented concerning the average number of years of schooling embodied in an occupational category or in the total labour force.

(i) *Occupation-Education Relationship and Economic Indicators*

The basic dependent variables in this paragraph are $L_{jk}/L_j$ and $L_{jk}/L$. The first one stands for the number of people in occupation j with educational level k as a proportion of the total number of persons in occupation j. The second variable stands for the number of people in occupation j with educational level k as a proportion of the *total labour force*. The explanatory variables (Z) retained are output per worker (X/L); the non-monetary index of Niewiaroski (In), and gross capital formation per worker ($\Sigma$ I/L). The relationships to be tested in this paragraph are, therefore, the following :

$$\log L_{jk}/L_j = a + b \log (Z) \qquad [4.1]$$

$$\log L_{jk}/L = a + b \log (Z) \qquad [4.2]$$

Because of the smaller number of observations available as compared with the investigation carried out in section 3, the changes in occupational categories alone have been examined again with the aid of equation [3.1], but adopting the same observations as for the above two equations. Finally, for comparison purposes and anticipating on section 6 of this paper, the education categories have been examined directly :

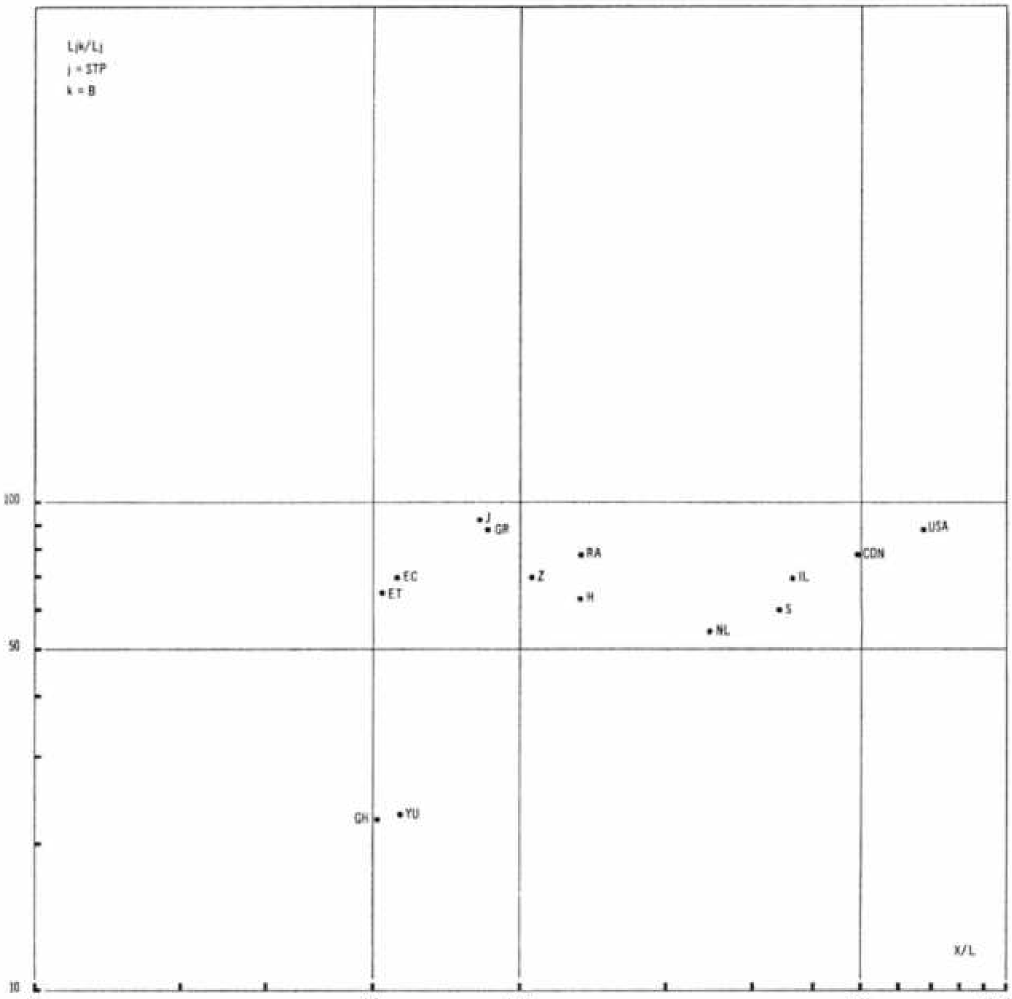
$$\log L_k/L = a + b \log (Z) \qquad [4.3]$$

Table 4 contains some of the results of the correlation and regression analysis carried out between $L_{jk}/L_j$ and the three

TABLE 4 : Whole Economy : Occupations, Education and Indicators of Economic and Technological Development : Correlation and Regression Coefficients of the Following Equation : $\log L_{jk}/L_j = a + b \log(Z)$.

| | | University Degree (A) | | | Compl. Secondary and over (B) | | | More than eight years (C) | | | Eight years and less (D) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | r | b | n | r | b | n | r | b | n | r | b |
| *Major Groups* | | | | | | | | | | | | | |
| 0 | X/L | 25 | 0.28 | 0.20(0.15) | 21 | 0.42 | 0.15(10.07) | 17 | 0.40 | 0.08(0.05) | 17 | -0.38 | -0.40(0.25) |
| | In | 25 | 0.38 | 0.37(0.19) | 21 | 0.53 | 0.25(0.09) | 17 | 0.41 | 0.13(0.07e | 17 | -0.38 | -0.59(0.37) |
| | ΣI/L | 22 | 0.20 | 0.12(0.14) | 19 | 0.41 | 0.12(0.06) | 13 | 0.41 | 0.06(0.04) | 13 | -0.42 | -0.36(0.23) |
| 1 | X/L | 25 | 0.12 | 0.10(0.17) | 21 | 0.28 | 0.16(0.12) | 17 | 0.53 | 0.19(0.08) | 17 | -0.39 | -0.24(0.15) |
| | In | 25 | 0.23 | 0.25(0.22) | 21 | 0.34 | 0.25(0.16) | 17 | 0.44 | 0.23(0.12) | 17 | -0.33 | -0.30(0.22) |
| | ΣI/L | 22 | 0.37 | 0.24(0.13) | 19 | 0.42 | 0.19(0.10) | 13 | 0.68 | 0.18(0.06) | 13 | -0.45 | -0.24(0.14) |
| 3 | X/L | 25 | 0.42 | 0.59(0.27) | 21 | 0.51 | 0.78(0.30) | 17 | 0.69 | 0.64(0.17) | 17 | -0.63 | -0.31(0.10) |
| | In | 25 | 0.41 | 0.80(0.37) | 21 | 0.44 | 0.91(0.42) | 17 | 0.61 | 0.84(0.28) | 17 | -0.57 | -0.42(0.16) |
| | ΣI/L | 22 | 0.34 | 0.41(0.26) | 19 | 0.47 | 0.48(0.21) | 13 | 0.64 | 0.37(0.14) | 13 | -0.56 | -0.24(0.11) |
| 7/8 | X/L | | | | 21 | 0.48 | 0.95(0.40) | 17 | 0.59 | 0.70(0.25) | 17 | -0.36 | -0.16(0.10) |
| | In | | | | 21 | 0.39 | 1.02(0.56) | 17 | 0.52 | 0.91(0.39) | 17 | -0.28 | -0.18(0.16) |
| | ΣI/L | | | | 19 | 0.45 | 0.54(0.26) | 13 | 0.49 | 0.44(0.24) | 13 | -0.31 | -0.11(0.11) |
| *Minor Groups* | | | | | | | | | | | | | |
| STP | X/L | 19 | -0.09 | -0.06(0.17) | 14 | 0.42 | 0.21(0.13) | | | | | | |
| | In | 19 | -0.09 | -0.09(0.24) | 14 | 0.42 | 0.29(0.18) | | | | | | |
| | ΣI/L | 16 | -0.01 | -0.01(0.17) | 12 | 0.40 | 0.18(0.13) | | | | | | |
| *Educational Category* | | | | | | | | | | | | | |
| ($I_k$/L) | X/L | 25 | 0.65 | 0.74(0.18) | 21 | 0.75 | 0.81(0.16) | 17 | 0.84 | 0.79(0.13) | 17 | -0.85 | -0.40(0.06) |
| | In | 25 | 0.71 | 1.09(0.22) | 21 | 0.76 | 1.09(0.22) | 17 | 0.81 | 1.12(0.21) | 17 | -0.86 | -0.27(0.04) |
| | ΣI/L | 22 | 0.57 | 0.54(0.17) | 19 | 0.73 | 0.61(0.14) | 13 | 0.76 | 0.56(0.14) | 13 | -0.83 | -0.23(0.05) |

GRAPH 9 : Whole Economy : Scientific and Technical personnel with complete secondary education and beyond ($L_{jk}/L_j$) and output per worker (X/L)




explanatory variables respectively. Moreover, the results with $L_k/L$ as the dependent variable are also shown (last three rows). One major group which was not included in the occupational analysis, makes an appearance here (major group 7/8 : craftsmen and production process workers).

The reason why $L_{jk}/L_j$ was chosen as one of the dependent variables has its origin in the fact that it represents one of the links in the methodological chain of the manpower approach. It will be recalled that in this approach, after the forecast of the occupational structure (the $L_j/L$'s), each of the occupational categories is converted into educational equivalents ($L_{jk}/L_j$'s). It is, therefore, not without interest to examine whether there are systematic changes in the proportion of persons holding certain educational levels within each occupational category at different levels of economic development. If one would still foster any illusions in this respect, a glance at the results presented in Table 4 will suffice to make them disappear. The large majority of the coefficients is non-significant. A few examples of the least unsatisfactory results (taken from Table 4) show the point.

For $j = 1$ and $k = C$, we obtain :

$$\log L_{jk}/L_j = 1.17 + \underset{(0.06)}{0.18} \log (\Sigma I/L) \quad t = 0.68 \qquad [4.4]$$

For $j = 3$ and $k = C$ :

$$\log L_{jk}/L_j = -0.62 + \underset{(0.17)}{0.64} \log (X/L) \quad r = 0.69 \qquad [4.5]$$

For $j = 7/8$ and $k = C$ :

$$\log L_{jk}/L_j = -1.06 + \underset{(0.25)}{0.70} \log (X/L) \quad r = 0.59 \qquad [4.6]$$

The results of Table 4 indicate that it is not possible to speak about a significant statistical relationship between the various $L_{jk}/L_j$'s and levels of economic development. This is also corroborated by Graph 9. The ratio under consideration seems to be too sensitive and too complex to be useful in an international comparison approach. It might have been expected, at the outset, that at least for the educationally very heterogeneous occupational categories, a somewhat better and systematic relationship would hold. This is to a limited extent the case for occupational groups 1 and 3 (Table 4). However, for clerical workers (major group 2, not shown in table) the correlation coefficients are lowest of all.

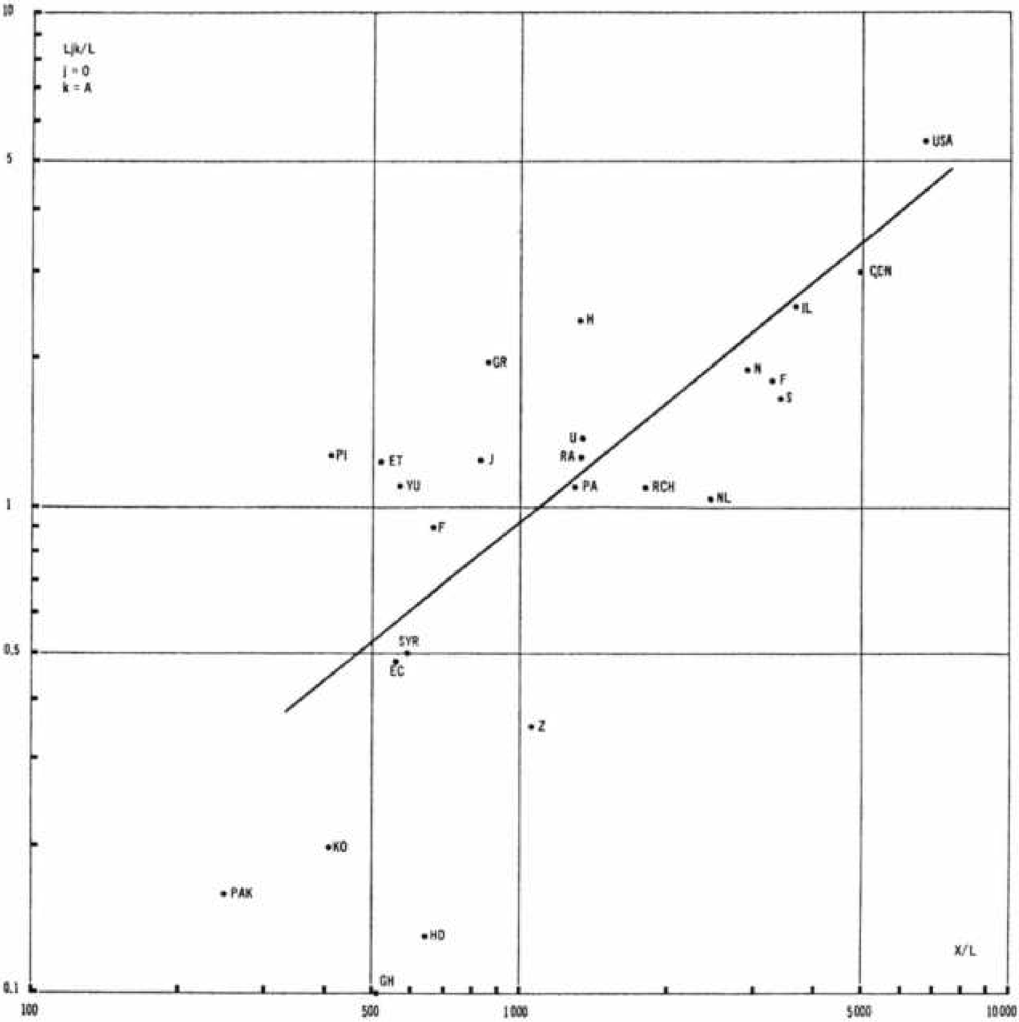
Table 5 presents the results of the analysis when $L_{jk}/L$ is taken as the dependent variable. This ratio can be considered as a weighted occupational percentage; it gives the same information as $L_{jk}/L_j$, but has the advantage of being a less "sensitive" ratio because of the much bigger denominator. Compared with those of Table 4, the present results are much more interesting from several points of view. First of all, the correlation coefficients should be compared with those found for the unweighted occupational categories, both in Table 1 and in the last three columns of Table 5 (these last two, calculated with different numbers of observations, give much the same results which reinforces the conclusions reached in Section 3). Second, the regression coefficients in Table 5 should be compared horizontally for each occupational category in order to identify "preferential educational levels". This aspect of the question will be taken up once more in the next paragraph, viewed from a slightly different angle.

Turning first to the values of the correlation and the significance of the regression coefficients, it will be noted that the introduction of educational levels into major group 0 causes a fall in r (as compared to Table 1 and last three columns of Table 5) and makes for less significant b-coefficients. The educational factor, apparently, introduces an element of rigidity caused, for example, by the high number of university graduates in this occupational category in certain low productivity countries (Greece, Egypt, Japan, Philippines are among them). This is illustrated in Graph 6. It is of interest to draw attention to the fact that, when isolating the STP category from the rest of major group 0, excellent results are obtained, particularly when weighting with "complete secondary and beyond". (See also Graph 8). The r is slightly higher as compared to the unweighted STP category. This finding may point to a disturbing role played in the professional and technical personnel group as a whole by the humanities and social science disciplines, resulting in what have been called "educational supply effects". More will be said about this later in this section. There is one occupational category, it will be recalled, which was not related to the level of development at all : major group 3, sales workers. But, as can be seen in Table 5, this is no longer the case when the level of education is brought into the picture. The correlation coefficients now become significant, and particularly so with the "more than eight years" level, although the b-coefficients (whilst still being significant) have high standard deviations attached to them, which makes their usefulness for forecasting purposes doubtful. Major group 2

TABLE 5 : Whole Economy : Occupations, Education and Indicators of Economic and Technological Development : Correlation and Regression Coefficients of the Following Equation : $\log L_{jk}/L = a + b \log(Z)$

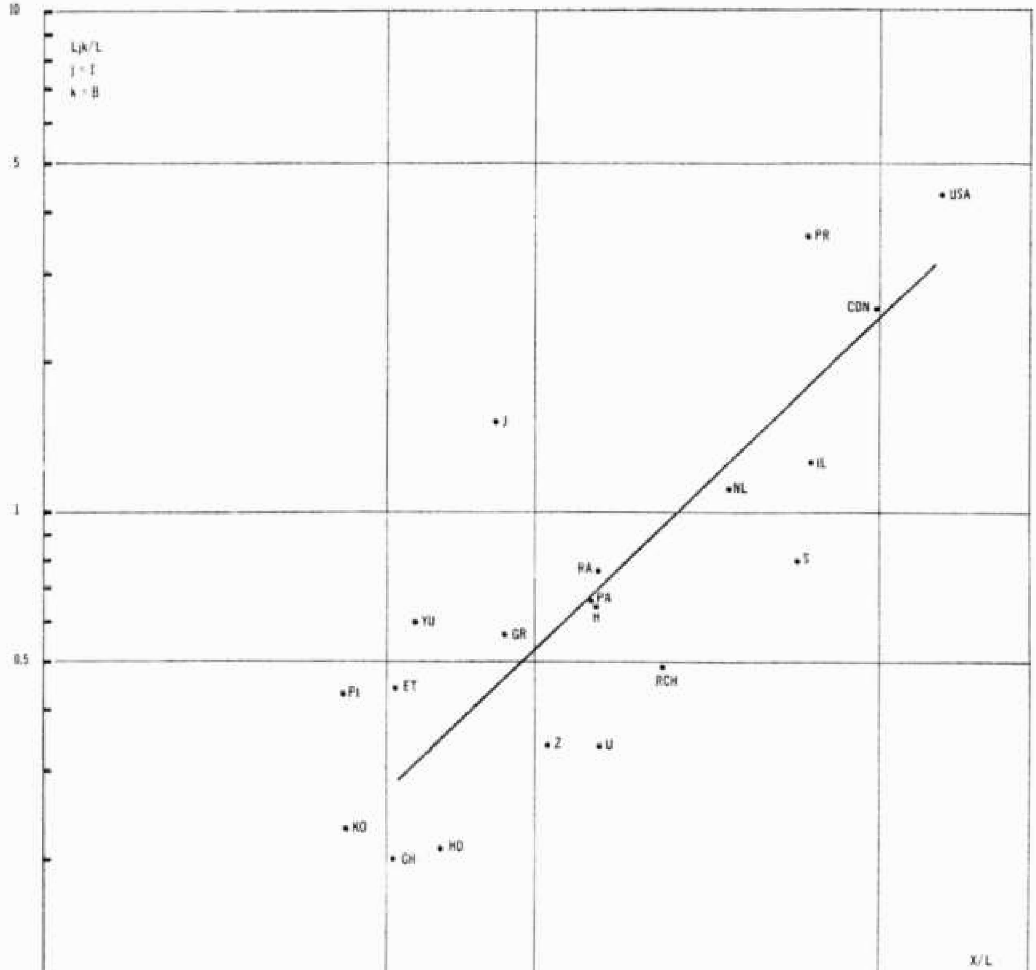
| | | University Degree (A) | | | Complete Secondary & Over (B) | | | More than 8 years (C) | | | Eight years and less (D) | | | Occupational Group Alone (Lj/L) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | r | b | n | r | b | n | r | b | n | r | b | n | r | b |
| *Major Groups* | | | | | | | | | | | | | | | | |
| 0 | X/L | 25 | 0.73 | 0.84(0.17) | 21 | 0.81 | 0.71(0.12) | 17 | 0.85 | 0.64(0.10) | 17 | 0.16 | 0.16(0.26) | 25 | 0.90 | 0.63(0.06) |
| | In | 25 | 0.79 | 1.23(0.20) | 21 | 0.87 | 1.02(0.13) | 17 | 0.85 | 0.95(0.15) | 17 | 0.16 | 0.24(0.39) | 25 | 0.90 | 0.85(0.09) |
| | ΣI/L | 22 | 0.64 | 0.61(0.16) | 19 | 0.81 | 0.57(0.10) | 13 | 0.87 | 0.51(0.08) | 13 | 0.11 | 0.09(0.24) | 22 | 0.87 | 0.48(0.06) |
| 1 | X/L | 25 | 0.63 | 0.80(0.21) | 21 | 0.79 | 0.91(0.16) | 17 | 0.80 | 0.95(0.19) | 17 | 0.44 | 0.52(0.27) | 25 | 0.73 | 0.70(0.14) |
| | In | 25 | 0.68 | 1.17(0.27) | 21 | 0.74 | 1.14(0.24) | 17 | 0,71 | 1.24(0.32) | 17 | 0.41 | 0.71(0.41) | 25 | 0.71 | 0.92(0.19) |
| | ΣI/L | 22 | 0.68 | 0.74(0.18) | 19 | 0.78 | 0.75(0.14) | 13 | 0.75 | 0.73(0.20) | 13 | 0.30 | 0.31(0.30) | 22 | 0.63 | 0.50(0.14) |
| 2 | X/L | 25 | 0.28 | 0.44(0.32) | 21 | 0.62 | 0.84(0.24) | 17 | 0.91 | 0.77(0.09) | 17 | 0.30 | 0.29(0.24) | 25 | 0.79 | 0.64(0.10) |
| | In | 25 | 0.32 | 0.69(0.42) | 21 | 0.58 | 1.05(0.34) | 17 | 0.87 | 1.09(0.16) | 17 | 0.43 | 0.60(0.33) | 25 | 0.84 | 0.92(0.12) |
| | ΣI/L | 22 | 0.21 | 0.29(0.30) | 19 | 0.55 | 0.52(0.19) | 13 | 0.82 | 0.58(0.12) | 13 | 0.38 | 0.29(0.22) | 22 | 0.75 | 0.50(0.10) |
| 3 | X/L | 25 | 0.50 | 0.78(0.28) | 21 | 0.61 | 0.96(0.29) | 17 | 0.78 | 0.85(0.18) | 17 | −0.09 | −0.10(0.29) | 25 | 0.23 | 0.18(0.16) |
| | In | 25 | 0.53 | 1.11(0.37) | 21 | 0.58 | 1.23(0.39) | 17 | 0.74 | 1.21(0.28) | 17 | −0.04 | −0.06(0.42) | 25 | 0.29 | 0.31(0.21) |
| | ΣI/L | 22 | 0.44 | 0.58(0.26) | 19 | 0.60 | 0.65(0.21) | 13 | 0.68 | 0.55(0.18) | 13 | −0.07 | −0.06(0.28) | 22 | 0.25 | 0.17(0.15) |
| 7/8 | X/L | | | | 21 | 0.65 | 1.35(0.37) | 17 | 0.75 | 1.06(0.24) | 17 | 0.17 | 0.20(0.30) | 21 | 0.45 | 0.40(0.18) |
| | In | | | | 21 | 0.61 | 1.71(0.51) | 17 | 0.73 | 1.53(0.37) | 17 | 0.26 | 0.45(0.43) | 21 | 0.58 | 0.69(0.22) |
| | ΣI/L | | | | 19 | 0.66 | 0.87(0.24) | 13 | 0.70 | 0.76(0.24) | 13 | 0.20 | 0.21(0.30) | 19 | 0.44 | 0.33(0.16) |
| *Minor Groups* | | | | | | | | | | | | | | | | |
| STP | X/L | 19 | 0.76 | 0.92(0.19) | 14 | 0.85 | 0.88(0.16) | | | | | | | 19 | 0.82 | 0.99(0.17) |
| | In | 19 | 0.77 | 1,35(0.27) | 14 | 0.88 | 1.27(0.20) | | | | | | | 19 | 0.82 | 1.43(0.25) |
| | ΣI/L | 16 | 0.75 | 0.72(0.17) | 12 | 0.81 | 0.78(0.18) | | | | | | | 16 | 0.75 | 0.72(0.17) |

GRAPH 6 : Whole Economy : Professional and Technical workers with University degree ($L_{jk}/L$) and ouput per worker ($X/L$)



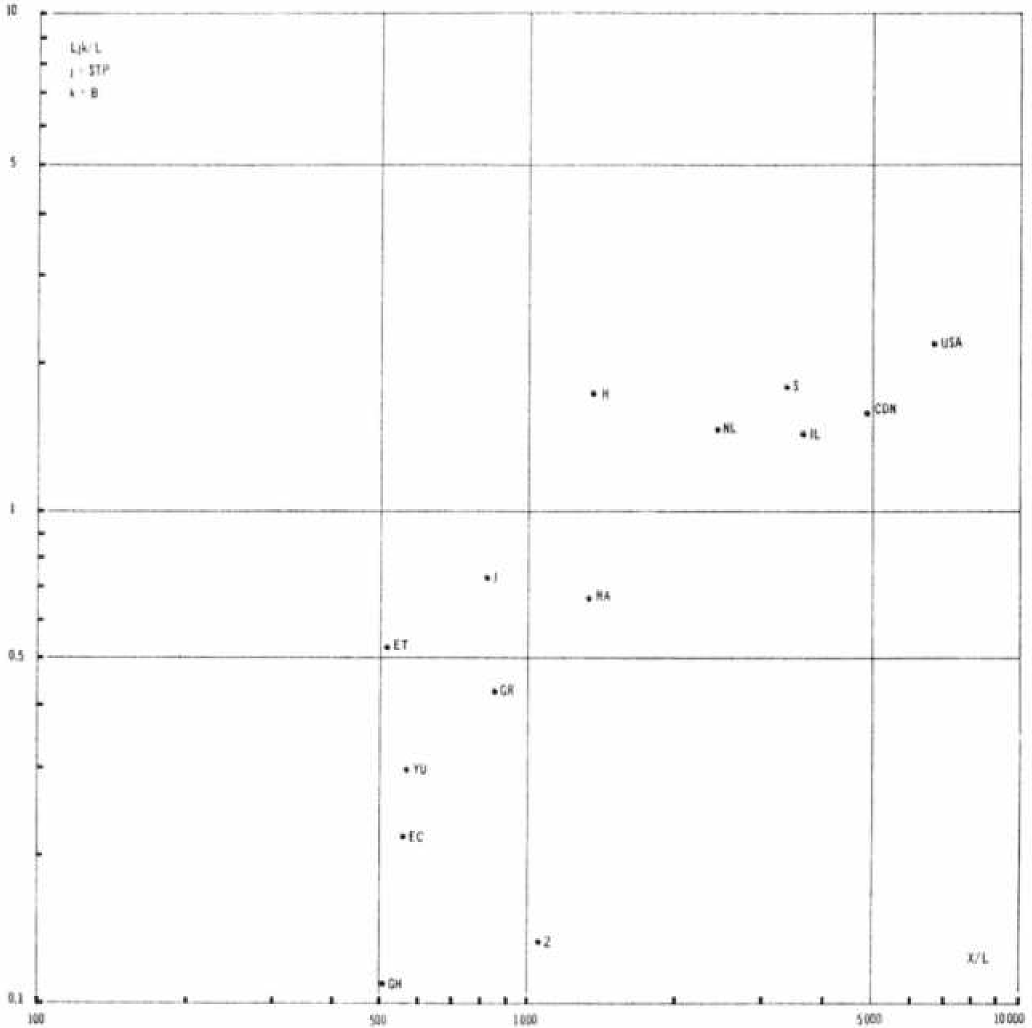

(clerical workers)—which was already fairly satisfactorily related to levels of development—obtains a remarkable correlation coefficient (0.91 with X/L) when only those with more than eight years of schooling" are taken. An analogous remark could be made concerning major group 1 weighted with educational group B and C. The important conclusion, therefore, is that

Graph 7 : Whole Economy : Administrative, Executive and Managerial workers with colmpete secondary education and beyond ($L_{jk}/L$) and output per worker (X/L)




precisely for those vague and heterogeneous occupational categories such as clerical and salesworkers, the introduction of educational levels (or better, maybe, the exclusion of the "eight years and less" level) increases significantly the relationship with levels of development.

GRAPH 8 : Whole Economy : Scientific and Technical personnel with complete secondary education and beyond ($L_{jk}/L$) and output per worker ($X/L$)




Turning now to the values of the elasticity coefficients, the pattern is more or less the one to be expected. Within professional and technical personnel (o), with rising levels of economic and technological development, the university degree holders increase relatively more rapidly than those with lower levels of education.

Within the other occupational categories it is complete secondary education which grows quickest (although not significantly so) as compared to the other levels of education. The standard deviations are high, relatively less so for educational level C. On the whole, however, and judging from the last three rows of Table 4, it would appear as if the three levels of education distinguished here grow in a rather balanced manner (i.e. at about the same speed) as the economy develops. Just an additional remark on these last three columns of Table 4 : the educational category "eight years and less" which has been rather neglected in this article, is negatively and very significantly correlated with all three economic indicators (—0.85 with X/L, for example). Again at the macro-economic level, this relationship may prove to be of use.

As observed in the beginning of this section, an analysis was also carried out by taking the average number of years of schooling embodied in the different occupational categories or in the total labour force, as the dependent variable. The best results were obtained for the total labour force :

$$\log kt = -1.04 + \underset{(0.12)}{0.56} \log (X/L) \qquad r = 0.74 \quad n = 20 \qquad [5.7]$$

$$\log kt = -0.41 + \underset{(0.15)}{0.75} \log (In) \qquad r = 0.76 \quad n = 20 \qquad [5.8]$$

where kt stands for the average number of years of schooling of the labour force.

### (ii) *Educational levels within occupations and the weight of occupations in the labour force*

It has been shown in Section 3 that there exists, in general, a close relationship between the occupational structure of the labour force and levels of economic development as reflected in the values of the indicators selected (for the whole economy). It is, therefore, not altogether arbitrary to attempt to relate the educational profile of an occupation directly to the weight of this occupation in the total labour force. Although bearing in mind that changes in these weights reflect to a certain extent differences in development levels the more interesting point to examine is how the educational profile of an occupational category behaves

TABLE 6 : Whole Economy : Educational levels of occupations and the weight of occupations in the labour force : correlation and regression coefficients of the following equation : $\log L_{jk}/L = a + b \log (L_j/L)$

| | University degree (A) | | | Complete secondary and beyond (B) | | | More than eight years (C) | | | Eight years and less (D) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | r | b | n | r | b | n | r | b | n | r | b |
| *Major Groups* | | | | | | | | | | | | |
| 0 | 25 | 0.79 | 1.29(0.21) | 21 | 0.94 | 1.27(0.11) | 17 | 0.97 | 1.15(0.07) | 17 | 0.29 | 0.47(0.40) |
| 1 | 25 | 0.77 | 1.03(0.18) | 21 | 0.88 | 0.96(0.12) | 17 | 0.96 | 1.09(0.08) | 17 | 0.85 | 0.96(0.15) |
| 2 | 25 | 0.56 | 1.08(0.34) | 21 | 0.69 | 1.10(0.26) | 17 | 0.93 | 1.00(0.10) | 17 | 0.75 | 0.92(0.21) |
| 3 | 25 | 0.40 | 0.79(0.37) | 21 | 0.32 | 0.58(0.39) | 17 | 0.56 | 0.75(0.29) | 17 | 0.91 | 1.23(0.15) |
| 7/8 | — | — | — | 21 | 0.36 | 0.83(0.50) | 17 | 0.55 | 0.88(0.35) | 17 | 0.96 | 1.28(0.10) |
| *Minor Groups* | | | | | | | | | | | | |
| STP | 19 | 0.84 | 0.83(0.13) | 14 | 0.88 | 1.04(0.16) | — | — | — | — | — | — |

when the latter grows more or less important in the labour force. The equation through which this is examined is the following :

$$\log L_{jk}/L = a + b \log (L_j/L) \qquad [4.9]$$

As just implied, the main interest of this analysis lies in the values of the regression coefficients for the different educational levels within the same occupational category, rather than in the correlation coefficients. The analysis is a "horizontal" one (Table 6). Before discussing the results presented in this table, a preliminary remark must be made. Equation [4.9] is easily interpretable in terms of the educational profiles of occupational categories (the $L_{kj}/L_j$'s), because of the tautological relationship existing between the three ratios $L_{jk}/L_j$, $L_{jk}/L$ and $L_j/L$ (*) a b-coefficient (equation 4.9) of around one means that the proportion of persons with a given level of education within the occupational category ($L_{jk}/L_j$) has a tendency to remain constant. An elasticity coefficient superior or inferior to unity indicates, for the same reason, that the educational level under investigation has a tendency to rise or to decline in relative terms within the occupation in question.

Turning now to Table 6, attention will be focussed on the values of the regression coefficients within the same occupational category (horizontal analysis). For major group 0 these coefficients are above unity for educational levels A, B and C, and more particularly for A and B. There exists, therefore, a tendency for the educational profile to centre more and more around complete secondary and university education, whereas the proportion of persons with "eight years and less" diminishes, as the occupational category grows in relative importance.

Within the managerial category (major group 1), all elasticities are situated around unity, with a very slight peak for the "more than eight years" level. This confirms, therefore, the fact that this occupational category remains very heterogeneous as to its educational profile when its weight in the labour force increases, which in turn is, *grosso modo*, related to rising levels of development. In other words, it is not possible to observe a tendency

(*) The tautology is the following : $L_{jk}/L_j = (L_{jk}/L)\ (L/L_j)$

towards a more "centred" educational profile for this occupational group. As has already been mentioned on other occasions, this is no doubt due to the heterogeneous nature of the managerial category itself.

An analogous pattern is shown by the clerical workers (major group 2). There are nevertheless indications that within this occupational category the educational profile shifts relatively more towards secondary and university education when the occupation grows in importance. However, the very large standard deviations make this kind of conclusion very tentative indeed.

For sales workers and for craftsmen and production process workers (major groups 3 and 7/8 respectively), the results shown in Table 6 suggest that the "eight year and less" educational level takes a more important place in their educational profiles, when the weight of these occupational categories in the total labour force increases. This is not surprising as far as sales workers are concerned, when it is remembered that this category is not related at all with levels of development (Table 1), but that it *is* when only those sales workers with more than eight years of schooling are taken into account (Table 5). In most developing countries important numbers of "sales workers" (this group also includes such "occupations" as street vendors) can be found in the towns among those migrated from rural areas. The relatively important number of developing countries in our "sample" explains the above results. As to the production process workers (7/8) who, as will be recalled, are not correlated with development indicators either (Table 5, last three columns), the results shown in Table 6 are to no small extent due to the fact that in the earlier stages of development emphasis is on the quantitative extension of this category, and only later—when the rural reserves are drying up—on its qualitative development.

Finally, the STP group shows a tendency to centre its educational profile around complete secondary education rather more rapidly than around university education. The difference is not significant, however.

(iii) *Educational levels within occupations and "educational supply"*

So far in this article, the discussion has been exclusively "demand oriented". What is meant by this is that economic and technological indicators have been selected, quantified and used as explanatory variables with respect to the occupational percentage distribution (weighted and unweighted) and to the educational profiles of occupational categories ($L_{jk}/L_j$). Obviously, all these variables themselves are the result of the interplay between demand and supply relationships and as such it is difficult to speak about a demand relationship without mentioning the difficulty of the "identification" problem. Within the limitations of the present study, it is not possible to tackle this problem in any detail, although it is imperative to draw attention to it.

With these limitations in mind, it is the purpose of this paragraph to examine whether differences in "educational supply" of qualified personnel are reflected in the amount of education embodied in the various occupational categories. It can indeed be expected that the relative rates of educational and of economic-technological expansion patterns in the different countries result in differences in the educational profiles of occupational categories. Unless "educational supply" has always and everywhere been in perfect harmony with economic and technological "demand", it can therefore be expected that "educational supply" has an independent, explanatory role to play in the subject under consideration. It would have been desirable to examine relative salary differentials in this respect. This, obviously, has not been possible given the scope and country coverage of this study. Moreover, "shortages" and surpluses" of certain types of qualified personnel are not necessarily reflected fully in the salary levels, especially not in developing countries which form the majority of the observations available. It is therefore not without interest to examine this aspect—as the others in this study—in "real" terms. The question we will address ourselves to in this paragraph is : how do graduates and schoolleavers distribute themselves among occupational categories when educational systems develop ? In line with the remarks made above, it is our contention that the occupation-education matrix already contains sufficient information to obtain a first approximation to the problem. The occupational and, particularly, the educational detail of the matrix available for this study is very crude indeed. However this may be, and even if it is not possible to go very far in the *present* analysis, the question concerning the impact of educational expansion on the occupational choice of graduates and schoolleavers is a valid one and needs further investigation.

"Educational supply" in a country has been approximated by taking the total proportion of people in the labour force with a given level of education ($L_k/L$). This proportion reflects, and is the outcome of, the educational history of a country during the past forty to fifty years. I would have been preferable to take the stock of educated persons in the *total* population, but this was not possible. The equations tested are the following :

$$\log L_{jk}/L = a + b \log (L_k/L) \qquad [4.10]$$
$$\log L_{jk}/Lj = a + b \log (L_k/L) \qquad [4.11]$$

Of these, only some results of (4.10) will be presented here. Table 7 presents the outcome of the regression analysis for several occupational categories with "university degree" and "complete secondary and beyond".

Whereas in the previous paragraph (Table 6), the analysis was "horizontal" by looking at relative changes in the different educational levels within the same occupational category as the latter grows in importance, this time (Table 7) the analysis is "vertical" by examining how the same educational level, as it develops, distributes itself among the various occupational categories.

Table 7 indicates that the total supply of university degree holders—insofar as this is caught in our variable—is highly

TABLE 7 : Whole Economy : Educational levels of occupations and "educational supply" : correlation and regression coefficients of the following equation : $\log L_{jk}/L = a + b \log L_k/L$

| | University degree (A) | | | Complete secondary and beyond (B) | | |
|---|---|---|---|---|---|---|
| | n | r | b | n | r | b |
| *Major groups* | | | | | | |
| 0 | 25 | 0.97 | 0.99(0.05) | 21 | 0.90 | 0.73(0.08) |
| 1 | 25 | 0.87 | 0.98(0.12) | 21 | 0.88 | 0.95(0.12) |
| 2 | 25 | 0.80 | 1.12(0.17) | 21 | 0.91 | 1.13(0.12) |
| 3 | 25 | 0.81 | 1.11(0.17) | 21 | 0.86 | 1.26(0.17) |
| 7/8 | — | — | — | 21 | 0.89 | 1.73(0.21) |
| *Minor groups* | | | | | | |
| STP | 19 | 0.92 | 1.04(0.11) | 14 | 0.76 | 0.70(0.17) |

correlated with the number of graduates in each of the occupational categories. According to the regression coefficients, the more university graduates are available the more they can be found in *all* the non-manual occupational categories. All elasticities are around unity; the higher elasticity coefficients for clerical and sales workers have to be jugded in the light of the equally higher standard deviations.

As to the educational level "complete secondary and beyond" the correlation coefficients are quite high again. It is only the STP group for which a higher r was found when related to the economic indicator X/L. It is probably not a coincidence that this more narrowly defined occupational group appears to be better correlated to levels of economic development than to "educational supply". Contrary to the pattern observed for university graduates alone, there is here a distinct difference between the value of the regression coefficients for groups 0, STP and to a lesser extent 1, on the one hand, and the "lower" categories—(2, 3 and particularly 7/8)—on the other. As more persons who have completed secondary education become available, the more they tend to go into those "lower" occupational categories. This corroborates the phenomenon of "upgrading of jobs" through educational supply effects.

This is also confirmed when, instead of educational levels, the average number of years of schooling (k) is taken :

for j = sales workers and t = whole economy :

$$\log kj = 0.05 + \underset{(0.07)}{0.99} \log kt \quad \begin{array}{l} r = 0.96 \\ n = 20 \end{array} \tag{4.12}$$

for j = farmers and t = whole economy :

$$\log kj = -0.50 + \underset{(0.06)}{1.45} \log kt \quad \begin{array}{l} r = 0.99 \\ n = 20 \end{array} \tag{4.13}$$

(iv) *Educational levels within occupations*; *economic indicators and "educational supply"*

Finally, it would be tempting to combine the various explanatory variables used individually and successively in the foregoing paragraphs. For example :

$$\log L_{jk}/L = a + b \log L_k/L + c \log Z \qquad [4.14]$$

and

$$\log L_{jk}/L_j = a + b \log L_k/L + c \log L_j/L \qquad [4.15]$$

The rationale of equation [4.14] is to combine the economic "pull" factors and the educational push" factors in order to examine their respective and relative impacts on the changes observed in the educational profiles of the different occupational categories.

Equation [4.15] can be described as follows : the educational profile of an occupational category is clearly influenced by the importance of that occupation in the labour force *and* by the number of people available with different levels of education, or, in other words, by economic requirements and social demand. If these two developments are known for the future, the above relationship might be helpful in deducing their consequences on the educational profile of occupations, and thus on the occupational choice of graduates and schoolleavers.

Clearly, the above equations are difficult to interpret, because of the interdependencies and the interactions existing among the variables. Some preliminary and tentative results suggest that, as far as changes observed in the number of university graduates in occupational categoties 0, 1 and STP are concerned, about 70 per cent would be due to educational supply effects and 30 per cent to economic requirements. This needs careful checking and the results will be presented in the final report. However, it must already be stressed that these tentative conclusions concerning the predominance of educational shifts over pure occupational shifts confirms research undertaken on the national level on a time series basis (1).

(vi) *Tentative and preliminary conclusions*

The tentative conclusions reached at the end of Section 3 have been confirmed in the present section as far as the whole economy is concerned. A certain number of further preliminary conclusions suggest themselves :

(1) See J. Folger and C. Nam : "Trends in education in relation to occupational structure", *Sociology of Education*, Vol. 38, 1964.

(a) there are no statistically significant relationships between the educational profiles of occupations ($L_{jk}/L_j$) and levels of development;

(b) the (educationally) weighted occupational percentages ($L_{jk}/L$) of the professional and technical personnel category (major group 0) have on the whole lower correlation and less significant regression coefficients than the unweighted occupational percentage. However, this is *not* the case with the STP category;

(c) moreover, precisely for these very heterogeneous occupational categories such as clerical and sales workers, the introduction of educational levels (or better, the exclusion of those with eight or less years of schooling) increases very significantly the relationship with levels of development. This is, therefore, useful supplementary information to the findings that came out of the occupational analysis;

(d) the proportion of persons in the total labour force with eight or less years of schooling is negatively and very significantly related to output per worker ($r = -0.85$);

(e) a certain amount of insight has been gained in the "educational behaviour" of occupational categories when they grow in relative importance;

(f) "educational supply" seems to play an important, independent role in the explanation of the amount of education associated with occupations. As more university graduates become available, the more they can be found in *all* occupational categories. As more people with complete secondary education become available, the more they go into the "lower" occupational categories;

(g) very tentatively, it could be advanced that educational changes within occupations are due 70 per cent to educational supply effects, and 30 per cent to economic and technological requirements.

## 5. EDUCATIONAL STRUCTURES OF THE LABOUR FORCE AND ECONOMIC DEVELOPMENT

The final purpose of the manpower approach is to indicate the minimum educational expansion requirements—particularly at the higher steps of the educational ladder—in the light of future economic and technological development perspectives. The analyses concerning occupational shifts and concerning changes in the amount of education associated with occupational categories are undertaken with this purpose in mind. Because of the uncertainties involved in each of the steps of the two-stage approach (first forecasting the occupational structure, and then converting the occupations into educational equivalents), the one-stage approach (forecasting directly the educational structure of the labour force) is sometimes advocated and actually applied. This article is not the place to go into the advantages and disadvantages of this "short-cut". In this section, we will simply present a few of the results concerning the relationship between the educational structure of the labour force on the one hand, and economic and technological indicators on the other. This analysis is, therefore, the equivalent, for the eaucational structure, of Section 3, which was concerned with the occupational structure.

It must be noted at the outset, however, that the independent role played by "educational supply", as suggested in the previous section, should prevent us from expecting too much from the present analysis.

The educational levels distinguished are the same as those set out in Section 4, i.e. A, B, C and D. The economic sectors selected for this article are the same as those presented in Section 3, i.e. manufacturing, services and the whole economy (these last results were already shown in the last three rows of Table 4). The economic and technological indicators (Z) retained have been presented in previous sections of this article. They are sector and total output per worker ($X_i/L_i$ and $X/L$); GDP per capita ($X/P$); energy consumption per capita ($En/P$); and the non-monetary indicator ($In$). Moreover, for the whole economy, gross capital formation per worker ($\Sigma I/L$) has been added again.

The dependent variables have been expressed in two ways in analogy with, and for the same reasons as, those adopted for the educational profile of occupational categories (1). One expresses the number of persons with a given level of education in an economic sector as a proportion of the labour force in that

(1) It will be recalled that we adopted both $L_{jk}/L_j$ and $L_{jk}/L$ as dependent variables.

sector ($L_{ik}/L_i$); and the other does this as a proportion of the total labour force ($L_{ik}/L$). The following two equations have, therefore, been tested :

$$\log L_{ik}/L_i = a + b \log (Z) \qquad [5.1]$$
$$\log L_{ik}/L = a + b \log (Z) \qquad [5.2]$$

The results can be found in Table 8 and in Graphs 10, 11 and 12. As for equation [5.1], the only significant correlation coefficients in Manufacturing and Services (see upper half of the table) are obtained with educational categories "more than eight years" and "eight years and less" (1). In Manufacturing, sector productivity is doing somewhat better than the other explanatory variables, whereas in Services the non-monetary index comes out on top of GDP per capita. The regression (elasticity) coefficients are substantially lower in services than in manufacturing, but most of them are plagued with very important standard deviations. Apart from the cleavage at eight years or less, noted above, these results are on the whole negative.

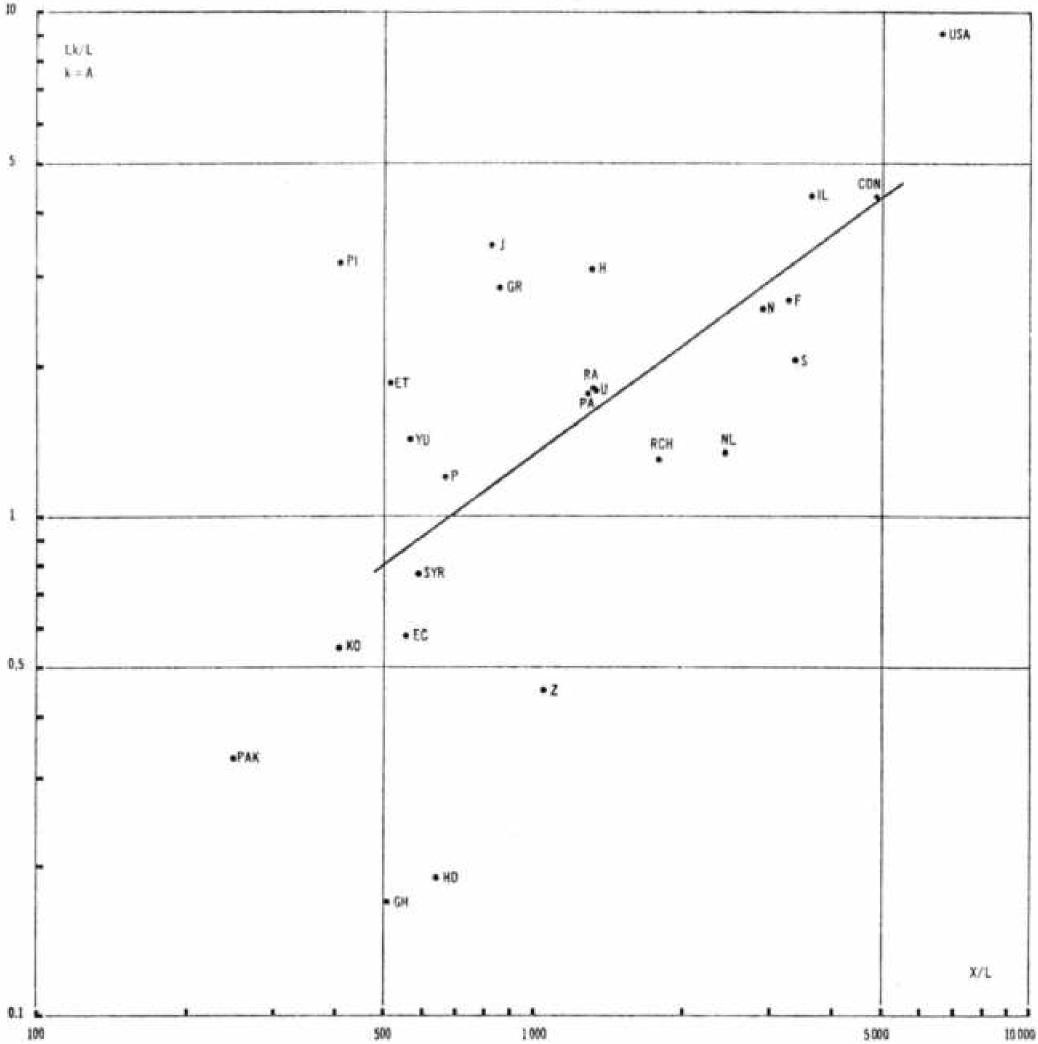
In the lower part of Table 8 the results are shown with $L_{ik}/L$ as the dependent variable; the outcome of the calculations for the whole economy are reproduced as well. The correlation coefficients are fair, in particular for services where In comes out better than X/P. In manufacturing as well, the non-monetary indicators (both In and En/P) perform somewhat better than output per worker ($X_i/L_i$). The correlation increases as the educational category becomes wider. Also in view of the low precision of the regression coefficients, these relationships can only be used with extreme care, especially for the higher and more narrowly defined educational categories. The coefficients for the "eight years and less" category are all non-significant, except for the whole economy where quite good results are obtained, as was already mentioned in the previous section. All in all, the results obtained are very meagre. This leads us to an examination of the graphs in order to see whether they can throw some light on these erratic findings, and whether they can help us in identifying those countries that deviate clearly from the general trend.

(1) As can be noted in the table, the number of observations available for the sector analysis becomes often very small indeed.

TABLE 8 : Educational Categories and Indicators Economic and Technological Development in Manufacturing, Services and Whole Economy : Correlation and Regression Coefficients

| | | University Degree (A) | | | Complete Secondary and Beyond (B) | | | More than 8 years (C) | | | Eight years and less (D) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | r | b | n | r | b | n | r | b | n | r | b |
| Results of the equation log Lik/Li = a + b log (Z) | | | | | | | | | | | | | |
| Manufacturing | Xi/Li | 18 | 0.56 | 0.63(0.23) | 13 | 0.61 | 0.90(0.36) | 10 | 0.84 | 0.81(0.19) | 10 | -0.79 | -0.29(0.08) |
| | In | 18 | 0.46 | 0.63(0.30) | 13 | 0.59 | 1.00(0.41) | 10 | 0.70 | 0.93(0.34) | 10 | -0.79 | -0.39(0.11) |
| | En/P | 18 | 0.53 | 0.35(0.14) | 13 | 0.62 | 0.52(0.20) | 10 | 0.78 | 0.49(0.14) | 10 | -0.81 | -0.19(0.05) |
| Services | X/P | 18 | 0.40 | 0.23(0.13) | 13 | 0.56 | 0.41(0.18) | 10 | 0.68 | 0.29(0.11) | 10 | -0.75 | -0.26(0.08) |
| | In | 18 | 0.45 | 0.33(0.16) | 13 | 0.69 | 0.61(0.19) | 10 | 0.72 | 0.39(0.13) | 10 | -0.69 | -0.30(0.11) |
| Results of the equation log Lik/L = a + b log (Z) | | | | | | | | | | | | | |
| Manufacturing | Xi/Li | 18 | 0.66 | 1.08(0.31) | 13 | 0.63 | 1.30(0.48) | 10 | 0.79 | 1.14(0.32) | 10 | 0.07 | 0.04(0.23) |
| | In | 18 | 0.73 | 1.45(0.34) | 13 | 0.81 | 1.88(0.42) | 10 | 0.85 | 1.69(0.38) | 10 | 0.41 | 0.37(0.29) |
| | En/P | 18 | 0.73 | 0.71(0.17) | 13 | 0.78 | 0.90(0.22) | 10 | 0.83 | 0.79(0.19) | 10 | 0.24 | 0.10(0.15) |
| Services | X/P | 18 | 0.70 | 0.49(0.13) | 13 | 0.77 | 0.67(0.16) | 10 | 0.90 | 0.68(0.12) | 10 | 0.26 | 0.13(0.17) |
| | In | 18 | 0.76 | 0.68(0.14) | 13 | 0.93 | 0.95(0.12) | 10 | 0.96 | 0.90(0.11) | 10 | 0.34 | 0.21(0.21) |
| Whole Econ. | X/L | 25 | 0.65 | 0.74(0.18) | 21 | 0.75 | 0.81(0.17) | 17 | 0.84 | 0.79(0.13) | 17 | -0.85 | -0.40(0.06) |
| | In | 25 | 0.71 | 1.09(0.22) | 21 | 0.76 | 1.09(0.22) | 17 | 0.81 | 1.12(0.21) | 17 | -0.86 | -0.27(0.04) |
| | ΣI/L | 22 | 0.57 | 0.54(0.17) | 19 | 0.73 | 0.61(0.14) | 13 | 0.76 | 0.56(0.14) | 13 | -0.83 | -0.23(0.05) |

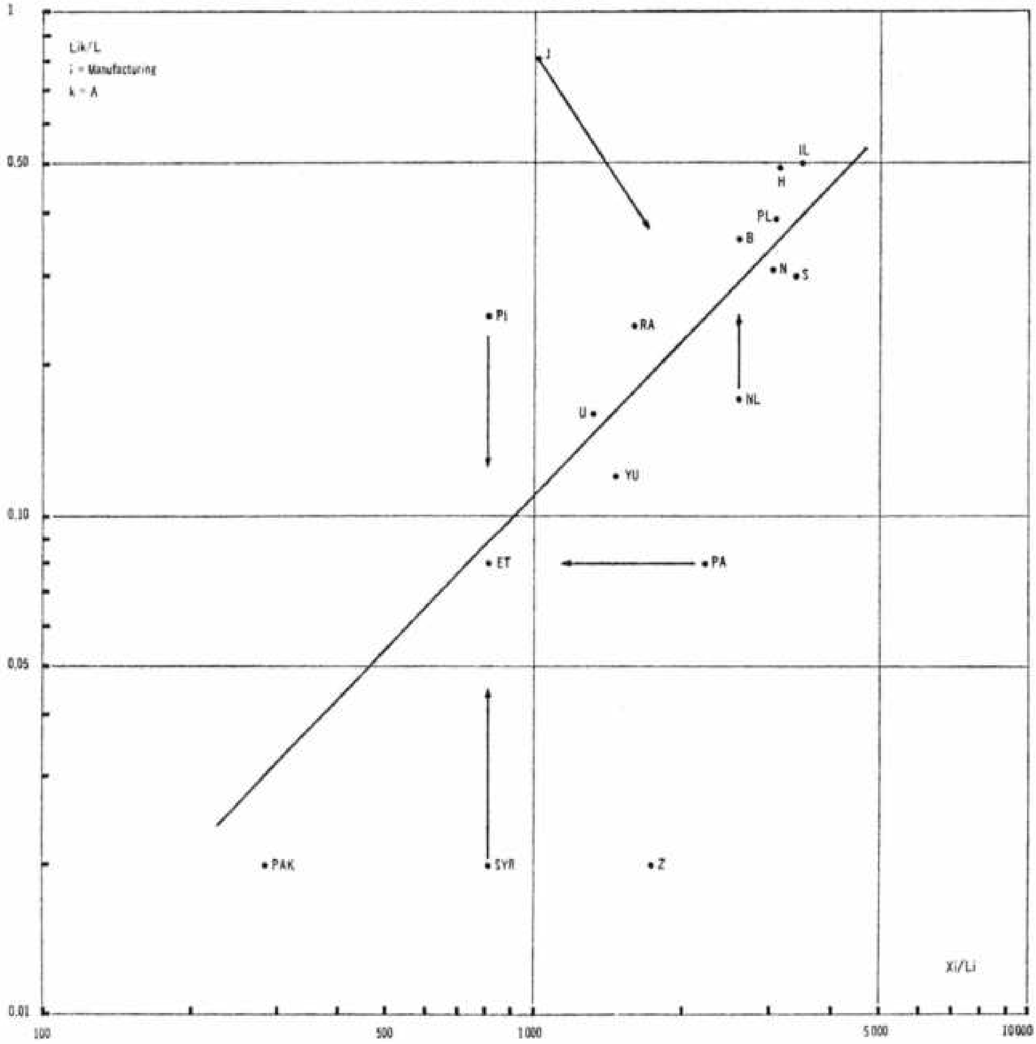
Graph 10 : Whole Economy : Personnel with University degree $(L_k/)L$ and output per worker $(X/L)$




In Graph 11 is depicted—for the Manufacturing sector—the number of persons with a university degree as a proportion of the total labour force $(L_{ik}/L)$ and sector output per worker $(X_i/L_i)$. The regression equation reads as follows :

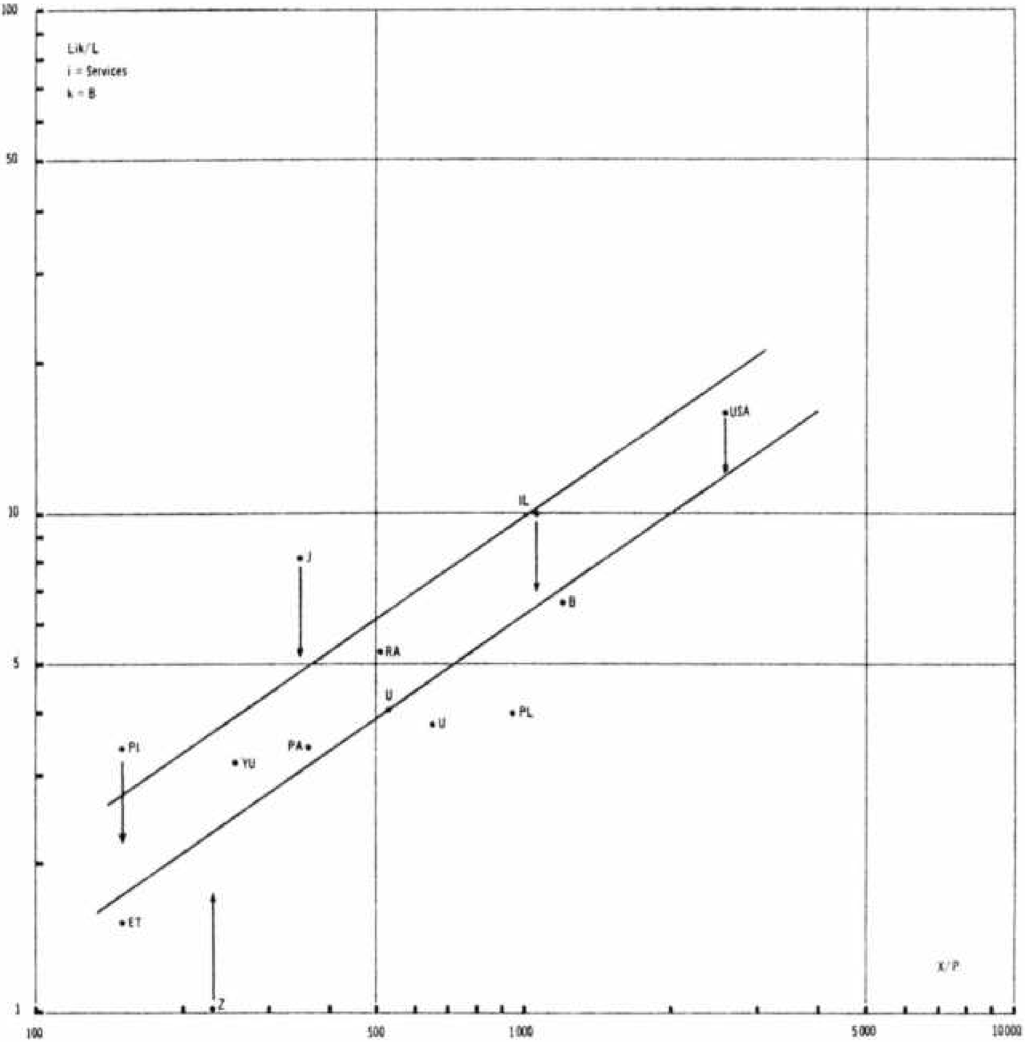
$$\log L_{jk}/L = -4.24 + 1.08 \log (X_i/L_i) \quad r = 0.66 \qquad [5.3]$$
$$(0.31)$$

GRAPH 11 : Manufacturing : Personnel with University degree ($L_{ik}/L$) and sector output per worker ($X_i/L_i$)




The "deviant" countries can be easily identified, and the arrows indicate which of the variables seems to be most responsible for the position occupied on the graph by the countries in question. Japan and the Philippines—which we have already singled out earlier—are "overeducated" at the university level. This may be due to the massive extension of short college courses, according

GRAPH 12 : Services : Personnel with complete secondary education and beyond ($L_{ik}/L$) and GDP per Capita (X/P)




to the American model, causing classification and definition problems. In the case of Japan the use of the official exchange rate may also have underestimated sector output per worker. The Netherlands, which is on the same productivity level as Belgium, suffers definitely from the exclusion of the post-secondary technical colleges (HTS) which—coupled with the extreme length of formal university education—tends to underestimate the amount of high level education embodied in its labour force. In the case of Panama the sector productivity figure appears to be artificially inflated. Zambia is probably in the same position owing to its highly developed mining industry. Analogous ad hoc reasoning can be applied to the situation depicted in graph 12 concerning the services sector.

The above digression suggests the interest and importance of graphic analysis. It points also and above all to the difficulties and limitations of a study of this kind, particularly in this domain of educational categories where definitional problems loom large.

In the present state of this analysis only one conclusion stands out, and that is a confirmation of the warning given in the beginning of this short section. It appears that, on the whole, the educational structure of the labour force is not very much related to levels of development, at least less so than the occupational structure. There is no doubt that classification and definition problems—the whole field of educational equivalents across countries—have an important responsibility in this state of affairs. There is no doubt either, however, that what have been called "educational supply effects" play also an important part in "disturbing" the picture. It is still an open question, of course, whether the relationships presented so far in the framework of the two-stage approach (Sections 3 and 4) will lead to a more reliable forecast of educational requirements than those presented in the present section. All one can say is that working through the occupational distribution of the labour force provides us with a useful checking device which enables us—if not to eliminate—at least to control for the educational supply effects.

## 6. ADDITIONAL INVESTIGATIONS INTO THE OCCUPATION-EDUCATION RELATIONSHIPS

The occupation-education relationship is the most delicate aspect of any quantification between the economy and the educational system via the so-called manpower approach. This is amply confirmed by the present study and by the few examples presented in Section 4. In that section only a few educational categories were distinguished and, moreover, they were examined one after the other, in succession. This was necessary in order to make use of as many country observations as possible. But what was gained in breadth was lost in depth. It was therefore considered essential to conduct a further analysis, on a case study basis, which would bring into the picture the whole educational profile of the different occupational categories. This is, of course, only possible for those countries which have made available more detailed information concerning their occupation-education matrix.

The object of this further analysis is to examine the development—over time and/or across sectors of economic activity within a country—of the association between occupations and education, taking account both of the interrelations between the different educational categories and between the different occupations. The problem to examine in this context is whether the association between occupations and education becomes looser or, on the contrary, becomes more rigid.

The statistical tool used for this analysis is the one described by GOODMAN and KRUSKAL (1). The measures selected are *global* or *synthetic* measures of association. Their interest resides in the fact that they summarise in one figure —which can vary between—1 to + 1—the association existing in a matrix, thus facilitating the comparison between different matrices. If their value is close to 1 there exists a close association between occupations and education; if their value is close to 0 there is a very weak association.

This analysis has been applied to the data available for Canada, Argentina and Peru. Other authors have already attempted this kind of approach, using data for the United States, France and Uruguay (2).

In the case of Canada and Argentina, the analysis is based on three-way classifications : occupations by age-groups cross-

(1) L. A. GOODMAN and W. H. KRUSKAL : "Measures of associations for cross-classifications", *Journal of the American Statistical Association*, Dec. 1954, March 1959 and June 1963.

(2) The United States analysis can be found in the already cited article by J. FOLGER and C. NAM in the *Sociology of Education*. The analysis for Uruguay, by A. SOLARI, can be found in *Revue Internationale des Sciences Sociales*, UNESCO, No. 3, 1967.

classified by levels and branches of education (1). This information permits an investigation of the development of the association between occupations and education over time, as this is reflected in the changing educational profiles of the same occupational category according to age-group. In the case of Peru the educational profiles have been examined across economic sectors.

Back of space does not permit to present illustrations of this analysis. They can be found in the full Report mentioned in the beginning of this article.

(1) The Canadian data are drawn from G. W. BERTRAM : *The Contribution of Education to Economic Growth*, Economic Council of Canada, Staff Study No. 12, June 1966, Appendix Table A-2. For Argentina, see *Education, Human Resources and Development in Argentina*, O.E.C.D., 1967, Table III-26.

# ANNEX 1

## COUNTRY OBSERVATIONS AND ABBREVIATIONS

### 1. *For the Occupational Analysis*

OECD COUNTRIES

| | |
|---|---|
| Belgium | B |
| Canada | CDN |
| Denmark | DK |
| France | F |
| F. R. Germany | D |
| Great Britain | GB |
| Greece | GR |
| Ireland | IRL |
| Japan | J |
| Netherlands | NL |
| Norway | N |
| Portugal | P |
| Sweden | S |
| Turkey | TR |
| United States | USA |

NON-OECD COUNTRIES

| | |
|---|---|
| Argentina | AR |
| Chile | RCH |
| Costa Rica | CR |
| Ecuador | EC |
| Egypt | ET |
| El Salvador | ES |
| Finland | FL |
| Ghana | GH |
| Honduras | HD |
| Hong Kong | HK |
| Hungary | H |
| Israel | IL |
| Jamaica | JM |
| Korea (S) | KO |
| Mexico | MEX |
| Pakistan | PAX |
| Panama | PA |
| Peru | PE |
| Philippines | PI |
| Poland | PL |
| Puerto Rico | PR |
| Rumania | R |
| Sierra Leone | SL |
| South Africa | SA |
| Syria | SYR |
| Uruguay | U |
| USSR | USSR |
| Zambia | Z |

### 2. *For the Occupational/Educational Analysis*

OECD COUNTRIES

| | |
|---|---|
| Canada | CDN |
| France | F |
| Greece | GR |
| Japan | J |
| Netherlands | NL |
| Norway | N |
| Portugal | P |
| Sweden | S |
| United States | USA |

NON-OECD COUNTRIES

| | |
|---|---|
| Argentina | RA |
| Chile | RCH |
| Ecuador | EC |
| Korea (S) | KO |
| Pakistan | PAX |
| Panama | PA |

| | | | |
|---|---|---|---|
| Egypt | ET | Phillippines | PI |
| Ghana | GH | Syria | SYR |
| Honduras | HD | Uruguay | U |
| Hungary | H | Zambia | Z |
| Israel | IL | | |

ASSOCIATE MEMBER COUNTRY

| | |
|---|---|
| Yugoslavia | YU |