Investigation for an Optimum Structure of Labour Force Using a Linear Programming Model[1]

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Abstract

The paper uses a Linear Programming (LP) Model to propose a procedure to find an adequate structure of different educational levels of labour force. Several constraints such as job creation for different educational levels of labour force are considered to maximise the Gross Regional Products (GRP) of the Golastan Province of Iran. A Social Accounting Matrix is used to estimate the necessary coefficients for LP Model. It was demonstrated when unemployment is the result of inconsistency between supply and demand for labour force, an optimum structure leads to an increase in labour force employment and the GRP.

Key words: Linear Programming, Social Accounting, Labour force Planning, Education Structure.

Introduction

A huge number of researches have been carried out to determine of the role of education in economic growth and employment. The role of basic education on economic growth and employment especially in the early stages of development is evident. So a considerable evidences have confirmed it practically. For example, McLean (1983) referred to a popular belief

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about the contribution of education in non-industrial countries in late 1950s and early 1960s. But towards the end of the 1960s, this belief came to lose its popularity, so the economic effects of education gained less weight in the 1970s according to the reports of the World Bank and UNESCO. The investment rate of return to male elementary education in nineteenth-century England especially by private sectors was higher than alternative investments (Mitch 1984). Through a comparative analysis of different countries' data, Buchert (1994) concluded that relative priority of basic education represents a narrowing of the perspective of human resource development, which is crucial for sustainable development. Studying the Brazilian states in 1970 and 1980, Lau *et al.* (1993) found that one additional year of average education per person of the labour force increases real output by approximately 20 percent. In addition, based on Glick and Sahn's (1997) studies on Conakry, Guinea claims that education plays an important role in allocating labour force among all kinds of employment alternatives. Finally, Tambe (1994) also pointed out the positive relationship between basic education and national development in China and India.

Furthermore, a number of studies highlighted the role of higher education on economic growth and employment. For instance, West and Hore (1989) illustrated the advantages of higher education for adult students in Australia cause improvement in their occupational status and their job prospects showing substantial increase in their work or job happiness and satisfaction. Moussouris (1998) examined the connection between higher education and economic development in Massachusetts. So, higher education expansion can be said to have led to a new regulation for public service in the 1990s keyed to upgrading the state's industrial base and co-ordinating with labour market needs.

In contrast, a number of studies have demonstrated that investment, especially on the secondary and higher education, in somewhere has had less return in comparison with other alternatives. For example, although the human capital was considered as a factor of GRP in Woo's (1991) research in Taiwan, he found that due to a close match between the student's skills and labour market demand, Taiwan did not have a large educated unemployment problem. As a case of successful of planning in Taiwan, he suggested a raise in the basic education from six years to nine years, shift of the secondary levels toward vocational fields, strict limitation in the supply of university graduates, and shift of emphasis towards the science and engineering subjects in the university curriculum. Chatterji (1998) focused on the potential role of tertiary education in enhancing economic growth. Based on his results, obtained based on data from several countries, the role of tertiary education on economic growth depends on the condition of countries. "It is more important for countries seeking to reach the world leaders, but less important for the world leaders since their tertiary enrolment rates are already near the maximum. For these advanced countries, tertiary education cannot be expected to play a further growth enhancing role" (p. 353). Duggan (1991) from his study in Thailand concluded that educational development does not necessarily promote economic development. In addition, Based on Japan's Post-war rapid economy growth and extreme efficiency of Japan's educational system since 1950's, Yano (1997) contends that supply of graduates has been able to adjust flexibility to rapid changes in demand for labour. Moreover, according to Quan and Beck (1987), the effects of educational expenditures on the levels of wages and employment in the Northeast and Sunbelt in U.S. are different. In the Northeast, the expenditures on education had positive and significant effects on the levels of wage and employment, through the opposite being the case in Sunbelt.

Therefore, irrespective to the stage of the development of countries, although general or vocation education can be taken into account as a positive step for development of regions or countries, the evidence indicates the investment on secondary and especially higher education was not always economical. Hence, it can be proposed that investment on higher education should be regionally determined.

Based on Neoclassical economics any surplus of a particular type of labour force is only temporary. The immediate impact is a decrease in wages. When this occurs, demand will grow as employers substitute other types of labour or other factors of production and a new short-run equilibrium will be reached. Simultaneously, the less wage rate will decrease the supply.

However, since there are certain other factors involved which have been neglected in this theory, it is unable to explain the facts of the economies. Hence, much research has been performed to compensate these deficits. For instance, the imperfections and inadequacies in labour market to cope with shortages and surpluses, and the limited possibilities of substitution are the reasons that Hinchliffe (1995) summarised after a discussion about the Neoclassical theory for labour force forecasts. In addition, based on Keynesian views the full employment equilibrium is a rare phenomenon; so equilibrium generally happens with less than full employment for labour force. Hence, governments are advised to intervene so there could be full employment in the countries.

To this end, several procedures have been proposed. For example, International comparison is one of these procedures that is based on similarity of labour force growth in all countries in the economic development process. Based on this procedure, an underdeveloped country should follow the structure of labour force of a developed country if it is selected as a future growth object. This procedure was applied in Nigeria (Ahmad and Blaug, 1973) and several East African and Southeast Asian countries (Hinchliffe, 1995).

Following the progressive firms in an industry is another procedure that is based on international comparison logic in which progressive firms have more effective structure of labour force compared with backward firms in the same industry. Using the staff norms in which continuing normal process of economic activities is another procedure that acts based on a constant ratio between a special job and population variables as well as a constant ratio between a special kind of labour force to another one. Another procedure is to Continue the previous trend in which forecasting of labour force is based on previous trends of employment and level of production. And finally, forecasting of necessary special labour force based on questionnaires that are prepared from different institutions is still another procedure.

Thus, this paper intends to propose a procedure to find an optimum educational structure for labour force. Based on the rationality assumption, the previous structure of labour force in different activities is taken to be acceptable. If so, by calculating the optimum production levels of different sectors, the necessary labour force of these sectors as well as the structure of labour force associated with these sectors is calculated. As to the analysis of the future planning, although there exist procedures such as econometric (Lau *et al.* 1993 and Graff 1996) and economic data base analysis (Chatterji 1998), among others, a linear programming model has been devised in the present study for it can yield an optimal structure.

The model is then applied to examine the labour force structure of Golastan Province in Iran in two different scenarios. In the first scenario it was demonstrated that when unemployment is the result of inconsistency between supply and demand for labour force, an optimum structure leads to an increase in labour force employment as well as improvement in the GRP. But in the second scenario, although an optimum structure of labour force can be calculated, it has been found that, due to certain reasons such as shortage in production resources labour structure has no effect on employment level and the GRP of the region. Thus the technique can be applied for education development planning to consider the economic viewpoint.

Methodology

a- Linear Programming Model

A Linear Programming Model linked to Social Accounting Model is used in this paper. The GRP of the region is taken into account as the objective function. Several relationships in terms of job creation for different educational groups of labour force, income distribution inequality, and supply and demand constraints for products of sectors are considered as constraints of the model.

The necessary data were derived from a semisurvey approach collection for Golastan province of Iran (see Sharify 2000). A social accounting model is used to estimate the following coefficients as are shown in Table 5. The target amounts of labour force as they are shown in Table 2 and Table 3 have been estimated from relevant unemployed and forthcoming economic active population of the region for the year 2002.

The objective function is shown as equation (1). The production activities of the region disaggregated into 27 sectors. v_1, v_2,…, v_{27} as shown in Table 4 to explore the impact of a unit increase in products of sectors 1^{st}, 2^{nd},…, 27^{th} on the GRP of the region.

The constraints are considered as two scenarios. The difference originates from the amounts of supply and demand for products of three sectors that are displayed in Table 1. Hence, two scenarios lead to two different results.

Non-equations (2) to (5) concerned with job creation for different groups of education levels. $l_{i,j}$, refer to the effect of a unit increase in goods or services that are produced in the j^{th}

production sector on the i^th group of education level of labour force. b_1 to b_4 display the size of labour force supply of different educational groups. Since full employment, as it is shown in Table 2 and Table 3, is not possible for even one group of labour force in two scenarios, smaller and equal signs, ≤, are used that indicate the possibility of unemployment for a part of the related labour force in the model.

Non-equation (6) is concerned with income distribution inequality. The relative mean deviation index is used that can be written as a linear form with some assumptions.$\alpha_{1,j}$ reveals the role of a unit products that are produced in sector j on income distribution inequality of the region. In addition, b_5 as specified in Table 2 and Table 3 shows a target income inequality that is aimed to be obtained for these labour forces that are employed in the region.

Finally, non-equation (7) is used to consider the supply and demand for the products of sectors of the region constraints in the model. It is representative of 27 constraints for 27 production sectors. d_j the maximum possible products of sector j is shown in Table 4. In addition, since X_j indicates the goods or services that are produced in the sectors, they are positive or at least zero that are referred to in the equation (8).

$$GDP = v_1 * X_1 + v_2 * X_2 + \Lambda + v_{27} * X_{27} \tag{1}$$

$$l_{1,1}X_1 + l_{1,2}X_2 + \Lambda + l_{1,27}X_{27} \leq b_1 \tag{2}$$

$$l_{2,1}X_1 + l_{2,2}X_2 + \Lambda + l_{2,27}X_{27} \leq b_2 \tag{3}$$

$$l_{3,1}X_1 + l_{3,2}X_2 + \Lambda + l_{3,27}X_{27} \leq b_3 \tag{4}$$

$$l_{4,1}X_1 + l_{4,2}X_2 + \Lambda + l_{4,27}X_{27} \leq b_4 \tag{5}$$

$$\alpha_{1,1}X_1 + \alpha_{1,2}X_2 + \Lambda + \alpha_{1,27}X_{27} \leq b_5 \tag{6}$$

$$X_i \leq d_i \qquad ,i = 1, \Lambda ,27 \tag{7}$$

$X_i \geq 0 \quad , i = 1, \Lambda , 27$ (8)

The structure cases of labour force are studied in two different situations as second scheme of scenarios A and B. Hence, four models were derived based on scenarios A and B conditions with respect to the labour force as a whole and separated into four different levels of education.

Table 1: The differences of scenario A and B

Items	Scenario A	Scenario B
Maximum supply and demand of Fish-breeding sector	180613222	32252361
Maximum supply and demand of Carpets sector	39929959	1949786
Maximum supply and demand of Health sector	6318109	1192096

b- Mathematical analysis

Constraints have an important role in the maximisation of Linear Programming models. In fact, each effective constraint acts as a barrier that prevents the objective function to pass to a higher maximum position beyond that barrier. Hence, it seems, by studying these constraints, it is possible to improve them to some extent.

This case can be studied mathematically. For this purpose, in a two-independent-variables case; P, R and Q are assumed as follows:

$$P = \{(x, y) / ax + by \leq c\} \tag{9}$$

$$R = \{(x, y) / a'x + b'y \leq c'\} \tag{10}$$

$$Q = \{(x, y) / (a' + a)x + (b' + b)y \leq (c' + c)\} \tag{11}$$

Where P, R and Q are associated to the sets of feasible solutions that can be considered as constraints of an LP model, it can be proved $P \cap R \subset Q$:

Prove:

Based on inequalities properties, if:

$$\begin{cases} ax + by \leq c \\ \qquad\qquad \Rightarrow (a + a')x + (b + b')y \leq (c + c') \\ a'x + b'y \leq c' \end{cases} \tag{12}$$

Hence, for any:

$$(x, y) \in P \cap R \Rightarrow (x, y) \in Q \Rightarrow P \cap R \subset Q \tag{13}$$

This problem for a three-independent-variables case in which:

$$P_3 = \{(x, y, z)/\ ax + by + cz \leq d\} \tag{14}$$

$$R_3 = \{(x, y, z)/\ a'x + b'y + c'z \leq d'\} \tag{15}$$

$$Q_3 = \{(x, y, z)/\ (a' + a)x + (b' + b)y + (c' + c)z \leq d + d'\} \tag{16}$$

can be proved:

$$(x, y, z) \in P_3 \cap R_3 \Rightarrow (x, y, z) \in Q_3 \Rightarrow P_3 \cap R_3 \subset Q_3 \tag{17}$$

In addition, this theme can be extended to an *n* variables case that can be supposed to be drawn in an *n* dimensions space. Hence, it is proved that combining of constraints generally leads to a larger feasible solution area.

Furthermore, a two variables case can be illustrated graphically. In fact, when two non-equations are not equal with each other, their structure (sum of left- hand sides and right-hand sides together, respectively) leads to the expansion and improvement of the feasible solution area. As can be seen in following Figure, the constraint Q, which is obtained by adding constraint P and R, expands as well as improves the feasible solution area from under P and R constraints to under that of Q constraint. Obviously, in this case, it causes an increase in the optimum solution if it is not located on the intersection of these constraints.

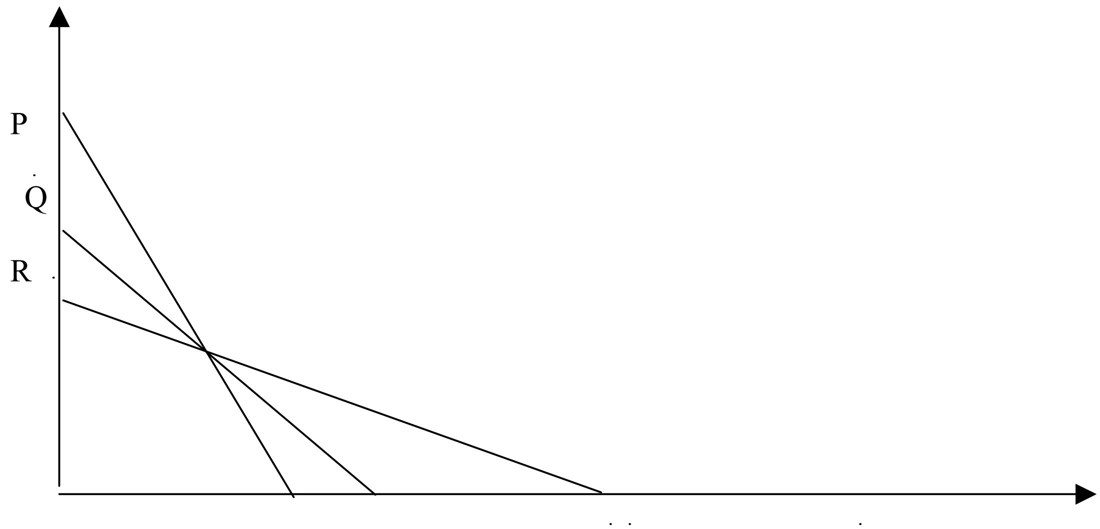

Figure: The effect of combined constraints on the feasible solution area

Application of the model

For this purpose, the scenarios are solved in two schemes. In the first scheme, four different educational groups of labour force are considered in the model. In the second scheme, however, a combined labour force constraint is used instead of four different educational labour force constraints.

In the case of scenario A, as it is shown in Table 2, the first scheme suffers from the shortage of supply and demand for all except one sector's products as well as a surplus of three higher educated labour force. In spite of these educational groups of labour force, the relevant shadow prices[2] demonstrates a unit increases in the right hand side of without high school diploma labour will increase the GRP. Thus, although there are a plenty of unused capacity in the carpets' sector a considerable labour force remains unemployed due to inconsistency between labour force's demand and supply.

[2] The shadow prices of without-high-school-diploma labour force in both schemes of scenario A is 1129.

To find an optimum structure of labour force, one labour constraint rather than four is considered in the second scheme. A comparison of the results associated with the first and second schemes in Table 2 demonstrates that the economy of the region is capable of creating job for all of its labour forces with an acceptable income distribution and higher GRP if there is no inconsistency between labour force supply and demand. In addition, it also can be concluded that the economy of the region needs more without-high-school-diploma labour force instead of that with higher education. Hence, so long as the economy is not faced with structural, i. e., technological, as well as supply and demand changes, investing in the other groups' education will lead to the wasting of resources, more unemployment and lower economic growth. Therefore, in a comparable situation in which the model suffers only from the structure of different groups of labour force, it is possible to find an adequate education policy.

Table 3 is about to scenario B. Like scenario A, all conditions except the labour constraints are the same in the two schemes. The labour constraint was derived like that for scenario A, but the results in the two columns are the same. In fact, by Sensitivity Analysis it can be demonstrated that this is due to insufficient resources for job creation for even one of those labour force groups. So, as it is shown in Table 3, the slack variable of all groups of labour force was positive. Since a part of all labour force groups are unemployed, the labour force constraints do not have an effective role in influencing optimum solutions. In fact, in a graphical analysis, the labour constraints are not in the feasible solution area. Thus, considering the whole labour constraint instead of partitioned labour, constraints do not change the results.

Furthermore, educational subjects of labour force can also be considered in this manner. For this purpose, a similar data with respect to subject and level of education will be required. Hence, the subject as well as the level of necessary education can be estimated.

Table 2: The results of scenario A on the economic parameters of the region(Thousands 2002 Rials/Persons)

Title	Results		Target	Slack Variables	
	First scheme	Second scheme	-	First scheme	Second scheme
GRP	125220881	133924950	-	-	-
Under HS diploma	38193	45906	38193	0	-7713
HS diploma	3660	3661	7889	4229	4228
Undergraduate	2890	2890	6310	3420	3420
Postgraduate	156	156	221	65	65
Total job creating	44899	52613	52613	7714	0
Income Distribution Index	0.29	0.34	0.34	0.05	0

Table 3: The results of scenario B on the economic parameters of the region (Thousands 2002 Rials/Persons)

Title	Scenario B		Target	Slack Variables	
	First scheme	Second scheme	-	First scheme	Second scheme
GRP	55426788	55426788	-	-	-
Under HS diploma	12876	12876	38193	25317	25317
HS diploma	1429	1429	7889	6460	6460
Undergraduate	838	838	6310	5472	5472
Postgraduate	45	45	221	176	176
Total job creating	15188	15188	52613	37425	37425
Income Distribution Index	0.097	0.097	0.34	0.243	0.243

Table 4: Slack variable and maximum associated to supply and demand for products of sectors constraints

j	Sectors	Scenario A		Scenario B		d_j
		First Scheme	Second Scheme	First Scheme	Second Scheme	
1	Farming	0	0	0	0	31855796
2	Traditional Livestock	0	0	0	0	41229
3	Modern Husbandry	0	0	0	0	166787
4	Modern Hen-breeding	0	0	0	0	1023365
5	Fish-breeding	0	0	0	0	See Table 1
6	Forestry	0	0	0	0	2772049
7	Fishery	0	0	0	0	1268760
8	Mining	0	0	0	0	134943
9	Food Processing Industri	0	0	0	0	1592552
10	Textile industries	0	0	0	0	558553
11	Carpet	11798948	70041	0	0	See Table 1
12	Wood Products	0	0	0	0	6641249
13	Publication & Paper	0	0	0	0	35854
14	Chemical Products	0	0	0	0	31537
15	Non-metals Products	0	0	0	0	292576
16	Metal Products	0	0	0	0	12678
17	Machinery Products	0	0	0	0	487290
18	Other Industry	0	0	0	0	272617
19	Water, Electricity and Ga	0	0	0	0	3184642
20	Construction	0	0	0	0	278669
21	Communication	0	0	0	0	93635
22	Transportation	0	0	0	0	1757197
23	Bank and Insurance	0	0	0	0	315909
24	Education	0	0	0	0	1617758
25	Health	0	0	0	0	See Table 1
26	Public Services	0	0	0	0	864689
27	Personal Services	0	0	0	0	5657055

Table 5: Coefficients of objective function, constraints and right hand side terms of the supply and demand constraints

Sectors	v_j	$l_{1,j}$	$l_{2,j}$	$l_{3,j}$	$l_{4,j}$	l_j	$\alpha_{1,j}$
Farming	0.76033	0.000238	8.19E-06	3.36E-07	0	0.00025	1.65E-09
Traditional Livestock	0.5446507	0.000157	0	0	0	0.00016	6.68E-10
Modern Husbandry	0.3340084	3.78E-05	5.85E-06	1.91E-06	7.88E-07	4.63728E-05	7.60E-10
Modern Hen-breeding	0.3620972	1.85E-05	2.88E-06	9.68E-07	4.19E-07	2.27832E-05	7.14E-10
Fish-breeding	0.3128147	5.08E-05	1.23E-05	1.23E-05	0	0.00008	3.71E-10
Forestry	0.9476191	8.34E-05	1.37E-05	4.19E-06	0	0.00010	9.76E-10
Fishery	0.6844605	4.33E-05	1.04E-05	8.80E-06	5.93E-07	0.00006	6.49E-10
Mining	0.7643516	9.97E-05	3.76E-06	7.74E-07	0	0.00010	1.13E-10
Food Processing Industries	0.4169656	5.17E-05	1.09E-05	2.51E-06	2.03E-07	6.53503E-05	2.58E-10
Textile industries	0.4210933	7.23E-05	1.56E-05	2.63E-06	2.31E-07	9.07007E-05	2.55E-10
Carpet	0.742104	0.000658	4.09E-08	0	0	0.00066	4.20E-09
Wood Products	0.542334	0.000102	1.65E-05	5.95E-06	5.72E-07	0.00013	6.01E-10
Publication & Paper	0.3913791	5.90E-05	1.46E-05	1.46E-06	0	0.00008	8.13E-10
Chemical Products	0.4134836	3.91E-05	6.41E-06	1.28E-06	0	0.00005	9.18E-10
Non-metals Products	0.5431433	9.18E-05	1.15E-05	3.06E-06	1.42E-07	0.00011	1.00E-09
Metal Products	0.3759892	5.91E-05	9.52E-06	0	0	0.00007	7.43E-10
Machinery Products	0.4564759	9.22E-05	1.65E-05	1.70E-06	8.48E-08	0.00011	4.90E-10
Other Industry	0.5965997	3.44E-05	8.06E-06	1.06E-06	5.30E-07	0.00004	4.77E-10
Water, Electricity and Gas	0.3777943	4.06E-05	1.91E-05	7.59E-06	8.04E-07	6.80894E-05	2.39E-10
Construction	0.4814218	0.000145	4.90E-06	6.56E-07	0	0.00015	5.57E-10
Communication	0.8087719	6.84E-05	3.20E-05	2.14E-05	0	0.00012	2.47E-10
Transportation	0.6878442	0.000123	1.65E-05	5.72E-07	0	0.00014	8.14E-10
Bank and Insurance	0.8019311	3.92E-05	4.66E-05	8.10E-06	0	0.00009	3.72E-10
Education	0.907719	1.31E-05	0.000146	0.000146	4.62E-06	0.00031	8.67E-10
Health	0.7615014	0.000101	7.99E-05	4.52E-05	2.17E-05	0.00025	1.11E-09
Public Services	0.8133859	0.000181	5.00E-05	4.44E-05	8.30E-07	0.00028	6.83E-10
Personal Services	0.8116181	7.95E-05	1.47E-05	2.34E-07	4.10E-07	9.48545E-05	1.53E-09

Conclusion

From the study of different views associated with education it can be concluded that the investment on higher education should be made according to the regions or the countries involved. Although several procedures have been proposed for this propose, none of them leads to an optimum structure. Hence, the present study aimed to propose a procedure to find an adequate structure of labour force. For this purpose, an LP Model in which the GRP of the region is the objective function of the model as well as several constraints in terms of job creation for different educational groups of labour force, income distribution inequality, and supply and demand constraints for products are proposed. A Social Accounting Matrix framework is used to estimate the necessary coefficients of LP Model. With respect to supply and demand for the products of economic sectors two scenarios have been assumed.

In the first scenario, scenario A, although a part of all high school diploma, undergraduate and postgraduate levels of labour force are unemployed, the model suffers from a shortage of without-high-school-diploma labour force. Hence, it demonstrates that a better structure of labour force would lead to a better result for the model. Thus, using an optimum structure of labour force, with respect to the condition of the region, leads to the full employment of labour force and a higher GRP for the region.

One advantage of using this procedure is economising in payment on education. Since a large part of the investment is used for education in the region, it should be proportionate to the region's labour force demand. In addition, this procedure enables one to estimate the structure of different subjects and levels of education with respect to the condition of the region or the country.

The second scenario has extra labour force for all levels of education groups. Hence, the problem originates from some reasons such as shortage of economic resources. Therefore, it is demonstrated that the results of this procedure will not change and this procedure cannot be useful in this case.

References

Buchert L (1994) Education and development- A study of donor agency policies on education in Sweden, Holand and Denmark, *International Journal of Educational Development* 14(2): 143-157

Chatterji M (1998) Tertiary education and economic growth, *Regional Studies* 32(4): 349-354

Duggan SJ (1991) Education and economic- Development in Thailand, *Journal of Contemporary Asia* 21(2): 141-151

Glick P, Sahn DE (1997) Gender and education impacts on employment and earnings in West Africa: Evidence from Guinea, *Economic Development and Cultural Change* 45 (4): 793-823

Graff_M (1996) On the contribution of education to economic development, *Kolner Zeitschrift fur Soziologie und Sozialpsychologie* 48(2): 274-297

Hinchliffe K (1995) Manpower Analysis in Carnoy M (ed.) *International Encyclopaedia of Economics of Education,* Peygamon, UK.

Lau LJ, Jamison DT, Liu SC, Rivkin S (1993) Education and economic growth some cross-sectional evidence from Brazil, *Journal of Development Economics*, 41(1): 45- 70

McLean M (1983) Education and economic growth in the development countries Mandi P (ed.), *Third World Quarterly* 5 (2): 490-494

Mitch D (1984) Underinvestment in literacy- The potential contribution of government involvement in elementary education to economic growth in 19th century England, *Journal of Economic History* 44 (2): 557-566

Moussouris L (1998) The higher education-economic development 'connection' in Massachusetts: Forging a critical linkage?, *Higher Education* 35 (1): 91-112

Quan NT, Beck JH (1987) Public education expenditures and state economic growth Northeast and Sun-belt regions, *Southern Economic Journal* 54 (2): 361-376

Tambe N (1994) Basic education and national development- Lessons from China and India- Ahmed M, Kai C, Jalaluddin AK, Ramachadran K (ed.) *Comparative Education Review* 38 (2): 278-280

West LHT, Hore T (1989) The impact of higher education on adult students in Australia .1. Employment, *Higher Education* 18 (3): 341-352

Woo JH (1991) Education and economic growth in Taiwan- A case of successful planning, *World Development*, 19 (8): 1029-1044

Yano M (1997) Higher education and employment, *Higher Education* 34 (2): 199-214