Investigation for an Approach to Optimise the Structure of Human Force

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Received: 2016/05/21 Accepted: 2016/06/26

Abstract

This paper proposes an approach to find an optimum structure for educational levels of human forces. To this end, a Linear Programming (LP) Model integrated with a Social Accounting Matrix (SAM) was employed. The integrated model was employed using the SAM of Golestan Province of Iran. It was demonstrated that when unemployment is the result of inconsistency between supply and demand for human force, an optimum structure leads to an increase in human force employment and the value of the object. First contribution of this paper concerns with finding an optimum educational structure for human force with respect to the objective function and conditions of a region or country. The second contribution of this approach concerns finding obstacles in the process of obtaining the objective. Proposing a tool for policy making through sensitivity analysis of educational groups of human forces is yet another contribution of the paper.

Keywords: Linear Programming, Social accounting, Human Force Planning, Educational Structure, Sensitivity Analysis.

JEL Classification: C610, I280, J200, O210, R150.

1. Introduction

Education has different effects on the personal and social life of countries. However, due to higher education development in the world, in addition to the lots of expenditures that are paid for educational purposes, a confliction has appeared between the supply of educated human forces and the demand for these human forces. To this end, a number of theories have been proposed to examine an education policy in economic studies.

According to the Becker (1962) theory, investment in human capital is a pervasive phenomenon. Similarly, Mincer (1981)

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concluded to the simultaneously of human capital and economic development. In fact, the human capital theory which is the basis of neo-classical analysis of labour market and economic growth, education leads to a rise in employment and economic growth through increasing the productivity of educated human forces (Temple 1994). So, based on this theory, the over-education phenomenon that is due to increasing in higher education labour supply, is a short-run problem of the labour market. Consequently, this problem will be removed by adjusting production processes of firms.

However, according to Spence’s job-screen and Thurow’s job-competition models, the over-education phenomenon can be a permanent problem (Tsang & Levin, 2010). To avoid this problem, screening theory argues that the value of higher education is primarily dependent on the potential demand for the ability of such qualifications (Van der Merwe 2010). Thus, according to this theory, the value of higher education depends on the demand for educated human forces.

A huge number of studies have been carried out to determine the role of different levels of education in economic growth and employment. Among them, the role of basic education in economic growth and employment, especially in the early stages of development, has been confirmed practically. So, the Mitch (1984), Lau et al. (1993), Buchert (1994), Glick & Sahn (1997), and Nomura (2007) studies in different countries confirm the positive effect of general education on employment and economic growth.

In contrast to basic education, the experiences in higher education of countries are dependent on the condition of their economies. For instance, although a number of studies such as West & Hore (1989), Moussouris (1998), Carpentier (2006), Zhang & Zou (2007), Greene & Saridakis (2008), Stengos & Aurangzeb (2008), Fadaee Khorasgan (2008), Baldwin et al. (2011), Pradhan (2011) highlighted the positive role of higher education on economic growth and employment in different countries, Quan & Beck (1987), Duggan (1991), Chatterji (1998), O'Higgins & Ivanov (2006), Rehme (2007), De La Croix et al. (2008), Zeira (2009), Nilsson (2010), Ren et al. (2011), Wang et al. (2012), Chan (2015), Mok (2016), and Yeom (2016) have demonstrated that investment, especially on secondary and higher
education, in some places has had less return in comparison with other alternatives. In addition, according to the World Bank data sources, the percentage of tertiary educated unemployed labour force has increased in a number of countries (Table 1).

Therefore, irrespective of the stage of the development of countries, although general or vocational education can be taken into account as positive steps for development of regions or countries, evidence indicates that investment on secondary and especially higher education has not always had positive effects on employment and economic growth. Hence, it can be proposed that investment on higher education should be rationally determined.

Table 1: Unemployment with Tertiary Education

<table>
<thead>
<tr>
<th>Countries</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armenia</td>
<td>21.8</td>
<td>23.4</td>
<td>26.9</td>
<td>-</td>
</tr>
<tr>
<td>Bhutan</td>
<td>3.9</td>
<td>5.5</td>
<td>6.7</td>
<td>13.0</td>
</tr>
<tr>
<td>Bosnia and Herzegovina</td>
<td>5.1</td>
<td>7.6</td>
<td>8.4</td>
<td>9.1</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>10.5</td>
<td>13.4</td>
<td>15.7</td>
<td>-</td>
</tr>
<tr>
<td>Jordan</td>
<td>30.7</td>
<td>34.3</td>
<td>34.4</td>
<td>37.0</td>
</tr>
<tr>
<td>Mauritius</td>
<td>6.0</td>
<td>7.9</td>
<td>-</td>
<td>19.9</td>
</tr>
<tr>
<td>Moldova</td>
<td>19.3</td>
<td>19.9</td>
<td>21.3</td>
<td>23.5</td>
</tr>
<tr>
<td>Morocco</td>
<td>-</td>
<td>17.5</td>
<td>18.3</td>
<td>18.5</td>
</tr>
<tr>
<td>Peru</td>
<td>20.2</td>
<td>-</td>
<td>21.2</td>
<td>-</td>
</tr>
<tr>
<td>South Africa</td>
<td>5.4</td>
<td>5.8</td>
<td>5.8</td>
<td>-</td>
</tr>
<tr>
<td>Thailand</td>
<td>28.3</td>
<td>32.9</td>
<td>33.6</td>
<td>36.1</td>
</tr>
<tr>
<td>Venezuela, RB</td>
<td>27.3</td>
<td>29.4</td>
<td>33.4</td>
<td>-</td>
</tr>
</tbody>
</table>


To this end, a number of methods have been implemented to examine the role of education in employment and economic growth. Among them, the return of the human capital approach was employed by Becker (1993), and Barceinas-Paredes et al. (2000) studies. Hinchliffe (1995) referred to the international comparison procedures based on similarity of labour force growth in all countries in the economic development process that was implemented in East African and Southeast Asian countries. Based on this procedure, an underdeveloped country should follow the structure of the labor force of a developed country if it is selected as a future growth object. A regression analysis was used in the Lau et al. (1993); Graff (1996), and Van der Merwe (2010) studies to examine the role of higher
education as human capital. In addition, an economic data base analysis was also implemented by Chatterji (1998). And finally, an elementary game theory model was also used by Correa (2004) to analyse the interaction of government as the supplier of education and the responses of the public to the government decision.

To find a structure of labour force in a region or country, this paper proposes a procedure to find an optimum educational structure for labour force in a region or country. To do so, among others, an LP model integrated with a SAM has been devised. The Gross Regional Products (GRP) equation of Golestan Province is employed as the objective function of the LP model. A number of constraints of the economy are also considered as constraints of the LP model.

The model has then been applied to examine the labour force structure of the region in two different schemes. The first scheme, concerns the case in which unemployment of the region is the result of inconsistency between supply and demand for labour force only, hence, an optimum structure of labour force would lead to an increase in labour force employment, as well as improvement in the GRP of the region. But the second scheme concerns a case in which the shortage in production resources is the reason of labour force unemployment of the region. Accordingly, improvement in labour force structure will not increase the employment level and the GRP of the region (Appendix).

This approach has three major contributions to be employed in the structure of human force. First contribution of this approach concerns with finding an optimum educational structure of human force to meet the objective of an economy. The second contribution of this research concerns finding the obstacles of obtaining the objective of a region or country. The shadow price of educational groups of human force in sensitivity analysis that can be considered as an indicator to measure the effect of investment on educational groups is yet another contribution of the paper.

The paper contains four sections. Section 2 is devoted to the methodology including an introduction to the LP model. An empirical result of the model was considered for the Golestan Province in Iran to explore the structure of labour force of the region in the third section. Finally, the concluding section ends the paper.
2. The Model
An LP model linked to a SAM framework has been used in this paper. Although this method has been employed for other purposes such as resource allocation and impact analysis in Sharify & Batay (2006); Harris et al. (2008), and Kim et al. (2011) studies, it seems it is a new implementation for the integrated LP with the SAM model to be used for labour force structure of a region or country. It allows the researchers to find the optimum structure for labour force to obtain an objective of the region or country with respect to its conditions. This is the advantage of this method when compared with other alternatives.

To this end, 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 human forces, income distribution inequality, mean income for human force and supply and demand constraints for products of sectors are considered as constraints of the model.

Based on the basic equation of the SAM model, we have:

\[ X = M \cdot Y \]  

(1)

The column vectors \( X \) and \( Y \) refer to the endogenous and exogenous parts of the model, respectively. \( M \) as shown in Equation (2), refers to the matrix of coefficients that can be divided into several blocks such as \( M^{14} \) that is located between \( m_{1,k+1} \) and \( m_{k,k+p} \) concerned with the effect of one unit of exogenous increase in final demand for products on the associated production factors holders’ income of the region.
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\[ M = \begin{bmatrix}
    m_{t1} & \cdots & m_{tk} & m_{tk+1} & \cdots & m_{tk+p} & m_{tk+p+1} & \cdots & m_{tn} \\
    \vdots & & \vdots & \vdots & & \vdots & \vdots & & \vdots \\
    m_{k-t1} & \cdots & m_{k-1k} & m_{k-1k+1} & \cdots & m_{k-1k+p} & m_{k-1k+p+1} & \cdots & m_{k-1n} \\
    m_{k1} & \cdots & m_{k,k} & m_{k,k+1} & \cdots & m_{k,k+p} & m_{k,k+p+1} & \cdots & m_{kn} \\
    m_{k+1k} & \cdots & m_{k+1k,k} & m_{k+1k,k+1} & \cdots & m_{k+1k,k+p} & m_{k+1k,k+p+1} & \cdots & m_{k+1k,n} \\
    \vdots & & \vdots & \vdots & & \vdots & \vdots & & \vdots \\
    m_{k+p1} & \cdots & m_{k+p,k} & m_{k+p,k+1} & \cdots & m_{k+p,k+p} & m_{k+p,k+p+1} & \cdots & m_{kn} \\
    \vdots & & \vdots & \vdots & & \vdots & \vdots & & \vdots \\
    m_{n1} & m_{n,k} & m_{n,k+1} & m_{n,k+p} & m_{n,k+p+1} & m_{nn}
\end{bmatrix} \]

\( k \) and \( p \) refer to the number of primary factors holders and the number of individual sectors, respectively.

The GRP of the region is divided into two parts. The first part includes the value added concerned with private or public production factors that is generated in the region, as examined by Equation (3). If \( M^1 \), a row vector in which \( M^j \) is concerned with the vertical sum of the block \( M^i \) in matrix \( M \), thus \( M^j = \sum_{i=1}^{k} m_{i,j} \) reveals the impact of one unit exogenous final demand generated in the \( j^{th} \) sector of the region on the production factors holders’ income. Hence, \( GRP_1 \) explores the total income generated as a result of responding to the exogenous final demand for products of the region:

\[
GRP_1 = M^1.Y^* \\
= \sum_{i=1}^{k} m_{i,k+1}Y_{k+1} + \sum_{i=1}^{k} m_{i,k+2}Y_{k+2} + \sum_{i=1}^{k} m_{i,k+3}Y_{k+3} + \cdots + \sum_{i=1}^{k} m_{i,k+p}Y_{k+p} = M^1.Y^* \\
+ \sum_{i=1}^{k} m_{i,k+p}Y_{k+p} = M^1.Y^* + M^2.Y^* + M^3.Y^* + \cdots + M^p.Y^*
\]

\( Y^* \) is a \( p \times 1 \) sub-vector of \( Y \) associated with the exogenous final demand for products of production sectors, including \( Y_{k+1}, Y_{k+2}, Y_{k+3}, \ldots, Y_{k+p} \).

The second part of \( GRP \), denoted as \( GRP_2 \), is concerned with the net indirect taxes received by the government in the region.

\[
GRP_2 = t.X^* \quad (4)
\]
where \( t \), is a \( 1 \times p \) row vector in which individual elements \( t_j \) refer to the net indirect taxes received from a unit of goods or services produced in the \( j^{th} \) production sector in the region and \( X^* \) is a \( p \times 1 \) sub-vector of \( X \) concerned with the total products of the sectors, including \( X_{k+1}, X_{k+2}, X_{k+3}, \ldots, X_{k+p} \). By means of Equations (1) and (2), \( X^* \) is decomposed into two parts, so Equation (4) can be rewritten as follows:

\[
\text{GRP}_2 = t. M^p. Y^* \tag{5}
\]

\( M^p \) is a \( p \times p \) sub-matrix of \( M \) located between \( m_{k+1,k+1} \) and \( m_{k+p,k+p} \) that measures the effect of a one unit exogenous increase in final demand for products on total production of the region. Now, if we let \( C = t. M^p \), where \( C_1, C_2, C_3, \ldots, C_p \), denoted as the total net indirect tax receivable in the region from a unit increase in \( Y_{k+1}, Y_{k+2}, Y_{k+3}, \ldots, Y_{k+p} \), respectively. Hence, \( \text{GRP}_2 \) can be rewritten as Equation (6):

\[
\text{GRP}_2 = C. Y^* \tag{6}
\]

Finally, \( \text{GRP} \) of the region can be derived by the summation of increasing \( \text{GRP}_1 \) and \( \text{GRP}_2 \) that is examined through Equation (7).

\[
\text{GRP} = \text{GRP}_1 + \text{GRP}_2 = (M_{i1} + C_1) Y_{k+1} + (M_{i2} + C_2) Y_{k+2} + (M_{i3} + C_3) Y_{k+3} + \cdots + (M_{ip} + C_p) Y_{k+p} + g_1 Y_{k+1} + g_2 Y_{k+2} + g_3 Y_{k+3} + \cdots + g_p Y_{k+p} \tag{7}
\]

Thus \( G \), a row vector in which \( g_j \) is used instead of \( M^p_{i,j} + C_j \), is considered as the coefficient matrix of the objective function.

The total employment among different groups of workers in various sectors can be computed by Equation (8):

\[
L = 1. X^* \tag{8}
\]

where, \( L \) and \( 1 \) are \( h \times l \) and \( h \times p \) matrices, respectively. \( h \) refers to the number of different education attainment groups of workers.

Thus, \( L_{i} \), the element of \( L \) shows the amount of employment in the \( i^{th} \) educational category. In addition, \( l_{ij} \) the element of \( 1 \) refers also to the size of the \( i^{th} \) educational group of labour force that is required for a unit of output in the \( j^{th} \) sector.

Like Equation (5), \( L \) can be rewritten as Equation (9):

\[
L = 1. M^p. Y^* \tag{9}
\]
Let \( N = I \times M^p \). Hence, \( N \) is an \( h \times n \) matrix as follows:

\[
\begin{bmatrix}
I_{11} & I_{12} & \cdots & I_{1p} \\
I_{21} & I_{22} & \cdots & I_{2p} \\
\vdots & \vdots & \ddots & \vdots \\
I_{h1} & I_{h2} & \cdots & I_{hp}
\end{bmatrix}
\begin{bmatrix}
m_{1,1,1} & m_{1,1,2} & \cdots & m_{1,1,p}
m_{1,2,1} & m_{1,2,2} & \cdots & m_{1,2,p}
\vdots & \vdots & \ddots & \vdots \\
m_{1,p,1} & m_{1,p,2} & \cdots & m_{1,p,p}
\end{bmatrix} = 
\begin{bmatrix}
l_{1,1}m_{1,1,1} + l_{1,2}m_{1,1,2} + \cdots + l_{1,p}m_{1,1,p} \\
l_{2,1}m_{1,2,1} + l_{2,2}m_{1,2,2} + \cdots + l_{2,p}m_{1,2,p} \\
\vdots & \vdots & \ddots & \vdots \\
l_{h,1}m_{1,h,1} + l_{h,2}m_{1,h,2} + \cdots + l_{h,p}m_{1,h,p}
\end{bmatrix}
\]

\[
\begin{bmatrix}
N_{1,1} \\
N_{1,2} \\
\vdots \\
N_{1,p}
\end{bmatrix}
\begin{bmatrix}
N_{2,1} & N_{2,2} & \cdots & N_{2,p} \\
N_{3,1} & N_{3,2} & \cdots & N_{3,p} \\
\vdots & \vdots & \ddots & \vdots \\
N_{h,1} & N_{h,2} & \cdots & N_{h,p}
\end{bmatrix} = 
\begin{bmatrix}
N_{1,1}Y_{k_1} + N_{1,2}Y_{k_2} + \cdots + N_{1,p}Y_{k_p} \\
N_{2,1}Y_{k_1} + N_{2,2}Y_{k_2} + \cdots + N_{2,p}Y_{k_p} \\
\vdots & \vdots & \ddots & \vdots \\
N_{h,1}Y_{k_1} + N_{h,2}Y_{k_2} + \cdots + N_{h,p}Y_{k_p}
\end{bmatrix}
\]

By setting \( h = 4 \), corresponding to 4 categories of without-high-school-diploma, high school diploma, first grade educated and master and Ph. D. educational groups, Equations (12) to (15) concern job creation for different groups of education levels:

\[
\begin{align*}
N_{1,1}Y_{k_1} + N_{1,2}Y_{k_2} + \cdots + N_{1,p}Y_{k_p} & \leq b_1 \\
N_{2,1}Y_{k_1} + N_{2,2}Y_{k_2} + \cdots + N_{2,p}Y_{k_p} & \leq b_2 \\
N_{3,1}Y_{k_1} + N_{3,2}Y_{k_2} + \cdots + N_{3,p}Y_{k_p} & \leq b_3 \\
N_{4,1}Y_{k_1} + N_{4,2}Y_{k_2} + \cdots + N_{4,p}Y_{k_p} & \leq b_4
\end{align*}
\]
to $b_4$ display the size of labour force supply of different educational groups. The sign of $\leq$, indicates the possibility of unemployment for a part of the related labour force in the model.

The mean income of the human force is considered as a constraint of the model. The block $M \nu^2$ located between $m_{1,k+1}$ and $m_{k-1,k+p}$ that measures the effect on private endowment as a result of a one unit exogenous increase in final demand for products of the region, is considered in this circumstance. To formulate the mean income constraint, $M_{v^2} = \sum_{i=1}^{k-1} m_{i,j}$ the components of $M \nu^2$ are calculated by Equation (2). Hence, the mean income of the human force is calculated by Equation (16):

$$\mu = \frac{1}{U}(M_{v^2,k+1} \times Y_{k+1} + M_{v^2,k+2} \times Y_{k+2} + \ldots + M_{v^2,k+p} Y_{k+p}) =$$

$$r_{1,j} Y_{k+1} + r_{2,j} Y_{k+2} + \ldots + r_{p,j} Y_{k+p} \geq b_5$$

$\mu$ refers to the mean per capita income for human forces of the region, $U$ refers to the number of human forces and $r_{1,j}$ measures the effect of a unit exogenous final demand for products in sector $j$ on the mean income for employed human forces of the region. $b_5$ is the minimum desired mean income for the human forces that are planned to be employed.

Equation (17) concerns the employed income distribution inequality. The relative mean deviation index, $I$, promoted by Kakwani (1980) is used which can be written as a linear form with some preparation.

$$I = (\sqrt{2 \times U \times \mu}) M^{pc} = (\sqrt{2 \times \mu}) (M_{1}^{pc} \times Y_{k+1} + M_{2}^{pc} \times Y_{k+2} + \ldots + M_{p}^{pc} \times Y_{k+p}) =$$

$$a_{1,j} Y_{k+1} + a_{2,j} Y_{k+2} + a_{3,j} Y_{k+3} + \ldots + a_{p,j} Y_{k+p} \leq b_6$$

$M^{pc}$ is a row vector in which its components, $M_{j}^{pc} = |p_{j} - \mu|$, exhibit the difference of sectors production factors’ per capita income, $p_{j}$, from $\mu$ due to a unit exogenous final demand for goods and services produced in these sectors. Hence, $a_{j,j}$ reveals the role of a unit of products that is produced in sector $j$ on income distribution inequality of the region. In addition, $b_6$ shows a maximum income inequality that is aimed to be obtained for the human forces that are
employed in the region.

The size of $\mu$ is calculated by Equation (16), but the mean income of current human forces of the region is considered as the initial size of $\mu$. To this end, the model was run through several iterations. However, since the size of the mean income cannot increase infinitely, it is expected that the size of $\mu$ converge to a finite level after some iteration.

Equation (18) is used as the constraint of the model to consider the supply and demand for products of production sectors of the region. Hence, Equation (18) is representative of $p$ constraints for products of $p$ production sectors in which $d_i$ show the maximum possible products of sector $i$.

$$\mathbf{X}^* = \mathbf{M}^p \times \mathbf{Y}^* \leq d_i, i = 1, \cdots, p$$

Finally, since all of the decision variables are considered as exogenous final demand for products of sectors, $Y^*_i$'s would be greater than or at least equal to zero, as shown in Equation (19).

$$Y^*_i \geq 0, i = 1, \cdots, p$$

3. Results and Discussion
To examine the model, the SAM of Golestan Province of Iran, a province with different natural resources as well as a great deal of higher educated human forces, was employed (Sharify, 2000). The matrix has 54 dimensions with 52 endogenous parts including 27 production sectors. The social accounting model was used to calculate the related coefficients of the model. Other information including the target amounts of labour force and maximum sectors’ production level, have been estimated using the regional situation in the base year.

To examine the model, the education constraints were considered for two scenarios A and B. The amounts of supply and demand for products of 24 sectors are the same. The difference of these scenarios originates from the amounts of supply and demand for products of three critical sectors that are displayed in Table 2. The level of supply and demand for sectors in scenario A concerns the real cases of the region. However, due to critical effects of the levels of supply and demand of
these sectors on the results of the model, to demonstrate the ineffective role of education constraint when unemployment is due to insufficient capacity of production sectors, the amounts of these levels in scenario B are supposed to be about one tenth of their real size.

To reveal the effect of the educational constraint in different cases, each scenario is considered in two schemes. In the first scheme, the education of the labour force is considered, so four different educational groups of labour force are considered separately in the model. Whereas, in the second scheme, irrespective of the education level of labour force, a combined labour force constraint is used instead of four different educational labour force constraints. Hence, four models were derived based on scenarios A and B conditions with respect to the labour force as a whole or separated into four different levels of education.

Table 2: Maximum Supply and Demand of Sectors in Scenarios A and B

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Scenario A</th>
<th>Scenario B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Husbandry</td>
<td>1668</td>
<td>167</td>
</tr>
<tr>
<td>Industrial Hen-breeding</td>
<td>102337</td>
<td>10234</td>
</tr>
<tr>
<td>Forestry</td>
<td>277205</td>
<td>27720</td>
</tr>
</tbody>
</table>

Source: findings of the research

Using the model, in the case of scenario A, with respect to the size of the slack variable and shadow price of human force and sectors, as shown in Table 3 and Table 4, the first scheme suffers from the shortage of supply and demand for a number of sectors’ products as well as without-high-school-diploma human force. In spite of the other three educational groups of human forces, the relevant shadow prices demonstrate a unit increment in the right hand side of without-high-school-diploma labour force will increase the GRP. Thus, although there is plenty of unused capacity in several sectors, a considerable amount of labour force remains unemployed due to inconsistency between labour force’s demand and supply and lack of capacity in other sectors.

To find an optimum structure of labour force, one labour constraint rather than four has been considered in the second scheme. A comparison of the results associated with the first and second schemes
in Table 3 demonstrates that the economy of the region is capable of creating jobs for a larger number of some groups of its labour forces with an acceptable mean income, income distribution and higher GRP if there is no inconsistency between labour force supply and demand. On the other hand, the economy of the region needs more without-high-school-diploma labour force instead of those 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 no increase in economic growth of the region. Therefore, in a comparable situation in which the region suffers from the structure of different groups of human forces, it is possible to find an adequate education policy.

Table 3: The Results of Scenario A on Economic Parameters of the Region (Thousands Rials/Persons)

<table>
<thead>
<tr>
<th>Title</th>
<th>First* scheme</th>
<th>Second scheme</th>
<th>Target**</th>
<th>Slack Variables</th>
<th>Shadow Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRP</td>
<td>169221803</td>
<td>169748481</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Under HS diploma</td>
<td>38193</td>
<td>43478</td>
<td>38193</td>
<td>-2585</td>
<td>672</td>
</tr>
<tr>
<td>HS diploma</td>
<td>595</td>
<td>635</td>
<td>7889</td>
<td>7294</td>
<td>7254</td>
</tr>
<tr>
<td>Undergraduate</td>
<td>1807</td>
<td>2025</td>
<td>6310</td>
<td>4503</td>
<td>0</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>77</td>
<td>74</td>
<td>221</td>
<td>144</td>
<td>147</td>
</tr>
<tr>
<td>Total job creating</td>
<td>40672</td>
<td>46211</td>
<td>52613</td>
<td>11935</td>
<td>6402</td>
</tr>
<tr>
<td>Mean Income</td>
<td>3810</td>
<td>3373</td>
<td>3323</td>
<td>487</td>
<td>50</td>
</tr>
<tr>
<td>Income Distribution</td>
<td>29</td>
<td>32</td>
<td>34</td>
<td>05</td>
<td>02</td>
</tr>
</tbody>
</table>

* The results of indicators of scenario A in different schemes
** The target value for different indicators in the region

Sources: findings of the research

Table 4 displays the unused capacity of sectors as slack variable of different scenarios and schemes. On the other word, irrespective of different scenarios and schemes, a part of these capacities remained unused due to other constraints of the models. In addition, because of some critical constraints that are considered in scenario B (see table2), the structure of labour force has no effect on the results, so unused capacity of sectors are the same in two schemes. In contrast, the sizes
of unused capacity of sectors in the second scheme of scenario A are generally greater than those of the first scheme. Hence, in addition to the results of the schemes in table 3, the educational constraints of human force lead to more unused capacity of sectors.

Table 5 is about scenario B. Like scenario A, all conditions except the labour constraints are the same in the two schemes. The labour force constraints were derived like those of scenario A, but the results in the two schemes are the same. On the other hand, the condition of labour force has no effect on the economy of the region. According to the sensitivity analysis, as shown in Table 4, it is demonstrated that human force unemployment is due to insufficient resources of production sectors. So, as it is shown in Table 5, the slack variable of all groups of labour forces is positive, with zero value of shadow prices.

### Table 4: Slack Variable and Maximum Size of Supply and Demand for Products of Sectors

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Scenario A</th>
<th>Scenario B</th>
<th>$D_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First Scheme</td>
<td>Second Scheme</td>
<td>First Scheme</td>
</tr>
<tr>
<td>Farming</td>
<td>20</td>
<td>0</td>
<td>14991591</td>
</tr>
<tr>
<td>Traditional Livestock</td>
<td>7685572</td>
<td>8288386</td>
<td>30274535</td>
</tr>
<tr>
<td>Industrial Husbandry</td>
<td>398581</td>
<td>414436</td>
<td>0</td>
</tr>
<tr>
<td>Industrial Hen-breeding</td>
<td>95003556</td>
<td>98253500</td>
<td>7944675</td>
</tr>
<tr>
<td>Forestry</td>
<td>276170918</td>
<td>260033025</td>
<td>27604270</td>
</tr>
<tr>
<td>Fishery</td>
<td>10277199</td>
<td>12033040</td>
<td>12192120</td>
</tr>
<tr>
<td>Mining</td>
<td>1177490</td>
<td>1175824</td>
<td>1241371</td>
</tr>
<tr>
<td>Food Processing Industries</td>
<td>3819971</td>
<td>3729244</td>
<td>7267964</td>
</tr>
<tr>
<td>Textile industries</td>
<td>1247570</td>
<td>622657</td>
<td>1961195</td>
</tr>
<tr>
<td>Carpet</td>
<td>182160171</td>
<td>176660036</td>
<td>194637334</td>
</tr>
<tr>
<td>Wood Products</td>
<td>0</td>
<td>0</td>
<td>6021794</td>
</tr>
<tr>
<td>Publication &amp; Paper</td>
<td>42379</td>
<td>115249</td>
<td>152024</td>
</tr>
<tr>
<td>Chemical Products</td>
<td>65556</td>
<td>61524</td>
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</tr>
<tr>
<td>Non-metals Products</td>
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<td>26797949</td>
<td>28006941</td>
</tr>
<tr>
<td>Metal Products</td>
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<td>8</td>
<td>50108</td>
</tr>
<tr>
<td>Machinery Products</td>
<td>16</td>
<td>9</td>
<td>1077771</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Title</th>
<th>First scheme</th>
<th>Second scheme</th>
<th>Target</th>
<th>Slack Variables</th>
<th>Shadow Price</th>
</tr>
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<tbody>
<tr>
<td>GRP</td>
<td>110055356</td>
<td>110055356</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Under HS diploma</td>
<td>23587</td>
<td>23587</td>
<td>38193</td>
<td>14606</td>
<td>14606</td>
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<tr>
<td>HS diploma</td>
<td>113</td>
<td>113</td>
<td>7889</td>
<td>7776</td>
<td>7776</td>
</tr>
<tr>
<td>Undergraduate</td>
<td>3015</td>
<td>3015</td>
<td>6310</td>
<td>3295</td>
<td>3295</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>84</td>
<td>84</td>
<td>221</td>
<td>137</td>
<td>137</td>
</tr>
<tr>
<td>Total job creating</td>
<td>26799</td>
<td>26799</td>
<td>52613</td>
<td>25814</td>
<td>25814</td>
</tr>
<tr>
<td>Mean Income</td>
<td>4107</td>
<td>4107</td>
<td>3323</td>
<td>784</td>
<td>784</td>
</tr>
<tr>
<td>Income Distribution</td>
<td>16</td>
<td>16</td>
<td>34</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

Refer to the maximum capacity of supply or demand for products of sectors

Source: findings of the research

Hence, since a part of all labour force groups are unemployed, the shadow prices of the resources are zero. Hence, the labour force constraints do not have an effective role in influencing optimum solutions. In fact, as it is shown in appendix A, in a graphical analysis, the labour constraints are out of the feasible solution area. Thus, considering the whole labour forces constraint instead of partitioned labour forces, the results would not change.

4. Conclusion

Through studying different views associated with education, it can be concluded that the investment on higher education should be made according to the regions’ or countries’ condition. Although several
procedures have been proposed for this purpose, none of them leads to an optimum structure for human force. Hence, the first contribution of this paper concerns proposing a procedure to find an optimum structure of human force. To this end, an LP model integrated with a SAM framework 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, mean income for human force, income distribution inequality, and supply and demand constraints for products are proposed. In addition, the model can be employed to find the optimum structure of human force for regions or countries with other objects and conditions. Moreover, this approach is capable of being employed to specify an optimal structure for human forces with respect to the subject and level of education in future studies.

Implementing the proposed model, it was demonstrated that in the case in which unemployment originates from inconsistency between supply and demand for labour force, using an optimum structure of labour force, with respect to the condition of the region, would lead to a higher level of employment for human forces and a higher GRP for the region. In contrast, in case the problem originates from some reasons such as shortage of other economic resources, using this approach will not affect the results. Accordingly, in addition to the optimum structure of human force, the approach allows the researchers to specify the main obstacle to obtain the object of the region or country.

And finally, a large part of the investment is used for education in a region or country. Using a shadow price indicator allows the researchers to evaluate the payment on education. Thus, the third contribution of the paper concerns proposing sensitivity analysis for investment on education.

Appendices
Constraints have an important role in the maximisation of LP models. In fact, as the first scheme, 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 that through combining these constraints, concerning the second scheme, it is possible to
improve them to some extent.

This case can be studied mathematically. To this end, in a two-independent-variables case; P, R and Q are assumed as Equations (A.1) to (A.3):

\begin{align*}
P &= \{(x, y)/ ax + by \leq c \} \quad (A.1) \\
R &= \{(x, y)/ a' x + b' y \leq c' \} \quad (A.2) \\
Q &= \{(x, y)/ (a' + a)x + (b' + b)y \leq (c' + c)\} \quad (A.3)
\end{align*}

where P, R and Q are associated with the sets of feasible solutions that can be considered as constraints of an LP model, it can be proved \( \text{P} \cap \text{R} \subset \text{Q} \):

Based on inequalities properties, if:

\begin{align*}
ax + by &\leq c \\
ax' + by' &\leq c'
\end{align*}

\Rightarrow (a + a') x + (b + b') y \leq (c + c') \quad (A.4)

Hence, for any:

\[(x, y) \in \text{P} \cap \text{R} \Rightarrow (x, y) \in \text{Q} \Rightarrow \text{P} \cap \text{R} \subset \text{Q} \quad (A.5)\]

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

\begin{align*}
P_3 &= \{(x, y, z)/ ax + by + cz \leq d \} \quad (A.6) \\
R_3 &= \{(x, y, z)/ a' x + b' y + c' z \leq d' \} \quad (A.7) \\
Q_3 &= \{(x, y, z)/ (a' + a)x + (b' + b)y + (c' + c)z \leq d + d' \} \quad (A.8)
\end{align*}

can be proved:

\[(x, y, z) \in \text{P}_3 \cap \text{R}_3 \Rightarrow (x, y, z) \in \text{Q}_3 \Rightarrow \text{P}_3 \cap \text{R}_3 \subset \text{Q}_3 \quad (A.9)\]

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, Figure 1 illustrates a two variables case graphically. In fact, when two inequalities are not dependent on each other, their combination, sum of left-hand sides and right-hand sides together, respectively, leads to an expansion and improvement in the feasible solution area. As can be seen in Figure 1, 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 area to under that of Q constraint area. Obviously, in this case, it causes an increase in the optimum solution if it is not located on the intersection of these constraints.

Figure 1: The Effect of Combined Constraints on the Feasible Solution Area
References


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