HUMAN RESOURCE FORECASTING MODELS

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Abstract

In this article the authors have proposed to study the effect they have on human resources on economic growth. Any forecast on GDP growth, factor in achieving economic growth must also focus on analyzing the ratio population / economy. Of course, the population is the main source of the active population in employment and in the end the number of employees. In this article the authors focused on identifying the main models used in forecasting human resources. in this respect, the widely used modern theory of economic growth, then demo-economic models of economic growth, focusing on the R.F. Harrod model, R.M. Solow model, L. Stoleru model or J. J. Spengler modelul. All these enable interpretation and then analyzing and then adapting to forecast labor resources. Further emphasis on identifying elements that underlie the comprehensive design of population trends by extrapolating the total number of people directly based on observed statistically term trend. Used statistical quantities such as average rate of growth and finally using polynomial function that provides an increase in these resources. Summarizing the above mentioned here, the authors also focuses on the role that occupies projection of the number of households, households, the number of families, etc., so as to give a clearer idea of the prospects realization of labor resources. Finally, it has a structure based on labor resources that can be identified structural events underlying this analysis.

Keywords: forecasting, human resources, population, demographic model, demoeconomic

Introduction

This study is based on the need to determine the trend of development and the role that human resources have increased production. Of course, human resources are a major factor of economic growth, based mainly on Cobb-
Douglas model, which emphasize three factors but stresses the important role it has resource work. In this study the authors used models based on the existence of correlations that exist between human resources and the volume of labor employed. Thus, for example, are listed models used by Harrod, Solow, Stoleru or Spengler, most of them from making the mathematical equations (models) on which starting from the realities that shows the demographic forecast is possible to identify how evolving labor resources. Models are studied empirical analysis or analytical methods, all starting from the use of statistical indicators by which to identify and foreshadowed growth. For easier înțelegere and estimate the size and the correlation between labor resources and utilization thereof was prepared a table structural labor resources being used in statistics all components demographic involved preparation of forecasts of labor. Finally the authors state that to develop forecasting labor, an important role is simulation model aggregate is divided into a number of calculation relations (authors may specify all) and on which fail to clarify the opportunities for existing scope of this type of forecast. Also try a survey based on the forecast balance of labor, which includes the main indicators used.

**Literature review**


**Research methodology and data**

Population-economy report called demo-economic correlation, summarizes some interdependencies. Under the most general, this report involves the analysis simultaneous two units namely population and economy, expressed in quantities comparable in relation measurable growth rate of one in comparison with the growth of other, size and structure of the national economy in a symmetry relationship.

Economy-population ratio is the relationship between population and its means of subsistence are two types of correlations demo-economic type demoalimentar and demo-economic-developed.

The first type of demoalimentară voltage generating correlation, and its variables are: the number and intensity of the population „demographic pressure” in relation to the surface of the population. The relationship indices IQA> Ipt is regarded as positive, which corresponds to the basic shape of the demo-economic correlation.

The second type of correlation is the result of economic development, growth of productive forces and social progress. Following these factors diversified needs, there are others, changes priorities satisfaction.

In contemporary society-population ratio economy takes the form complex relationship between „growth” and „population growth”, which became correlation demo-economic fundamental that actually includes a large number of economic variables and demographic, including setting a series of interdependencies and conditionality. Whatever type correlation population of a country appears in triple aspect or employment background, income and consumer topic.

Active population, number and structure is influenced by two sets of factors: demographic (number and structure of the population and, as such, birth and death rates of the population) and socio-economic (level of participation of people in social work, the national economic structure, endowment technical labor, territorial and professional mobility processes).

In economic growth models, we find a series of correlations that are considering and human resources. Without performing a detailed presentation, we will refer to the main models used in economic analyzes.
Modern growth theory models involve identifying each factor influencing action demo-economic relations. Are considered key economic growth labor and capital, in association with the technical and organizational (technical progress, labor productivity) and „residual factors”, understood as the influence increases, knowledge and skills, so the „brainpower”.  

On the other hand, we mention demo-economic models of growth. This category includes those models based on global production function Cobb-Douglas. The most popular models such as those developed by J.M. Keynes, R. Harrod, E. Dawar, J. Hicks and R.M. Solow.

The R.F. Harrod believes that the population is an exogenous variable. He studies the problem in two cases, when the population increases and technical progress remains unchanged when the population is stationary, and technical progress increases.

The notations used in models built on this criterion are:
- $Y_t$ - Net national product during the period „$t$";
- $K_t$ = existing capital stock at the beginning of period „$t$”;
- $St$ = savings (accumulation) during the period „$t$”;
- $It$ = investments made during the period „$t$”;
- $K$ = capital coefficient;
- $x$ = demographic variable;
- $k = \frac{K_t}{Y_t}$ - capital coefficient;
- $K_t = k \times Y_t$ - the amount of capital

In the first variant, the population is increasing in geometric progression and technical developments remain unchanged as productivity investments. In these conditions the allocation of net national product growth will equal the population growth in the period multiplied by the coefficient capital.

If the population at time $t + 1$ is:

$$x_{t+1} = x_t \times e^{mr}$$  \hspace{1cm} (1)

then:

$$K_{t+1} = K_t \times e^{mr} = K \times Y_t \times e^{mr}$$

Where from:

$$S_t = I_{t+1} - K_t = K \times Y_t \times (e^{mr} - 1)$$

In the second variant in the population is stationary, and technical progress in the growth capital required will be a constant part of net national product equal to its growth (or production), compared to the total, ie.;
The R.M. Solow model is based on general production function, but emphasizes the effect of varying the capital-labor ratio on the growth rate, ie the effect of net investment, which is the growth rate of the amount of capital \( \frac{dK}{dt} \) calculated from the relationship:

\[
\frac{dK}{dt} = s \times Y
\]

or

\[
\frac{dK}{dt} = s \times F(K, L)
\]

\[
Y = F(K, L)
\]

L. Stoleru model is based on the following production function:

\[
Y = A \times L^\alpha \times K^{1-\alpha}
\]

sau:

\[
\frac{dY}{Y} = \frac{dA}{A} + \alpha \times \frac{dL}{L} + \left(1 - \alpha \right) \times \frac{dK}{K}
\]

It expresses production growth by growth factors, where:

\[
\frac{dA}{A} = \text{residual term.}
\]

Regarding manpower he proposes two indices: the index of the amount of labor, ie the population number and structure, including working hours and quality index of labor, ie age, level of education and that the quality of labor.

The J.J. Spengler model, who starts from existence between economic and demographic variables, the relations of mutual dependence (or unilateral causal relationship), and the mutual influence exercised within a period of time.

The analysis of these models, that the main variable is employment, with its various features, which requires the use of a transformed production functions such as:

\[
Q_t = A_t^{\omega} \times (L_t e)^\alpha \times J_t^{1-\alpha},
\]

\( Q_t \) = production during the period „t”;

\( L_t e \) = improve the structure of the active population;

\( J_t \) = new elements of capital;

\( A_t \) = residual factor (increase due to technical progress, etc.).

Against this background is necessary to set demographic forecast.
Demographic trends are built, usually in three ways, namely: by estimating the total population in the country, operating variables aggregated by projecting the total population and structure (age and sex) for each county and then, incrementally, the country and/or by estimating the total population in urban and rural areas, the age structure and sex, and by adding them to the country.

Closely related to these three ways of working methods are applied, comprehensive and analytical.

The Global Approach is to design direct evolution of the population by extrapolating the total population of the country based on lasting trend observed statistically and possibly taking into account foreseeable changes that will take place in demographic behavior. The method involves the use of forecasting techniques:

- use the average rate of growth (in case of developments in arithmetic progression)

\[ P_t = P_0 + n \times \Delta P \times k \]

where:
- \( P_t \) = number of population at the forecast horizon;
- \( P_0 \) = number of population in the base year;
- \( \Delta P \) = ratio average annual population trends;
- \( n \) = number of years after the base year;
- \( k \) = factor correction unit or subunit mainstreaming.

- using average annual rate (in case of developments in geometric progression):

\[ P_t = P_0 \times (1 + r)^n \times k \]

- using a polynomial function:

\[ P_t = a + bt + ct^2 \]

where:
- \( a, b, c \) = correction coefficients;
- \( t \) = time variable.

The analytical method (component) is to design and population dynamics of the correlation components conditions.

This method involves the following sequence of calculations:
- preliminary number of population in the base year (\( P_0 \));
- the design of live births (\( N \)) between the base year and the year of prediction, multiplying the number of fertile female population, that is to say the range between 15 and 49 years (\( P_i \)) with age-specific fertility rate (\( f_i \)):

\[ N_0 \rightarrow t = \sum_{i=15}^{49} P_i \times f_i \times 0 \rightarrow t; \]
- determining the number of deaths (D), which reduce the population each year in the base year, thereby obtaining the number of survivors from the base year and the year of prediction.

For these calculations use mortality tables that show the probability of death, differentiated by age and sex and then in total.

- estimation of the number of migrants (E) and immigrants (I) by statistical observations;

- calculating population forecast horizon (Pt) based on the relationship: 
  \[ P_t = P_0 + N_{0-t} - D_{0-t} - E_{0-t} + I_{0-t} \]

  The difference between birth (live births) and mortality (number of deaths) is the natural growth (absolute).

  If natural increase and migration balance is affected resulting in the total country population dynamics, both in absolute and relative size (in per thousand).

  An important role is occupied and projection of the number of households (household) and the number of families using the relationship:

  \[ c = \frac{C}{N} ; \quad N = P \times c ; \quad \bar{p} = \frac{P}{c} , \]

  where:
  
  \[ c \] = average of heads of household (family);
  \[ C \] = number of heads of household (family);
  \[ N \] = the number of households (families);
  \[ \bar{p} \] = average number of persons per household (a family).

  Labor forecasting is a very complex various events.

To estimate the size and probable correlation of labor resources and the use (or under-utilization of it) is necessary to know the place that it occupies different categories of human resources in the labor market. The structure of labor resources is summarized in the following table.

### The structure of labour resources

<table>
<thead>
<tr>
<th>P</th>
<th>PVM</th>
<th>PAVM</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVMA</td>
<td>PIM</td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>PI</td>
<td></td>
</tr>
<tr>
<td>PO</td>
<td>RM</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

It can be seen that the total country population (P) are distinguished:

a) on the one hand:

PVM = working age population i.e. approximately between 16 and 65 years;
PAVM = populația activă;
PI = populația inactivă.

Within the population of working age are distinguished:
PVMA = population of working age and able to work;
PI = population of working age but incapable of work

Also active population includes:
PO = employment;
RM = reserves labor.

Within employed population are distinguished:
S = employees;
A = other categories of employed population,

In preparing the forecast labor, an important role is global simulation model, which is divided into 16 account relationships (PVM_t = P_t x v_t; PAVM_t = P_t x a_t; PVML_t = P_t x b_t; PIM_t = PVM_t x c_t; PAML_t = P_t x d_t; RMP_t = PVM_t + PAML_t - PIM_t; PSVM_t = PVM_t x e_t; PCVM_t = PVM_t x f_t; Mt_t = PVM_t x g_t; RMD_t = RMP_t - RM_t x RMD_t = PO_t; RMP_t = RMD_t + RM_t; Pa_t = PO_t + RM_t; Pi_t = P_t - PA_t; SAL_t = PO_t x k_t) pe baza cărora deduce the values of all sizes need prospective studies to human resources.

In this context, to predict the number of employees (total necessary labor for which there are jobs available) branches is called the relationship:

\[ L_{i,t} = \frac{X_{i,t}}{W_{i,t}} \]

or:

\[ \frac{X_{i,t}}{W_{i,t}} = P_0 - \sum \Delta L_{it} \]

where:
L_i = labor required number of branches „i”;
X_i = production industry „i”;

1 Significance notation is as follows: SOM = the number of unemployed persons; h = the share of SOM in PVM; RM = labour reserves; RMD = available labour resources; PO = occupied population; PA = active population; PI = inactive population; SAL = the number of employees; k = the share of SAL in PO; t = forecast year; P = total population; PVM = working age population; v = the share of PVM in P; PVAVM = age population out of work; a = the share of PAVM in P; PVML = working age population able to work; b = the share of PVML in P; PIM = working age population, but the inability to work; c = the share of PIM in PVM; PAML = people who continue to work beyond working age; d = the share of PAML in P; RMP = potential labour resources; PSVM = school population in working age, capable, from education day; e = the share of PSVM in PVM; PCVM = household population of working age, able to work; f = the share of PCVM in PVM; MT = the number of conscripts; g = the share of MT in PVM.
\( W_i \) = labour productivity for branch „i”;
\[ \sum_i \Delta L_{it} \] = the amount of savings relative labor force that is expected to take place at the expense of labor productivity growth factors;
0 = base year;
t = forecast year.

From the resulting model interdependencies that exist between output, labor productivity and labor required number.

In this case, the number of labor is determined by anticipated volume of production and the required level of labor productivity.

Under normal circumstances there is a relative labor economy, which means that an increase in production time, there is slower growth of labor staff or even its stagnation. If this actually will be in forecasting lower than base year there is an absolute economy.

These cases differ, of course, from one branch to another, depending on the factors influencing the structure of production and labor productivity.

In the final analysis, to be obtained can balance between \( PO_t \) (determined using a global mode) and \( \sum_P O_{i,t} \) (calculated using the design production and labor productivity by industry).

\[ PO_t = \sum_P O_{i,t} \]

Projections thus obtained pursuing a rational correlation between manpower and requisite their coverage, both in total and on branches and areas.

Based on total labor requirements can be established needs new jobs as the difference between \( L_t \) and \( L_0 \), thus corresponding with absolute employment growth:

\[ \Delta LM_t = \Delta PO_t \]

The design then needs additional manpower, ie the actual number of workers employed in the forecast again. It is calculated by the equation:

\[ \Delta L = (L_t - L_0) + M + P + A, \]

where:
\( \Delta L \) = additional labour requirements;
\( L \) = the number of labour force;
\( M \) = natural mortality losses in the workforce;
\( P \) = the number of those retiring;
\( A \) = other exits from the labour force (departures from military service, emigration).

Study on forecasting labor balance is shown in the table below, which presents the main indicators used.
FORECAST BALANCE OF LABOUR FORCE

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Total of which</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
</tr>
<tr>
<td>I. Potential labour resources (1 + 2 - 3)</td>
<td></td>
</tr>
<tr>
<td>1. Working age population</td>
<td></td>
</tr>
<tr>
<td>2. Age population outside of work, but working</td>
<td></td>
</tr>
<tr>
<td>3. Working age population, but the inability to work</td>
<td></td>
</tr>
<tr>
<td>II. Labor resources (employment) total, including branches</td>
<td></td>
</tr>
<tr>
<td>Branch I - total</td>
<td></td>
</tr>
<tr>
<td>from which:</td>
<td></td>
</tr>
<tr>
<td>- employees</td>
<td></td>
</tr>
<tr>
<td>- other</td>
<td></td>
</tr>
<tr>
<td>Branch n</td>
<td></td>
</tr>
<tr>
<td>III. Labor resources - total (1 + 2 + 3 + 4)</td>
<td></td>
</tr>
<tr>
<td>1. The school population in working age, capable, from education day</td>
<td></td>
</tr>
<tr>
<td>2. Domestic population of working age, able to work</td>
<td></td>
</tr>
<tr>
<td>3. Conscripts</td>
<td></td>
</tr>
<tr>
<td>4. Unemployed</td>
<td></td>
</tr>
</tbody>
</table>

Equilibrium relationship: I = II + III

Knowing the additional demand for labor is determined further sources of its coverage, namely:
- the absorption of the funds available in the economy in the unemployed;
- for graduate schools and faculties;
- the return of army conscripts;
- the predictable migration (between branches, between areas and between socio-professional).

Conclusion

From the above article presented based on the study conducted by the authors, some important conclusions can be drawn. First is about the role that human resource is the power factor labor factor underpinning economic growth. Second, conducting a study on demographic indicators, the authors arrive at certain conclusions about the correlation established between demographic trends of a country and the extent they have labor resources, important as growth of macroeconomic indicators results. The indicators used in this article are precisely synthesized, they can be used by any researcher interested in the study and prediction of human resources. In this sense, they are inventoried from the correlations that exist between labor resources, the models used. Sstfel make details of modern growth theory models, demo-economic models of growth and in this context is made clear in connection with models of this type developed by Keynes, Harrod, Dawar, Hicks, Solow and others. Another
conclusion is that, based on the models tested this model, states that using mathematical functions based on available data at a time, we can pinpoint the level you have these indicators. Finally, make some remarks about the adoption forecast labor, a very complex activity, the authors of a synthesized structure a presentation which includes all elements joined equation probable labor resources and utilization theirs. In preparing the forecast labor has an important role simulation model global structure based on precise calculation relations opportunities for improving human resources. Finally, another conclusion is that the study may be based on provisional balance of labor, which in addition to scales and presents key indicators that may underlie these analyzes forecasting.

References


