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Manpower Planning Model for Less Developed Countries

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Abstract

The need for manpower planning in underdeveloped countries is necessary to remove widespread unemployment and disguised unemployment in such economies. Models for predicting future manpower requirements are indispensable tools for planners and policy makers. A model which captures manpower demand and supply is developed in this study to predict future manpower structure in less developed countries (LDCs). In addition a partial adjustment to manpower planning model is proposed to off set the lag that may be present in manpower system.

***Keywords*:** Apprenticeship, brain drain, indigenization policy and transition probability.

1.0 Introduction

Manpower planning relates to the long – range development of semi – skilled and skilled manpower requirements of the economy, and to plan educational priorities and investments in human resource development so as to enlarge employment opportunities in the future (Jhingan, 2003 [2]).

Markov models are widely used for analyzing manpower planning systems. Most of these models bother either on estimating the grade – wise distribution of future manpower structure given the existing structure and promotion policies or on deriving policies towards promotion given the required future structure. Limited mobility of labour force from one organization to another has long – term irrevocable effects on the organization [see Leeson (1984) [4], McClean (1991) [6], McClean and Gribbin (1987) [6], and Reghavendra (1991) [12]].

Markovian model has also been applied to educational planning [see Osagiede and Ekhosuehi (2006a) [8], Osagiede and Ekhosuehi (2006b) [9], Uche (2000) 14], and Uche and Ezepue (1991) [13]]. Osagiede and Omosigho (2004) [10] attempted a solution to the method of estimating the number of new intake into the first grade in an educational system using modified Markov chain model. Osezuah (1998) identified manpower resources requirement and political influence as the two basic factors influencing educational planning and implementation.

In this work, a manpower planning model which encapsulates the basic manpower categories in LDCs is developed. Considering the lags that may be present in LDCs, a partial adjustment specification is given. The model can therefore be used to estimate the future manpower structure in an economy given sufficient data.

2.0 Model Development

Consider the following manpower categories in LDCs (see Jhingan, 2003) [[2].

***Category* 1**

Craftsmen and technical clerical personnel. In the former are tool – makers, machine – tool operators, welders, electricians, painters, etc. Technical clerical personnel relate to typists, stenographers, book – keepers, and business machine operators.

***Category* 2**

Sub–professional manpower and instructors. Sub–professional manpower include technicians, foremen, nurse, health assistants, etc. Instructors refer to primary, secondary and craft teachers.

***Category* 3**

Professional manpower such as scientist, engineers, doctors, agronomists and veterinarians.

***Category* 4**

Top–level managerial and administrative personnel. This encompasses general managers, production managers, cost accountants, entrepreneurs, etc.

The categories above are used to develop the manpower planning model.

2.1 Transition Matrix, Q

Let i denote the manpower category, i = 1, 2, … m. The probability of personnel in category i moving to category j within a period t, denoted by $p_{ij}(t)$, is assumed to satisfy the multinomial distribution given as

$$p\left(n_{i1}(t),\ n_{i2}(t),\ \ldots,\ n_{ir}(t)\right)=\frac{\left(\sum_{j=1}^{r} n_{ij}(t)\right)!}{\prod_{j=1}^{r}\left(n_{ij}(t)\right)!}\prod_{j=1}^{r} p_{ij}^{n_{ij}(t)}(t) \qquad (2.1)$$

$i = 1, 2, \ldots, m; j = 1, 2, \ldots, r; t = 1, 2, \ldots, n$

where $n_{ij}(t)$ is the flow of personnel from category i to j within period t. (see Uche and Ezepue, 1991) [13].

Using the likelihood function given in Lindgren (1993) [5], we obtain

$$\hat{p}_{ij}(t)=\frac{n_{ij}(t)}{n_i(t)}, \quad i=1, 2, \ldots, m; \quad j=1, 2, \ldots, r;\ t=1, 2, \ldots, n \qquad (2.2)$$

by the method of maximum likelihood. The hat on $p_{ij}(t)$ represents estimate of $p_{ij}(t)$, and $n_i(t)$ is the number of personnel in category i during period t. The pooled estimate of equation (2.2) gives

$$\hat{p}_{ij}=\frac{\sum_{t=1}^{n} n_{ij}(t)}{\sum_{t=1}^{n} n_i(t)} \qquad (2.3)$$

Equation (2.3) is valid provided there is a large data base for its estimation. The flow of personnel from category i to j is possible when personnel in category i upgrades his qualification (s) to meet the requirements of category j.

The multinomial distribution in equation (2.1) is employed instead of exponential distribution because a number of authors, for instance, Silock (1954) and Bartholomew and Forbes (1979) as cited by McClean and Gribbin (1987) [6], posited that the exponential distribution does not give a good fit to manpower data for completed length of service on leaving.

To develop the transition matrix, we assume no demotion *i.e.* $\hat{p}_{ij} = 0$, for $j \le i-1$, and the transition probability $\hat{p}_{ij}$ is stationary. However, from the manpower categories given in this section it is assumed that movement is possible from category 1 to 2, and also from category 1 to 3; category 2 to 3, and then category 3 to 4. It is also assumed that departure from the system (as a result of brain drain, retirement or death) is independent of new personnel entering the system. Let p_{i0} be the probability of departure in category *i* and let p_{0j} be the probability of new personnel entering the system. From the independence of probabilities, we have $(p_{i0}) \times (p_{0j})$. This may be interpreted as personnel who leave category *i* are being replaced by new personnel into category j.

The transition matrix, *Q*, is therefore given as

$$Q = \begin{pmatrix} P_{11} + (P_{10})(P_{01}) & P_{12} + (P_{10})(P_{02}) & P_{13} + (P_{10})(P_{03}) & 0 \\ (P_{20})(P_{01}) & P_{22} + (P_{20})(P_{02}) & P_{23} + (P_{20})(P_{03}) & 0 \\ (P_{30})(P_{01}) & (P_{30})(P_{02}) & P_{33} + (P_{30})(P_{03}) & P_{34} \\ (P_{40})(P_{01}) & (P_{40})(P_{02}) & (P_{40})(P_{03}) & P_{44} \end{pmatrix} \quad (2.4)$$

The transition matrix, Q, is stochastic since

$$\sum_{j=1}^{m} \left(P_{ij} + (P_{i0})(P_{0j})\right) = 1 \quad (2.5)$$

where *m* is the number of manpower categories. $P_{04} = 0$ since before an employee attains the managerial or administrative category, it requires a considerable length of experience in addition to qualification. This follows the assumptions made in this section.

2.2 Expansion of the System, $\Delta(t)$

Let $F_i(t)$ be new entrants into category *i* in the manpower structure during year *t*. Let the annual growth rate of the system in category *i* be β_i. Then the expansion of the system for category *i*, $\Delta(t_i)$, is

$$\Delta(t_i) = F_i(0)\,\beta_i\,(1+\beta_i)^t \quad (2.6)$$

where $F_i(0)$ is the initial manpower stock of the system in category i.

Equation (2.6) is similar to the system in Leeson (1984) [4]. The expansion of the system, $\Delta(t)$, is brought about by human capital formation by the educational sector and apprentice training. The growth rate in category *i* can be determined from Osagiede and Ekhosuehi (2006a) [8].

$$\ln(1+\beta_i) = \frac{12\sum_{t=1}^{n} t \ln F_i(t) - 6(n+1)\ln\prod_{t=1}^{n} F_i(t)}{n(n^2-1)} \quad (2.7)$$

(also see Osagiede and Ekhosuehi, 2006b [9]). Thus, the manpower planning model for LDCs is

$$(\hat{n}_i(t)) = Q'(n_i(t-1)) + \Delta(t) \quad (2.8)$$

which can simplify to

$$(\hat{n}_i(t)) = (Q')^t (n_i(0)) + \sum_{c=1}^{t} (Q')^{t-c}\Delta(c) \quad (2.9)$$

$i = 1, 2, 3, 4$

where the hat denotes estimate, Q' is the transpose of matrix Q, and $(n_i(0))$ represents a $m \times 1$ vector of manpower stock in category i at the initial period.

Equation (2.9) is the required manpower planning model for the LDCs and it is similar to the system in McClean (1991) [6]. However, unlike the model in McClean (1991) [6], equation (2.9) in this study takes into consideration possible expansion in the manpower system. This is possible because of the inclusion of the factor $\Delta(c)$ in equation (2.9). Further, Q in equation (2.9) is a modification of the transition probability matrix in McClean(1991) [6] to incorporate the variables in this study as illustrated in equation (2.4).

3.0 Manpower Shortages and Surpluses

Let equation (2.9) be the expected manpower structure (demand) determined by the manpower planner for optimum production in the economy. Let the actual manpower structure be ($n_i(t)$).

The difference ($n_i(t)$) - $(\hat{n}_i(t))$ (3.1)

is used to determine manpower shortages or surpluses in the system.

There exist manpower shortage for category i if $(n_i(t) - \hat{n}_i(t))$ is negative. This may arise in LDCs, as stipulated by Jhingan (2003) [2], due to lack of an organized employment market, immobility of labour, preference for university education to technical institute, underemployment and indigenization policy. In this regard, human resource development should be embarked upon. People who posses critical skills such as scientists, engineers, doctors, lecturers, entrepreneurs, to mention but a few, should be given due incentives to avoid brain drain. On–the–job training and apprenticeship programmes should be started. Moreso, technical institutes and universities should be encouraged to start part–time programmes. Meanwhile, modalities should be worked out to develop better educational techniques especially in the sciences and to improve teaching personnel.

Positive value of $(n_i(t) - \hat{n}_i(t))$ indicates manpower surplus for category *i*. There is likely to be unemployment in such economy. Reducing the effects of manpower surpluses include, inter alia, check over rapidly increasing population, increasing the length of human capital formation, and macroeconomic policy geared towards reducing structural bottlenecks and enhancing the rate of growth to increase job opportunities.

4.0 Partial Adjustment Specification

The adjustment of manpower stock to the desired or expected structure as determined by the manpower planner is only gradual (i.e. the existence of lag) due to economic, social and political events in LDCs (Jhingan, 2003). The gradual adjustment process may be expressed in the following adjustment equation.

$$(n_i(t)) - (n_i(t-1)) = (\delta_{ij})((\hat{n}_i(t)) - (n_i(t-1)))$$
$$0 < \delta_{ii} < 1 \qquad (4.1)$$

where

$$\delta_{ij} = \begin{cases} \neq 0 \ , \ i = j \\ = 0 \ , \ i \neq j \end{cases}$$

Equation (4.1) is similar to the partial adjustment model in Koutsoyiannis (1977) [3] (δ_{ij}) is an mxm matrix, and the element δ_{ij} is the $(i, j)^{th}$ adjustment coefficient. The higher δ_{ii} is, the more rapid the adjustment of actual manpower stock to the optimum. (Koutsoyiannis, 1977 [3], and Iyoha, 1976 [1]) δ_{ij} is determined by the manpower planner.

The constraints on δ_{ij} enables the manpower planner to know the range of values of stock to expect and also constrain the computation of one grade after the other with the δ_{ij} =0, for $i \neq j$. This makes computation easier than that of Koutsoyiannis(1977) [3].

5.0 Conclusion

In this study, we derive a manpower planning model for LDCs. The model hinges on equations (2.9) and (4.1) which are refinements of McClean (1991) [6] and Koutsoyiannis (1977) [3] respectively. These two equations together have taken care of the existing manpower structure, the educational system and other training institutes as determinant of manpower supply, and the expected manpower required to turn the economy around. This was not the case with McClean (1991) [6] that considered flow of stock from one manpower grade to the other without regard to possible expansion in the system; and Koutsoyiannis (1977) [3] that placed no restriction on the adjustment coefficient. To bridge the gap between the actual / existing manpower structure and the one determined by the manpower planner for policy making, some measures have been suggested, hence, a partial adjustment model is specified to estimate the rate of adjustment. This is an improvement over other manpower systems in literature such as Raghavendra (1991) [13], McClean (1991) [6], Koutsoyiannis (1977)[3], Uche (2000), and Osagiede and Ekhosuehi (2006a) [8] and (2006b) [9].

To a large extent, estimation of future manpower structure in LDCs is hindered by lack of empirical data on the manpower structure and the changes in occupational requirement as specified in Jhingan (2003) [2]. However, given sufficient data, equation (2.9) and (4.1) can be used to predict the manpower structure in LDCs.

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