Mapping the Human Resource Endowment in Ethiopia

An Empirical Research Based on Gray Forecast Model

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Abstract. As Ethiopia has been developing human resources to match its national blueprint, it is necessary to examine the future human resources demand. Thus, the gray forecast model was introduced to predict the needed employees in the primary, secondary, and tertiary sector of Ethiopia via MATLAB. The results show that, up to 2029, there will be a 26.72% employment growth demand in the primary sector, while an increase of 306.89% and 402.17% in secondary sector and tertiary sector respectively compared to 2007.

Keywords: Human resources · Endowment · Ethiopia · Gray forecast

1 Introduction

1.1 Research Background and Significance

Ethiopia is an important cooperative country participating in the Belt and Road Initiative and is a comprehensive strategic partner for China. In addition, it is the country where the African Union and the UN Economic Commission are located. It possesses a unique status across the African continent and international influence worldwide. As the second most densely populated and one of the fasted economically growing African countries, Ethiopia has been experiencing an urgent demand for various resources, particularly human resources, to accelerate poverty reduction and promote socio-economic development.

As it is well acknowledged that, investment in human resources is one of the most fundamental and prominent factors for national competitiveness. Massive research on human resources development (HRD) has been done from global, regional to national perspectives. Nevertheless, Ethiopia, like most African countries, is confronted with uneven balance and mismatch between the supply side and demand side of human resources. Therefore, it is critical to examine and forecast the human resources needed in the future, to facilitate corresponding policy guidance, education, training, and so on.

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There is a situation that most of the research on the referred issue in the Ethiopian context is qualitative, the mixture of qualitative and quantitative research is relatively less. This paper has realized inter-disciplinary research from both education and economics, as well as comprehensive problem-solving via qualitative and quantitative methods.

1.2 Research Methodology

A combination of qualitative and quantitative research is adopted in this paper. Given the characteristics of qualitative research, vast information and resources can be collected through literature research. Meanwhile, information other than objective data can be obtained through the qualitative research method [1]. Thus the deep-seated social perspectives can be summarized.

Besides, considering the disadvantages of qualitative research, that is, the lack of objectivity and universality as the one decoding any written materials might have diverse understandings, the method of quantitative research is utilized as well. The official and published data collected from relevant governments and departments will be analyzed via MATLAB to improve the universality, accuracy, and credibility of the research conclusions. By these means can the research problems will be examined scientifically and objectively [2].

2 Relevant Theoretical Term

2.1 Human Resource Endowment

One term that must be put forward first is "factor endowment". In economics, the "factor endowment" commonly refers to the available resources, including natural resources and human resources a country possesses, for instance, mineral resources, agricultural resources, technologies, labor force, and so on. The comparative advantage of a country in the production of a particular commodity is linked closely with its factor endowment [3].

In terms of human resources and human capital, research has been widely done. After making up for the shortcomings of neoclassical growth theory, Theodore W. Schultz put forward the human capital theory based on the research results of the agricultural economy in 1961. It was stated that there was a significant positive correlation between the development level of human resources and the level of economic growth, and the output efficiency of human resources input was much higher than that of material capital input [4]. Similarly, Hirofumi Uzawa [5], Paul M. Romer [6], Robert E. Lucas, Jr. [7], and other economists and scholars all proposed that human resources, knowledge innovation, and technological level are the internal driving forces of economic growth for a certain country.

Thus, this paper raises a term entitled "human resource endowment" to indicate the overall number and availability of human resources in a national context, while stressing the critical functions and importance of human resources.

2.2 Gray Forecast Model

The gray forecast model is commonly applied to forecast the law of things' development by establishing a gray differential forecast model. The gray system theory holds the statement that any irregular sequence of numbers changing within a certain range has a potential orderly law. Therefore, the gray forecast model can take advantage of the benchmark data of small samples, generate new data through accumulation, weaken the randomness, and then predict the future development law, to show a more obvious regularity. The advantage of the gray forecast model is that it deduces the potential order law based on the existing data, without any other immeasurable influencing factors, such as the cultural environment, policy guidelines, and changes in individual values [8]. Considering the characteristics of the gray forecast model, it is assumed to be a suitable research method for the Ethiopian context. The estimated results are hence demonstrated and analyzed for policymakers, stakeholders, or any parties involved.

3 Problem Statement

Ethiopia aims to occupy a place in the global industrial chain through the development of the manufacturing industry. A series of government documents and strategies have been published to cultivate human resources for the secondary sector, especially the manufacturing industry. It is of great importance to examine whether the policy orientation aligns with future development. Thus, the paper proposes the problems below:

- What is the number and the changing tendency of employees participating in the primary sector, the secondary sector, and the tertiary sector needed in the future?
- Whether the estimated number of employment required in the future majors in the secondary sector as the national strategy focusing on?

4 Model and Data

4.1 Model Building

The Gray Forecast Model GM (1, 1) is applied. The original time series data is processed by the matrix built via MATLAB, and the obtained data will be analyzed to forecast the number of employees needed in the future.

First, the original data of the research objectives is set as:

$$\left\{X^{(0)}(t_i)\right\} = \left\{X^{(0)}(t_1), X^{0}(t_2), ..., X^{(0)}(t_n)\right\} \tag{1}$$

was accumulated to obtain 1-AGO sequence $Y_t(t = 0, 1, 2, 3...n)$, which is expressed as

$$Y_t = \sum_{i=0}^{t} X_i \tag{2}$$

After calculating the moving average of (2) series $Z_t = \frac{(Y_t - 1 + Y_t)}{2}$, the gray model GM (1, 1) is built. The corresponding first-order linear differential equation is.

$$\frac{dY_t}{d_t} + \alpha Y_t = \beta, \quad t = 0, 1, 2 \cdots, n \tag{3}$$

To obtain the undetermined parameters, the above differential Eq. (3) is converted to

$$Y_t = \left(X_0 - \frac{\beta}{\alpha}\right) e^{-at} + \frac{\beta}{\alpha}, \quad t = 0, 1, 2 \cdots, n \tag{4}$$

The undetermined coefficient α, β in the first-order linear differential equation is obtained by the least square procedure as

$$\alpha = \left(\sum_{t=1}^{n} X_t \sum_{t=1}^{n} W_t - n \sum_{t=1}^{n} X_t W_t\right) \Big/ \left\{ n \sum_{t=1}^{n} W_t^2 - \left(\sum_{t=1}^{n} W_t\right)^2 \right\}$$

$$\beta = \left(\sum_{t=1}^{n} X_t \sum_{t=1}^{n} W_t^2 - \sum_{t=1}^{n} X_t W_t \sum_{t=1}^{n} W_t\right) \Big/ \left\{ n \sum_{t=1}^{n} W_t^2 - \left(\sum_{t=1}^{n} W_t\right)^2 \right\}$$

The estimated $\widehat{Y}$ is obtained by substituting the obtained α, β back into the first-order linear differential equation.

The estimated value of (1) is

$$\widehat{X_t} = \widehat{Y_t} - \widehat{Y_{t-1}}, \quad t = 0, 1, 2 \cdots, \mathrm{N}$$

Once the estimated statistics are obtained, the standard deviation S_2 and relative error δ_t are calculated with the original data.

$$\delta_t = X_t - \widehat{X_t}, t = 0, 1, 2..., n$$

$$S_2 = \sqrt{\frac{\sum_{t=1}^{n} (\delta_t - \widehat{\delta})^2}{n}} \quad C = S_2 / \sqrt{\frac{\sum_{t=1}^{n} \left(X_t - \hat{X}\right)^2}{n}}$$

$$P = P\left\{ \left| \delta_t - \hat{\delta} < 0.6745 S_1 \right| \right\}$$

The calculation of the C and P values will be examined according to the forecast accuracy criteria (see Table 1) to determine whether the estimated statistics can be applied to the forecast.

Table 1. Forecast accuracy criteria

Accuracy level	Goodness of fit	C	P
Level I	Good	<0.35	>0.95
Level II	Qualified	<0.5	>0.8
Level III	Barely	<0.65	>0.7
Level IV	Unqualified	≧0.65	≦0.7

Table 2. Employment in the three sectors in Ethiopia from 2007 to 2019

Year	Primary Sector	Secondary Sector	Tertiary Sector
2007	64,364,545	5,272,317	11,362,737
2008	65,893,248	5,241,480	12,050,163
2009	67,226,862	5,371,828	12,816,709
2010	67,666,118	5,497,203	14,532,332
2011	67,998,808	6,393,320	15,654,629
2012	69,284,141	6,723,456	16,436,576
2013	68,959,653	7,013,152	18,914,919
2014	69,497,482	7,744,553	20,124,739
2015	69,798,267	8,621,041	21,453,726
2016	70,642,845	9,193,759	22,566,592
2017	72,245,550	9,703,673	24,461,343
2018	73,497,105	10,070,491	25,645,891
2019	74,678,056	10,445,737	26,954,934

4.2 Source of Data

The data of employees who participated in the three sectors, namely, the primary sector, the secondary sector, and the tertiary sector, of Ethiopia from 2007 to 2019 was extracted, processed, and calculated from the World Bank Database (see Table 2).

5 Results and Statistical Tests

5.1 Results

The results calculated via MATLAB are as follows (see Table 2, Table 3, and Table 4).

Table 3. Employment in the primary sector in Ethiopia from 2020 to 2029

Year	Statistics	α	β	C	P
2020	74475187	−0.0100	64991656.764719	0.0424	1
2021	75231197				
2022	75994883				
2023	76766320				
2024	77545589				
2025	78332768				
2026	79127937				
2027	79931179				
2028	80742574				
2029	81562207				

Table 4. Employment in the secondary sector in Ethiopia from 2020 to 2029

Year	Statistics	α	β	C	P
2020	11622356	−0.0681	4601359.55755547	0.0154	1
2021	12441411				
2022	13318186				
2023	14256750				
2024	15261457				
2025	16336968				
2026	17488272				
2027	18720712				
2028	20040004				
2029	21452270				

5.2 Statistical Tests

The goodness of fit is judged to determine whether the obtained data can be extrapolated. According to the C and P values presented in Table 3, Table 4, and Table 5, all three sets of values fit the Level I accuracy. Additionally, as the absolute error, relative error, and forecast accuracy was tested, the average forecast accuracy of the primary sector is 99.33%, and 97.93% and 96.38% of the secondary and tertiary sector respectively. Thus, it can be concluded that the GM (1,1) forecast model is valid, and the estimated statistics can be applied to the medium-term forecast.

Table 5. Employment in the tertiary sector in Ethiopia from 2020 to 2029

Year	Statistics	α	β	C	P
2020	29901674	−0.0718	11369082.1533597	0.0104	1
2021	32127567				
2022	34519158				
2023	37088779				
2024	39849683				
2025	42816111				
2026	46003361				
2027	49427871				
2028	53107304				
2029	57060634				

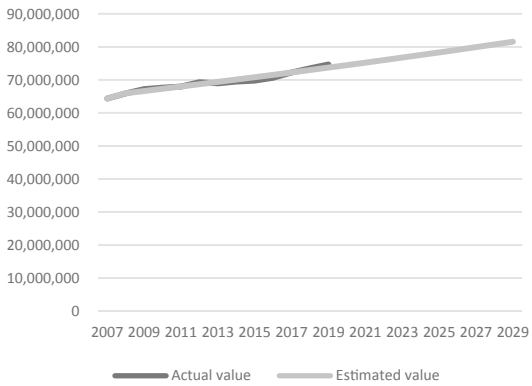

Fig. 1. Employment in the primary sector in Ethiopia from 2007 to 2029

6 Analysis and Discussion

As the diagrams of curves presented in Fig. 1, Fig. 2, and Fig. 3 shows, till 2029, there are up-going tendencies of human resources needed in the primary sector, secondary sector, and tertiary sector, which are consistent with the increasing trend of human resources in previous years. What is more, the changing trends of the secondary and the tertiary sector are more evident than that of the primary sector.

While taking a deep exploration of the percentage increase in the secondary sector and the tertiary sector, as the area chart indicated below (see Fig. 4), it has seen an increase of 306.89% and 402.17% for the secondary sector and the tertiary sector compared to the number in 2007 respectively. It can be summarized that though there will be a large demanding group of human resources specialized in the secondary sector, the future

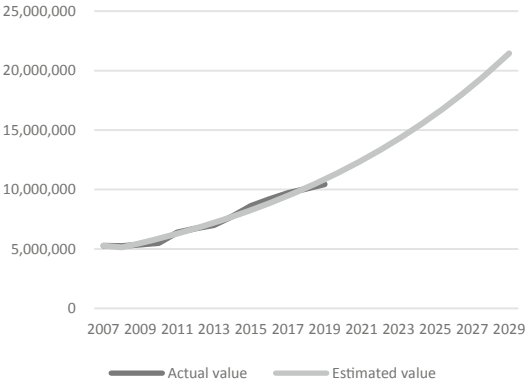

Fig. 2. Employment in the secondary sector in Ethiopia from 2007 to 2029

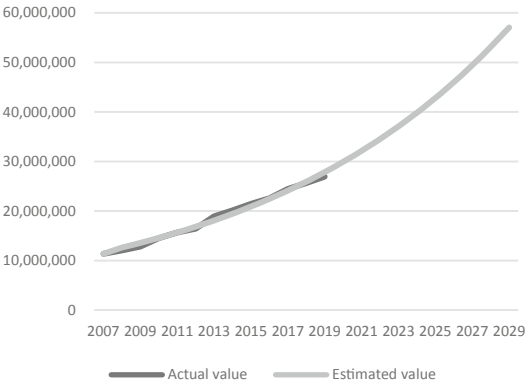

Fig. 3. Employment in the tertiary sector in Ethiopia from 2007 to 2029

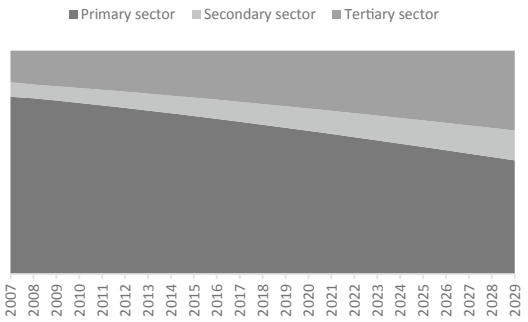

Fig. 4. The changing trend of the three sectors in Ethiopia from 2007 to 2029

demanding human resources mainly concentrated on the tertiary sector rather than the secondary sector.

Hence, one can see that in the future medium-term period, with the transformation of the national economic structure in Ethiopia, the human resources required by various sectors will be tied with corresponding trends. As for the primary sector, there will be only a 26.72% growth demand in the future, that is to say, accompanied by the process of national industrialization in Ethiopia, the human resources of the economic structure dominated by agricultural industries in the past have tended to be saturated. Based on agricultural modernization, the demand for human resources will gradually decrease, and there will be only a small amount of growing demand in the medium term of the future. The secondary sector and the tertiary sector are the ones with more growing demand. With the implementation of a large number of infrastructure construction and industrialization transformation projects, numerous secondary sector practitioners are urgently needed. The socio-economic requirement for industrial practitioners, especially technical practitioners, will increase greatly in the future. What is worth noticing is that the tertiary sector will experience a rapid growing demand even much more than the secondary sector, which is a more complex discourse for it involves diverse social participation.

7 Conclusion

The Ethiopian government has been seeking national solutions to poverty reduction and inclusive growth. Taking labor-intensive industries as the pilot industry, Ethiopia is striving to realize the transformation of economic structure, effectively promote industrialization, and become the "manufacturing center" of Africa. By establishing industrial parks and encouraging Foreign Direct Investment, it has stepped on the journey of functioning its "demographic dividend". It seems like the focus has been largely put on the secondary sector. However, according to the research results, a larger demand for human resources involved in the tertiary sector will arise, which should be attached immense attention to for the relevant policymakers and stakeholders to develop relevant policy guidelines, education systems, training mechanisms, social service and so on.

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