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Abstract: ***Purpose*** The rural redundant labor force plays an important role in rural revitalization. And the rural redundant workers become potential students in open education. To make open education serve the rural revitalization better, students matter. Regarding the characteristics of potential students, rural labor redundancy of different zones should be worked out for specific analysis. ***Methodology*** In this study, a relative algorithm was used to estimate the redundancy in the 20 years from 2000 to 2019. According to the fluctuation range and the trend of rural labor redundancy, all provinces in China were divided into five types: high (H), above-intermediate (Mh), intermediate (M), below-intermediate (Ml), low (L). ***Findings*** On the whole, the rural labor redundancy in china basically increased from 2000 to 2019. Different features were shown in different zones. The redundancy in H zone continued to rise, and was much higher than that in other zones. It increased obviously in Mh zone and slightly in M zone. The redundancy in Ml zone experienced many ups and downs. But it was higher than that in L zone, which was at the lowest level in China. On this basis, it is necessary to keep promoting "compensation for certificates" to help rural redundant workers obtain certificates, especially in H and Mh zones. In addition, more importance must be attached to "knowledge compensation", which is less time-consuming and more economic. Most importantly, credit bank should be used to connect "compensation for certificates" with "knowledge compensation". Therefore, integrated development of academic education and non-academic education can be achieved. It’s beneficial to help students to select appropriate courses in order

that they can achieve more in the future. ***Implications*** This research preliminarily outlined a framework of open education for rural redundant labor force, aiming to provide suggestions on how to allocate resources, promote the integrated development of academic and non-academic education and improve social benefits for open education.

Keywords: Rural revitalization; Redundant labor force; Open education; Demand of students

1 Introduction

At the Central Rural Work Conference in December 2020, President Xi Jinping stressed that we should comprehensively promote rural revitalization after the victory in poverty alleviation, which is a historic shift in the focus of the work of "agriculture, rural areas and farmers". The most fundamental factor in the process of rural revitalization lies in the rural human capital contained in human and human modernization. Education can lay the foundation for the accumulation and transformation of rural human capital (Yuan and Jiang, 2021). In February 2021, the general office of the Communist Party of China Central Committee and the general office of the State Council issued the opinions on accelerating the revitalization of rural talents, which proposed to cultivate workers that understand agriculture, love rural areas and farmers, so as to provide talents for promoting rural revitalization comprehensively, and accelerating agricultural modernization. In March 2021, the fourth session of the 13th National People's Congress voted and adopted the resolution on the 14th five year plan for national economic and social development and the outline of long-term goals for 2035, which called for building a digital China. With advanced information technology, high-quality educational resources should be applied to rural and remote areas. Meanwhile, situational learning, experiential learning and intelligent education management evaluation should be developed. In May 2021, the Ministry of Education, the National Development and Reform Commission, the Ministry of Finance and the National Rural Revitalization Administration jointly issued the opinions on connecting effectively rural revitalization with the achievements of poverty alleviation through education, which clearly required accelerating rural revitalization and contributing to the overall

construction of a modern country.

Open education not only gives basic support to lifelong learning for all people, but also becomes the pioneer of “Internet +” teaching mode. Meanwhile, it is vital to consolidate and extend the achievements of poverty alleviation, as well as help rural revitalization effectively. It is a "ballast stone" that undertakes the task of accelerating the development of education suitable for everyone in the process of building a well-off society in all respects (Jing, 2020). It has the following advantages. Firstly, taking cultivation of high-quality workers as the main task can greatly promote economic development, which is consistent with the essence of rural revitalization. Secondly, it is aimed at learners with low knowledge level and few skills, which is consistent with the object of rural revitalization. Thirdly, diversified teaching methods can guide learners to explore the path of getting rich according to their own characteristics, which is the key point of reform and development. Fourthly, it not only improves workers’ skills, but also makes them optimistic and self-reliant, which is consistent with the content of rural revitalization (Wang and Yan, 2018).

To develop open education and make it accurately serve the revitalization of rural areas, we should break the restraints of traditional thinking, reform adult teaching mode, provide high-quality practical educational resources, and strive to create a transmission chain of "knowledge helps students, students develop industry, and industry drives economic construction" (Yue and Gao, 2016). In the process, the demand of students has a great effect on specialty setting, curriculum development and teaching management. Thus, it is necessary to discuss the characteristics of students from different provinces. With the rapid development of Chinese economy, rural revitalization is now at a crucial stage. As a source of potential students in open education, the rural redundant labor force plays an important role in rural revitalization. Since China is a large country with extremely unbalanced economic development, the potential students should be zoned according to the redundancy of rural labor force so that it can be analyzed accurately. On this basis, it is critical to discuss how to build a learning system with more flexible methods, richer resources and more convenient operation. These can not only keep up with the trend of lifelong education, but also conform to the principle of building a lifelong learning system and a learning society.

2 Data source and estimate of rural labor redundancy

At this stage, no special method is used to measure the redundancy of rural labor force. Most of the existing studies measured the degree of excessive input of agricultural labor force by the number of agricultural surplus workers or agricultural production efficiency. There are also various calculation methods, mainly including labor productivity comparison calculation method, Cobb Douglas production function method, agricultural technology needs method, calculation method of per capita cultivated land area (Wang et al., 2018) and calculation of agricultural surplus labor force based on DEA (Data Envelopment Analysis) (Xiao and Zhang, 2012). Although various calculation methods for agricultural surplus labor force are theoretically reliable, due to their complex forms, it is difficult to obtain data (Xiao and Zhang, 2012), and most of the calculation results are absolute results. For example, using the calculation method of per capita cultivated land area, it was estimated that the number of Hebei agricultural surplus workers in 2016 was 4034.2 thousand (Wang et al., 2018). And using DEA model, it was estimated that the agricultural production efficiency of Ningxia in 2015 was 0.43 workers per ton of grain (Wang and Zhang, 2018). The absolute values obtained in these ways have valuable reference in policy-making and economic development in provinces. However, these also imply the impact of unbalanced economic development and inconsistent geographical environment, which is not conducive to horizontal comparative analysis across the country.

Therefore, this study used a relative algorithm to estimate the redundancy of rural labor force for the first time as below:

$$R_n = \frac{1 - I_n}{G_n}, \quad (n \neq 0)$$

R_n represents the rural labor redundancy of a province in a given year. I_n represents the urbanization rate of a province. And G_n represents the proportion of agricultural GDP of a province. n represents a year from 2000 to 2019.

The data of urbanization rate and the proportion of agricultural GDP are from the statistical yearbooks of the whole country and provinces, so as to keep the measurement standards and statistical methods consistent. The urbanization rate, which is the proportion of urban population in the total, is subtracted from 1, and the difference is the proportion of agricultural population in the total (Yue and Gao, 2016). This calculation can effectively eliminate the interference caused by uneven economic development and different geographical environment. The result is a relative value greater than 0, which can directly measure the redundancy of rural labor

force in a province. The closer the value is to 0, the lower the redundancy of rural labor force is, and vice versa.

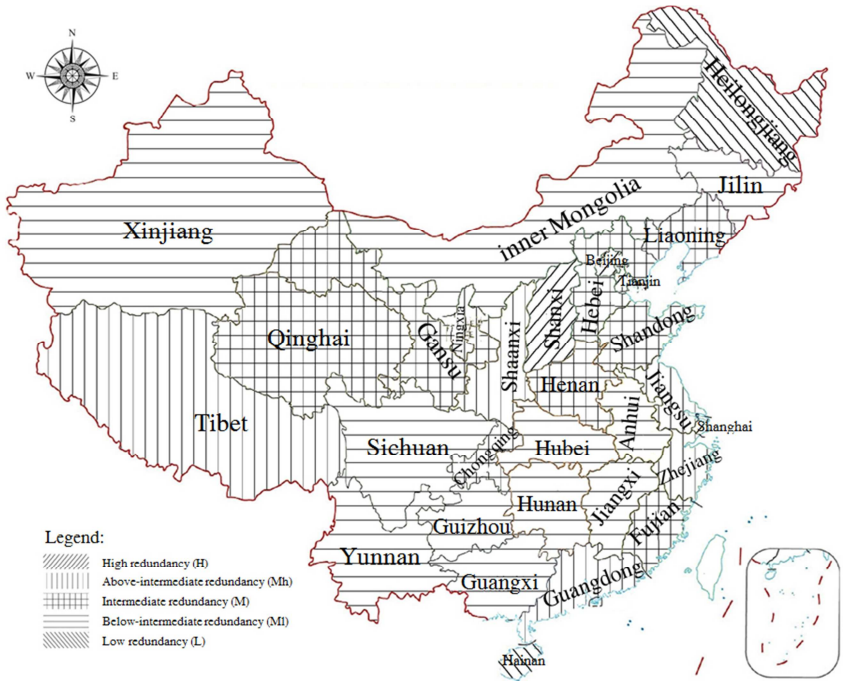

Figure 1. Provinces zoned according to the redundancy of rural labor force

3 Multidimensional clustering zoning

At present, there are few reports on the classification of provinces in the research of open education. According to the existing studies, regions were statically divided based on the speed of inter provincial urbanization, in which the threshold was defined subjectively, and the dynamic changes in provinces were shielded. This study calculated the multi-year redundancy of rural labor force, and vertically showed the dynamic change state in each province. Then, k-means (MacQueen, 1967) was used to calculate the Euclidean distance, which was implemented by Perl, without subjectively setting the threshold. The provinces were dynamically divided into five categories according to the temporal and spatial differences of rural labor redundancy: high, above-intermediate, intermediate, below-intermediate, low (Figure 1). On the whole, except for the obvious decline in Heilongjiang, the redundancy of rural labor force in China basically increased from 2000 to 2019 (Figure 2).

Among them, the redundancy of Beijing, Tianjin, Shanghai and Shanxi was high in

2000, and continued to rise (Figure 2A). The lowest was 6.42 in 2000 (Tianjin) and the highest was 44.67 in 2019 (Beijing). This was a highly redundant zone of rural labor force (H; Figure 1), in which the redundancy was much higher than that in other zones.

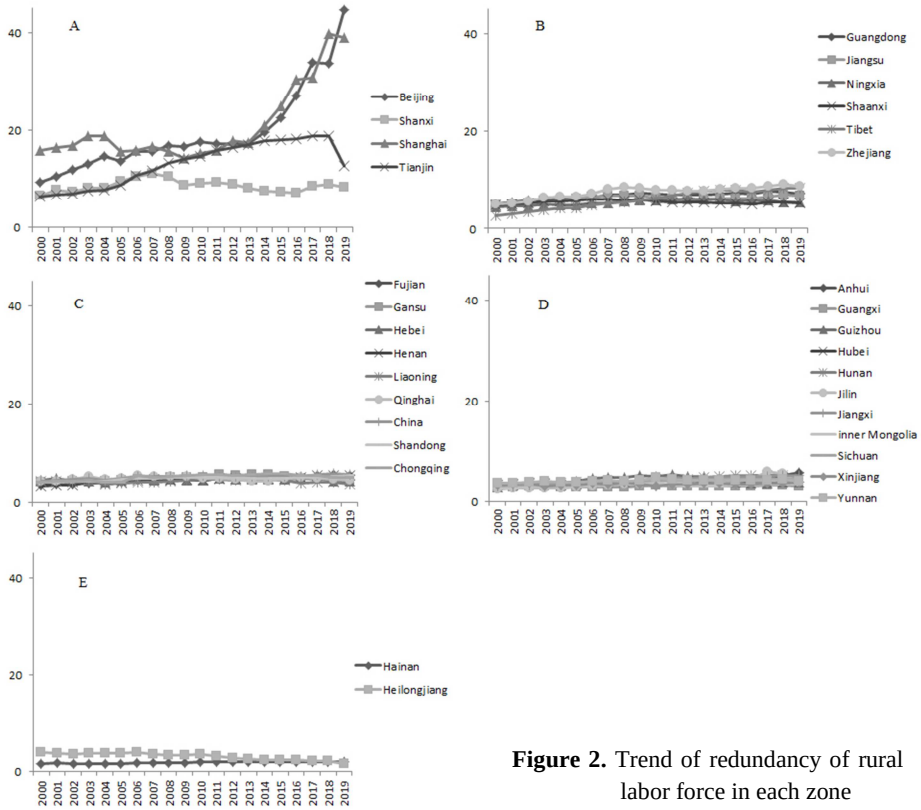

Figure 2. Trend of redundancy of rural labor force in each zone

The three coastal provinces (Jiangsu, Zhejiang and Guangdong), the two central provinces (Shaanxi and Ningxia) and Tibet composed the above-intermediate redundancy zone (Mh; Figure 1). The redundancy experienced an obvious improvement stage (2.68 ~ 5.04 in 2000, and 5.25 ~ 8.83 in 2019; Figure 2B).

The intermediate redundancy zone (M) included four provinces near Bohai Sea (Liaoning, Hebei, Shandong and Henan), two provinces in the Northwest (Gansu and Qinghai) and two provinces in the South (Fujian and Chongqing; Figure 1). Similar to the national situation, the redundancy remained in the range of 3.34 ~ 5.86, which increased slightly (Figure 2C).

The redundancy of four provinces in Central China (Anhui, Hubei, Hunan and

Jiangxi), four provinces in Southwest (Yunnan, Guizhou, Sichuan and Guangxi) and three provinces in North (Jilin, inner Mongolia and Xinjiang) was lower than that of the previous zone, which was called below-intermediate redundancy zone (Ml; Figure 1). There were many fluctuations in redundancy during this period (Figure 2D).

The redundancy of the northernmost and southernmost provinces (Heilongjiang and Hainan) did not exceed 2.01 in 2019 (Figure 2E). It was called low redundancy zone (L; Figure 1), in which the redundancy was at the lowest level.

4 Preliminary discussions on the differentiated needs of potential students

The industrial transfer of redundant labor force is not only the inevitable requirement of optimizing the allocation of social resources, but also a common social and economic phenomenon. Hundreds of millions of rural redundant workers are dying to learn multiple skills in the process of turning to non-agricultural production. These potential students of open education are scattered in different rural labor redundant zones. The development of open education should focus on the redundancy of rural labor force in various zones, so as to make the allocation of resources more reasonable, the effect more obvious and the achievements more prominent.

4.1 Continuing to promote "compensation for certificates" at the macro level

At the beginning of the establishment of the open universities, it enables students to obtain diplomas and compensate for the regret of missing school education, so as to increase their income and improve their status (Jing, 2020). When the rural redundant workers apply for employment in other industries, they can be in favorable positions with certificates to prove that they have enough knowledge and skills. In order to achieve this goal and not be eliminated, open universities should adapt to the non-agricultural education needs of rural redundant labor force and build itself as the best channel to obtain certificates.

In this study, the average value of rural labor force redundancy over 20 years was used as the macro demand rating index of non-agricultural majors in each zone, which was expressed by the letter *K*. The *K* was calculated as below:

$$K = \frac{R}{20m}, \quad (m \neq 0)$$

In a given zone, R represents a summation of R_n over 20 years, and m represents the number of provinces. The K decreases sharply from H zone to Mh zone. From Mh to L, it decreases gradiently (Figure 3).

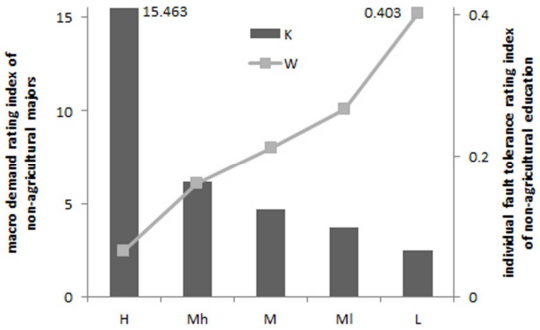

Figure 3. macro demand rating index of non-agricultural majors (K) and individual fault tolerance rating index of non-agricultural education (W)

For academic education in rural areas, we should make an inclined selection of non-agricultural majors according to local leading industries, geographical advantages, cultural characteristics and historical accumulation. However, with the most prominent rural labor redundancy, H zone can be used as a key zone for the construction of non-agricultural learning resources, in which the industrial transfer is the most urgent, and the demand for certificates in other industries is the strongest.

The investment in the construction of non-agricultural learning resources in the remaining 4 zones should be less than that in H zone according to the index. Mh zone is second only to H zone, and its K does not reach half of that in H zone. With the slow rise of redundancy, the investment can gradually increase over time. With the slight increase of redundancy, it is expected that the K of M zone and Ml zone will remain at the original level and the investment will remain unchanged for some time in the future. The K of L zone is the lowest, and the investment can be maintained at the lowest level or reduced appropriately with the continuous decline of redundancy.

4.2 Improving non-academic "knowledge compensation" at the individual level

China has entered the stage of popularization of higher education. In the new era, the task of open universities should change to compensating knowledge and developing skills (Jing, 2020). In order to reduce the cost, open universities should provide a variety of training courses for rural areas, which is less time-consuming and more

economic compared with obtaining certificates.

The reciprocal of *K* was regarded as the individual fault tolerance rating index of non-agricultural education, which was represented by the letter *W*. The *W* was calculated as below:

$$W = \frac{1}{K}, \ (K \neq 0)$$

The *W* increases sharply from H to Mh, and from Ml to L. From Mh to Ml, it rises gradiently (Figure 3).

We should follow the local policy guidance and economic development situation, cooperate with the use of online self-study, offline short-term face-to-face teaching and enterprise practice, so that students can quickly improve their knowledge and skills. With the lowest redundancy of agricultural labor force, the competitive pressure in L zone is low. There are many opportunities for trial and error in reemployment. As the *W* continues to rise with the decrease of redundancy, the relevant construction can be reduced.

The *W* of Ml zone or M zone exceeds half of that of L zone, and will remain at the original level for a foreseeable period of time. There are still many opportunities for trial and error, and the construction of non-academic education is slightly faster than that of L zone. The *W* of Mh zone is less than half of that of L zone, in which the construction of non-academic education can be gradually accelerated with the slow increase of redundancy. The index of H zone is the lowest, which is an important zone to expand MOOC resources, arrange short-term training and speed up the joint operation of schools and enterprises.

4.3 Using credit bank to connect up "two compensations"

Thanks to the high efficiency and flexibility of non-academic education, the rural redundant workers can apply what they have learned to an industry for a period of time, and strongly hope to get a diploma. At this time, workers will spend more to participate in academic education and re-learn the knowledge and skills that they have learned. Credit bank is a learning incentive system and educational management system to realize the storage, accumulation and transformation of all kinds of learning achievements at all levels, which measures credits according to unified standards. It imitates the "reservoir" function of the bank, and is an important infrastructure to break the closed structure of academic education in the era of lifelong learning and

ubiquitous learning (Li et al., 2020).

Based on this, in rural areas with high labor redundancy, especially H and Mh zones, we should vigorously promote the integrated development of academic education and non-academic education. The construction of academic courses should be scientific, systematic and orderly. At the same time, it should be concise and independent to meet the rapid needs of individual labor force for knowledge and skills. Non-academic education should be open, flexible and cumulative. Its teaching content, learning process and assessment rules are standardized, and easy to be known by people, which can effectively prove the authenticity of learning records.

In this way, the non-academic learning achievements of the open universities can be easily converted into academic credits and stored in the individual account of rural redundant worker. Finally, learners only need to learn some general courses, pay any remaining fees and pass the exams to get a diploma. These break the inherent restrictions of the school system and effectively connect non-academic education with academic education.

4.4 Trial implementation and popularization of new working mode of open education

Provinces with medium or higher rural labor force redundancy can be used as pilot areas for the new working mode of open education. After improvement, it can be popularized in the areas below the middle level. To explore a new working mode, we should consider comprehensively and must serve students well.

Firstly, in addition to tuition waiver, open universities can cooperate with financial institutions to allow students to pay by instalments with little interest. In this way, learners use “the compensated diploma or knowledge” to increase their income and improve their living standards, so as to contribute to the prosperity of the local economy. Secondly, open universities can try out multi-level teaching including vocational courses and undergraduate courses, appropriately reducing learning time and allowing students to graduate in the middle. Learners with lower original education can graduate after completing the courses at the corresponding level, and can also enjoy preferential treatment and continue to study at a higher level. Thirdly, educators should be active in the industrial transfer of redundant workers to help them understand the latest development trend of industry and the convenience of open education. At the same time, students are advised to take appropriate courses in

advance and adjust their learning states according to their own conditions, so as to accumulate academic credits and achieve more in the future.

5 Conclusion

A large number of redundant rural workers are potential implementers of rural revitalization. Open educational resources should match their characteristics and meet their needs. However, the demand for learning resources can’t be generalized, and rural labor redundancy of different zones should be worked out for specific analysis. This study made a superficial analysis by using the relative estimation method of redundancy and multi-dimensional clustering method, and tried to differentially discuss the demand for open educational resources, in order to provide suggestions for rational allocation of resources and promoting the integrated development of academic and non-academic education.

On this basis, improvement should be carried out in the following four aspects. The basic step is to keep promoting "compensation for certificates" to help rural redundant workers obtain certificates, which can prove that they have enough knowledge and skills, so that they can be in favorable positions when applying for jobs. In addition, more importance should be attached to "knowledge compensation". Instead of spending extra time and money obtaining a certificate, open education provides a variety of non-academic education for rural areas, which is less time-consuming and more economic. Most importantly, credit bank is applied to connect academic compensation with knowledge compensation. Therefore, integrated development of academic education and non-academic education can be achieved. What’s more, the credit bank can make great contribution to improving the talent cultivation. As for the experimental units with high redundancy, it’s better to reform their teaching modes, which means helping students to select appropriate courses in order that they can achieve success.

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