Health Poverty, Educational Capital and Industrial Integration of Rural Households: An Empirical Study Based on Micro-Data

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Keywords

Abstract

Industrial integration provides an important tool to promote the revitalization of rural industries and is an effective way to promote sustainable income growth for farmers and to build a well-off society. The main implementer of rural industrial integration are individual farmers. The fundamental state of life of the farm households determines the implement ability of industrial farming cooperation. The development of rural industries has played an irreplaceable role in the process of poverty eradication in China. Promoting the integration of the three rural industries can play an important role in consolidating the fight against poverty and bridging the stage of rural revitalization to continuously play a role in the development of rural industries and lay the foundation for the smooth implementation of rural revitalization. Whereas human capital was one of the important perspectives in studying the integration of three rural industries, the relationship between human capital in education and the integration of three rural industries was empirically analyzed based on data from the China Household Tracking Survey (CFPS). With the help of a Random Forest model algorithm, the importance of key elements affecting the integration of rural industries was measured and ranked. The results indicated that the higher the level of educated manpower, the better the level of integration of the three rural industries. Therefore, the accumulation of farmers' human capital should be enhanced during the bridging stage of poverty eradication and rural revitalization, so as to provide a continuous supply of quality labor for the integration of the three industries and rural revitalization.

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Contents

1 Introduction

Health and Manpower, which are essential issues affecting socio-economic development (Koišová et al., 2021). In particular, the health of the inhabitants of the farming community had a direct impact on the human capital of the countryside. With the new crown epidemic raging around the world, it deserves a closer study on how to deal with the economic downturn brought about by the health crisis. The economic downturn had become a reality (Mudita et al., 2022; Roman et al., 2021). The World Bank's Global Economic Prospects report for 2021 concluded that the economies of low-income countries continue to face challenges in an environment of uneven global economic recovery (Kronenberg & Fuchs, 2021).

China maintains a focus on lifting low-income rural groups out of poverty. After 10 years of development in consolidating the results of poverty eradication and rural revitalization, a mature set of experience in economic recovery was built up (Citrawathi et al., 2022; Guo & Liu, 2022) .After the overall victory in the fight against poverty, China had entered the stage of consolidating the results of the fight against poverty and revitalizing the countryside. How to solve the *Human capital issues* at this stage was related to the successful implementation of the rural revitalization strategy (Amarneh & Obeidat, 2022; Citrawathi et al., 2022; Xue et al., 2021). Looking back at the development of China's rural areas since the implementation of *precise poverty alleviation*, it was not difficult to find that the development of rural industries is the key to lifting poverty across the board (Mudita et al., 2022; Ovdiyenko et al., 2022; Sequera, 2022; Zhang et al., 2022). It was therefore crucial to sustain the income-generating effect of rural industries. At this stage, rural areas already have a good industrial base, and promoting industrial integration has become a new path for the sustainable development of rural industries and an important part of the implementation of the rural revitalization strategy. In promoting the integration of the three rural industries, the government, enterprises and social organizations all play their own important roles. However, it must not be overlooked that it plays an important role in the integration of the three industries and the revitalization of the countryside. After being fully lifted out of poverty, farmers' subjective status was guaranteed and their own identity changed, which in turn led to a significant increase in their subjective motivation, which is crucial for poverty return interdiction and rural revitalization (Loor et al., 2020; Manrique et al., 2020; Suryasa, Rodríguez-Gámez, Herrera, et al., 2022).

Some studies suggested that, given the same household resource endowment, the skill bias of migrant workers' identity significantly contributes to their return to entrepreneurship and employment, which can undoubtedly complement the human capital gap in rural development (Amarneh & Obeidat, 2022; Bindi et al., 2022; Mashudi et al., 2022). To sum up, it would be important to study the relationship between the degree of integration of the three industries as the dependent variable and the level of educational human capital as the independent variable, in order to further promote the integration of the three rural industries and the implementation of the rural revitalisation strategy.

Literature review

Industrial cohesion was an economic phenomenon that emerged as technology continued to innovate. Overseas research on industrial integration focused differently due to differences in national contexts. In terms of the current integration of the three rural industries in China, such problems as the low level of

integration and homogenization currently exist, which were normal when the integration of the three industries was in the development stage (Gerhart & Feng, 2021; Kusumajaya, 2021). At present, there were three types of rural industrial integration models in China: the intra-agricultural industrial restructuring and integration model, the inter-agricultural industrial cross-fusion model and the advanced technology to agriculture penetration-type integration model (Layuk et al., 2021; Polcyn, 2021; Suryasa et al., 2021). The intra-agricultural industry restructuring and integration model was developed to integrate the various sub-industries within the agricultural industry, such as planting, farming and aquaculture, with each other (Darmayanti et al., 2020; Liu et al., 2022; Ratini et al., 2020; Xie & Huang, 2021). By establishing organic links between upstream and downstream, it effectively integrated various resources and promoted the integrated development of various sub-industries within the agricultural industry to protect the environment, save resources and promote farmers' income (McInnis & Merajver, 2011). The agro-industrial cross-fertilization model was based on the unique natural, cultural and ecological resources of the countryside. This model could reveal the social, ecological, cultural and economic functions of agriculture, integrate agriculture with recreation and education, and develop leisure agriculture and rural tourism through facility-based and creative agriculture, mainly in the form of sightseeing, picking, dining and holiday (Čadil et al., 2014). The advanced technology to agriculture penetration type of integration model was using the Internet, big data, cloud computing and other new information technology, led by modern breeding industry (Kim & Ko, 2012). It was linked to technological innovation, expanding to the tertiary industry, solving the problem of precise matching of agricultural production and marketing, while achieving the sharing of the dividends of information technology development (Bourdin et al., 2021). Ultimately, by improving the level of information technology in industrial development, a mutually beneficial and win-win development pattern was formed for one and three industries.

The level of incomes affects the health capital of households. People of different genders, ages and regions will be affected to varying degrees (Ekaputri et al., 2020; Roman et al., 2021; Sribna et al., 2022). There was used data from the British Household Panel Survey (BHPS) 1991-1998 to analyzed the impact of changes in income on the health of male and female residents of the UK. The results showed that changes in income had a weak positive effect on the health levels of male residents in both studies using balanced and unbalanced panel data, while changes in income were not associated with the health levels of female residents when using unbalanced panel data (Arunrat et al., 2021; Kiani et al., 2021; Nina et al., 2022). The health-enhancing effect of increased income was only found in the male group and not in the female group. Some scholars were also comparing the health effects of income in urban areas and rural areas (Albert, 2022; Cedeño et al., n.d.; Nina et al., 2022). Fang Ya & Zhou Tripod (2021), found that the health effect of income was more pronounced among urban residents. Self-rated health/self-reported health was often used as a measure of health (Bean et al., n.d.; Jeyaramya, n.d.; Sharma et al., 2022; Suryasa, Rodríguez-Gámez, & Koldoris, 2022). The results found that levels of income, education and health status were associated with self-rated well-being; and that changes in income caused changes in self-rated health status, with decreases in income levels reducing people's self-rated health.

The human being makes up the bulk of technological innovation, and the quality of talent affects the depth and height of innovation. The level of human capital provides the main support and impetus for green technology innovation by changing the traditional knowledge base of the region and bringing new economic value (Kagamimori et al., 2009; S. M. br Sembiring, 2020; Tolmacheva et al., 2021). Most scholars studied human capital by narrowly equating it to the single-factor indicator of education and ignoring the importance of health, which may lead to large errors in the empirical results. Health capital, as an important form of human capital, was a prerequisite for the existence and effectiveness of human capital (Mossey & Shapiro, 1982; Pierce et al., 2020; Sikkema et al., 2000; Suwananta et al., 2020). In view of this, this paper would analyze the impact of human capital on industrial integration and innovation in two dimensions: education and health. Whether human capital investment to promote industrial innovation effectively was also influenced by external environmental policies, and healthy development was crucial. *The Porter hypothesis* suggested that appropriate environmental regulation would promote technological innovation and force firms to invest more in research and development to improve their pollution control capabilities, thereby promoting healthy social development (Jani & Subagio, 2021; Kelsey et al., 1996; Mataram, 2020; Velázquez et al., 2021). Health, as a form of human capital of equal importance to educational human capital, was a prerequisite for the existence and effectiveness of human capital. Positive health was a objective for

companies in their quest for harmony and overall development (Gueddari et al., n.d.; Haolai, n.d.; Nataliia et al., 2021; Varshney et al., n.d.). Investing in health care to maintain and improve the longevity, strength, power, energy, endurance and vitality of a company's workforce in order to improve their health could provide a good basis for employee training and further enhance the company's ability to innovate with green technology.

Studies revealed an intrinsic coupling mechanism between rural education and agricultural modernization development (Baeten et al., 2013; Bordiuk et al., 2022; Komilova et al., 2021; Tri et al., 2022). The ratio of the average years of education in the labor force and the number of rural scientific and technical personnel had a significant effect on the technical efficiency and labor productivity in agriculture (Burdette et al., 2011; Lesyk et al., 2022; Loccoh et al., 2021; Sribna et al., 2022; Wu & Kim, 2021). By raising the level of education of farmers and targeted farmer training helps to promote land transfer, the level of agricultural information technology and the invention and dissemination of agricultural technology, which could enhance household production performance. The contribution of rural educational human capital to agricultural economic growth was more evident than that of healthy human capital, the urbanization process and the level of industrialization, and was an important factor in promoting the upgrading of the industrial structure (Uhlmann & Frazzon, 2018).

From the above analysis, it was evident that health and education capital were the basis for the integration of rural industries, and that the ability of rural industries to innovate could effectively ameliorate the pressures of a downward economic spiral. Development was the first priority and manpower were the first resource (Hannan et al., 2022; Mudita et al., 2022; Sembiring et al., 2022; Stepanets et al., 2022). The move from low to high levels of educational human capital would contribute to the shift from an input-based to an innovative approach to economic growth. Therefore, studying the effects of the structural role of health and educational capital on the integration of the rural industries will be crucial in promoting the optimization and upgrading of the rural industrial structure and creating more economic benefits (Shim et al., 2022).

2 Materials and Methods

Research design

Health status was influenced by a number of factors in addition to those related to income, but also by a combination of other factors (Kiani et al., 2021). Age, gender, marital status, education, work status, and family environment were all considered to be associated with an individual's level of health (Albert, 2022).

This study used data collected from the China Household Tracking Survey (CFPS) for the empirical analysis. Based on the research necessity to select 2016 and 2018 data for analysis, the final sample size of 9394 households per year was obtained after processing the data.

In this study, the explanatory variable chosen was the level of integration of the three rural industries. Based on previous measurements and combined with the questionnaire, the index of integration of the three rural industries was constructed using the entropy method from several aspects such as the total output value of agriculture, forestry, animal husbandry and fishery, the increase in farmers' income from the extension of industrial chains, the leasing of land for large-scale production, the scale of agricultural operations and the degree of industrialization and the Engel coefficient (Kiani et al., 2021; Ridei et al., 2022; Shevchuk et al., 2022; Yusuf et al., 2022). The core explanatory variable in this study was educational human capital edu_j (the level of education was chosen as a proxy variable in this study). The control variables in this study included age, gender, marital status, and location, and the specific descriptive statistics of the variables are shown in Table 1.

Model design

The poverty line rate was adjusted to RMB 3,146 and RMB 3,535 for 2016 and 2018 respectively, based on the

2010 constant price (RMB 2,300) poverty line rate. Using net household income per capita as an inverse indicator, the maximum and minimum normative treatment was used to inscribe the income poverty indicator. In the construction of the Multidimensional Health-Poverty Index, the multidimensional poverty was measured by combining the availability of CFPS data with 5 indicators in 3 dimensions: health level, income level and living status.

Table 1
Dimensions, indicators and measures of healthy poverty (Multidimensional Health Indicator: MPI)

Diversity	Indicators	Explanation
Health Capital	Self-rated health	Self-rated health as 'unhealthy', considered healthy and poor, assigned a value of 1
	Medical insurance	
Income	Household income	Annual per capita income below the poverty line standard of RMB 2,300 (2010) was considered income poverty and is assigned a value of 1
Life Capital	Sources of drinking water	Household drinking water from natural sources (pond water, well water, etc.), assigned a value of 1
	Subsistence fuels	Cooking fuel based on unclean energy sources such as firewood and grass, assigned a value of 1

Indicators of industrial integration of farm households

Based on the construction method of Xiao Jingwen and Feng Mengli (2020) about the index system of the degree of integration of rural industries, the indicators of integration of industries were constructed by combining CFPS data and measured by using the entropy value method, and the specific index system is shown in Table 2.

Table 2
System of indicators for measuring the degree of industrial integration

Level 1 indicators	Level 2 indicators	Level 3 indicators	Implications	Direction of effect
Industrial integration	Industry Chain	Total value of agricultural and related products	Total value of agriculture, forestry, animal husbandry and fishery	Positive
	Multi-functionality	Wage income with farm work and working outside the home	Value-added benefits to farmers from the extension of the industry chain (assigned a value of 1 if yes, 0 if no)	Positive
	Modern, scaled-up production	Land for rent	Facilitate large-scale land production and the development of special agriculture, etc., to achieve multi-functionality in agriculture (rental is assigned a value of 1, otherwise 0)	Positive
		Total value of agricultural machinery	Agricultural scale management and mechanisation are closely related; modern production is an important sign of the development of agricultural industrialisation and is conducive to the integration of rural industries.	Positive
Industry	Economic	Engel's coefficient	The Engel's coefficient was reduced to	Reverse

integration performance	benefits		facilitate the linking of benefits and the integration of industries, i.e. household expenditure on food as a proportion of total expenditure.

Forecasting analysis of the importance of key elements

The general linear model provides an estimate of the regression coefficients of the independent variables, but does not provide an evaluation of the significance of the independent variables. Random Forest models are applicable to both classification and regression tasks, and can have good predictive power for cumbersome data that violate the basic assumptions of classical statistical models, such as correlation between independent variables and non-compliance with GM conditions(Bhuiyan et al., 2022; Sutthikun et al., 2022). It uses the bagging algorithm to randomly sample the sample information to produce multiple training sets, and then uses a decision tree as the base classifier for each training set, with the majority vote of the multiple trees as the final prediction. It ranks variables in order of importance based on the best variables selected as classification nodes in the decision trees (Disha & Waheed, 2022; Pham & Tran, 2022). The principle is that each time a decision tree is built by re-sampling with bagging, there will be some samples that are not selected which are also known as out-of-bag(oob) data and these samples can then be used for cross-validation.

Relevance analysis of independent variables

Based on the literature review and the data selected for this paper, the following model was set up.

$$IndustryIntegration_{ij} = \alpha_0 + \alpha_1 edu_j + \alpha_2 health_j + \alpha_3 X_{ij} + u_i$$

The explanatory variable in the model, $IndustryIntegration_{ij}$ represented the index of integration of rural household i in year j. The core explanatory variable of the model was the level of educational human resources edu_j and X_{ij} was the control variable and u_i represented the random error term. Descriptive statistics are presented in Table 3.

Table 3
Descriptive statistics for key variables

Variables	Description	Observations	Average	Standard deviation	Minimum	Maximum
Industry Mix	Three rural household products Integration index	9394	0.117	0.154	0	0.866
MPI	Mixed Health Poverty Index	9394	0.118	0.155	0	0.866
edu	Education Human Capital Level	9394	1.964	1.667	-8	6
familysize	Size of family	9394	3.983	1.993	1	21
age	Age of household	9394	54.051	12.889	19	91
gender	Gender of household (1 for males and 0 for female)	9394	0.565	0.496	0	1
marriage	Marital status of household (Married 1. Other status is 0)	9394	0.857	0.350	0	1

| party | Political Profile (Party member is 1, otherwise 0) | 9394 | 0.081 | 0.273 | 0 | 1 |

3 Results and Discussions

Baseline regression and robustness tests

In the benchmark regression, this study firstly examined the impact of the level of educational human capital on the integration of the three industries. The results indicated that educational human capital was significantly and positively correlated with the integration of the three rural industries, i.e. the higher the level of educational human capital of rural households, the higher the level of integration of the three rural industries in that area. After adding the control variables in succession, the results remained significant, which further suggests that the higher the level of educational human capital of rural households, the higher the level of integration of the three rural industries in that area.

In order to test the robustness of the results, this study took the approach of varying the total amount of data for robustness testing. The regression was run again after randomly selecting 85% of the original data and the results are shown in columns (3) and (4) of Table 4. The coefficient of educational human capital was positive and significant at the 1% level, which is a tentative indication that educational human capital is significantly and positively related to the integration of the three rural industries, without controlling for other factors, In other words, the higher the level of educational human capital of rural households, the higher the level of integration of the three rural industries in that area. After controlling for information on the characteristics of the household head and household characteristics, the results showed that the coefficient on educational human capital was still significantly positive and the above findings still hold. This indicates that the results of the benchmark regression were robust.

Table 4
Baseline regression and robustness test results

Statistical data				
	(1)	(2)	(3)	(4)
edu	0.0109***	0.0092***	0.0114***	0.0095***
	(0.0015)	(0.0014)	(0.0016)	(0.0015)
age		-0.0012***		-0.0011***
		(0.0002)		(0.0001)
gender		-0.0038		-0.0040
		(0.0042)		(0.0044)
marriage		0.0024		0.0042
		(0.0059)		(0.0062)
party		0.0614***		0.0614***
		(0.0096)		(0.0102)
familysize		0.0011		0.0010***
		(0.0011)		(0.0009)
Constant terms	0.0954***	0.1526***	0.0930***	0.2299***
	(0.0034)	(0.0138)	(0.0035)	(0.0012)
N	6576	6576	5590	5590
R2	0.014	0.154	0.015	0.035

(Figures in brackets were robust standard errors, ***, ** and * indicate significant at the 1%, 5% and 10% levels respectively.)

Heterogeneity analysis

Taking into account the differences in educational human capital across geographies and groups, this paper examined the control variables in group regressions according to the actual situation. Heterogeneity regression results were obtained by analyzing three aspects of heterogeneity: region, gender of household head and age (Table 5).

The regression results showed that there is a significant positive correlation between educational human capital and the integration of the three rural industries in both the eastern, central and western regions. The regression results showed that human capital in education is significantly and positively related to the integration of the three rural industries in the East, Central and West. The coefficients of educational human capital for the eastern, central and western regions are 0. 0090, 0. 0069 and 0. 0077 in that order, and this side indicates that the impact of educational human resources on the level of integration of the three rural industries has been more pronounced in the eastern region. This matched the reality of China, where the east has a clear advantage in terms of educational infrastructure, economic development and educational resources, which is more powerful for the accumulation of educational human capital. On the other hand, the impact of educational human capital on the level of integration of the three rural industries was greater in the west than in the center, because the poor areas in the west had such a poor foundation before, and through precise poverty alleviation and poverty eradication, the educational human capital in the poor areas in the west was relatively more significantly improved than in the center, so it had a greater impact on the integration of the three rural industries.

The gender of the household head was also a key factor influencing the integration of educational human capital with the three rural industries. The coefficients for male and female heads of household were 0. 0069 and 0. 0153. The results show that the educational human capital of female heads of households had a greater impact on the integration of the three rural industries than that of male heads of households, a result that is reasonable. In rural areas, male heads of household would have had a certain resource advantage over women in terms of education and skills training. With precise poverty alleviation and poverty eradication, the government empowered rural residents, and women received a greater boost in educational human capital from the empowerment, so their impact on the integration of the three rural industries was relatively greater.

This paper examined the relationship between educational human capital and the integration of the three rural industries using above-median and below-median subsamples for the regressions, i.e., by age into two groups of less than 54 years and more than 54 years respectively. The coefficients of 0. 0079 and 0. 0141 for the age less than 54 and age greater than 54 groups indicated that the effect of increased educational human capital on the integration of the three rural industries was greater for the age greater than 54 group. Such an outcome may seem unreasonable, but it would actually be consistent with the effectiveness of our poverty management in rural areas. The over 54s suffered from a deficit in basic education compared to the under 54s, but skills training for this group in poverty governance significantly increased their educational human capital. Therefore, the level of educational human capital of this group had a more pronounced impact on the integration of the three rural industries.

Table 5
Heterogeneity regression results

Serial No.	statistical data	Industry Integration			
		edu	Constants	Control variables	Sample size
1	east	0.0090*** (0.0032)	0.2125*** (0.0266)	Yes	2186
2	mid	0.0069*** (0.0032)	0.2006*** (0.0300)	Yes	1970
3	west	0.0077*** (0.0016)	0.0961*** (0.0171)	Yes	2420

Wang, Y., Deng, J., Teo, B. S.-X., & Jaharadak, A. A. (2022). Health poverty, educational capital and industrial integration of rural households: An empirical study based on micro-data. International Journal of Health Sciences, 6(3), 1452–1467. https://doi.org/10.53730/ijhs.v6n3.13031

4	Male	0.0069***	0.0734***	Yes	3718
		（0.0017）	（0.0084）		
5	Female	0.0153***	0.0837***	Yes	2858
		（0.0028）	（0.0102）		
6	Age Less than 54 years	0.0079***	0.1158***	Yes	3236
		（0.0020）	（0.0135）		
7	Age over 54 years	0.0141***	0.0592***	Yes	3131
		（0.0019	（0.0074）		

Relevance analysis

Based on data from the China Household Tracking Survey (CFPS), this thesis empirically analyzed the relationship between educational human capital and the integration of the three rural industries, drawing the following main conclusions.

First, educational human capital significantly affects the integration of the three rural industries, and this effect was positive, which meant that an increase in the level of educational human capital would increase the level of integration of the three rural industries. This showed that the accumulation of educational human capital in the farmers' community plays an important role in deepening the integration of the three rural industries, which is the key to further consolidating the achievements of poverty eradication, broadening the industrial chain of rural industries and gradually moving towards rural revitalizations.

Secondly, there was a geographical variation in the impact of farmers' educational human capital on the integration of the three rural industries. Impact levels were highest in the East, followed by the West and lowest in the Central region.

Thirdly, through precise poverty alleviation and poverty eradication, women and older cohorts who were previously relatively poor in educational human capital have greatly improved their educational human capital through a series of empowerment measures such as skills training, and have significantly influenced the level of integration of the three rural industries.

Importance evaluation of independent variables based on random forests

Generally linear models only display the relevant relationship of importance between categories within factors, but the importance between factors cannot be measured. In order to measure the importance of factors influencing the health status of the farming households, this paper established a Random Forest model with the degree of integration of the household industry as the dependent variable and factors such as health status, education level, number of household members, gender and age as independent variables. Through the process of model tuning, each node was set to determine the number of variables used for splitting by randomly selecting features 500, at which point the random forest model stabilized. The results were shown in Figure 1.
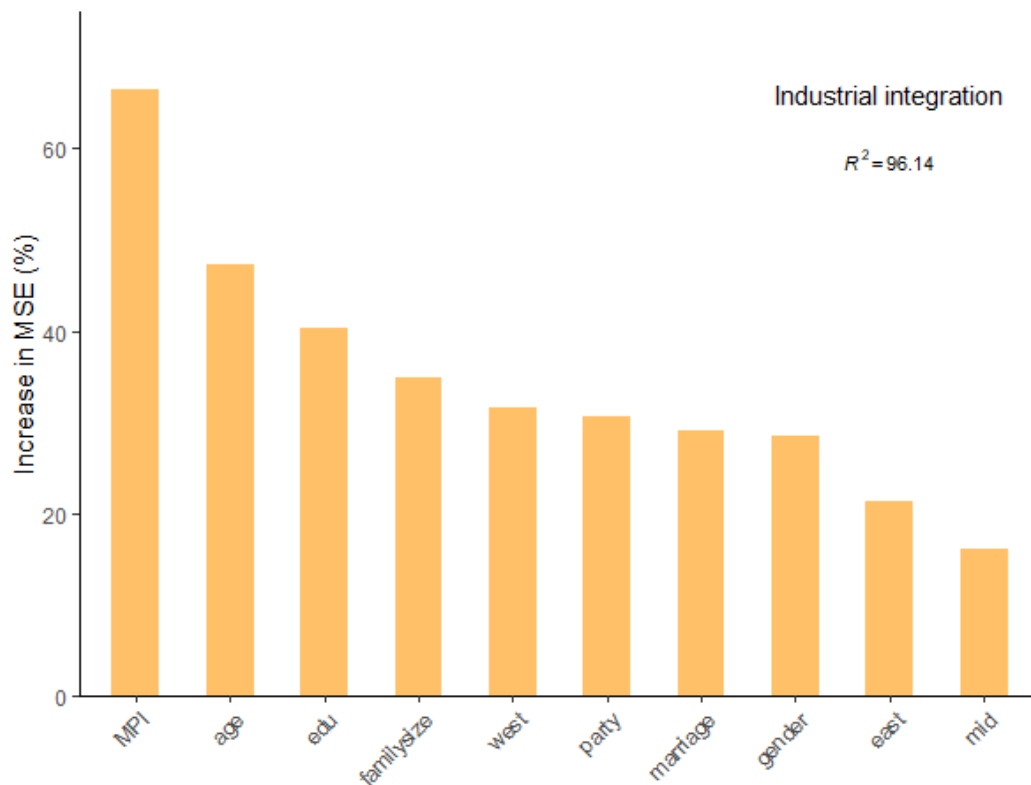
Figure 1 Ranking of the importance of the factors

4 Conclusion

These findings suggested that the level of educational human capital significantly and positively influenced the level of integration of the three rural industries. Based on this main conclusion this paper would like to make the following policy recommendations.

First of all, the government should provide an empowerment platform to continuously provide skills training to farmers to improve their educational human capital.

Second, attention should be paid to the education of children left behind in rural areas, and the standard of basic education should be raised so that educational resources are appropriately tilted towards rural areas and the role of education in interrupting the intergenerational transmission of poverty is brought into play.

Third, rural development industries should fit in with local strengths and form an ecosystem for the integration of three rural industries, in which farmers actively participate as participating subjects and work with the ecosystem to bring into play self-learning mechanisms for the continuous accumulation of educational human capital.

Fourth, the health aspect was the most important in relation to industry integration, followed by educational capital and the age profile of the population. This also affirmed scholars' assertion that healthy human capital drives social and economic dynamism. Educational capital was also extremely important compared to other factors, and the fundamental issue of healthy multidimensional poverty had to be addressed in order to drive industrial dynamism for economic development. This could be achieved by building an inclusive public health service, through cross-sectoral collaboration between NGOs, the private sector and policy makers, and through multidimensional changes in people's lifestyles.

Finally, it should insist on solidly promoting the human capital enhancement project in poor areas, cultivating the endogenous anti-poverty capacity in poor areas, and achieving an effective linkage with rural revitalizations.

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