Influence of Labor Transfer on Farmers' Biomass Energy Consumption —Based on national and regional perspectives

WANG Ping[1,2,a], LIU Jiao[1,b,*]

(1.School of Management, Xi'an University of Science and Technology, Xi'an, Shaanxi 710054;2.Xi'an University of Science and Technology Energy Economics and Management Research Center,Xi'an, 710054)

[a]wplqym@163.com

[b]853209225@qq.com

*LIU Jiao

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Abstract: Based on data of 29 provinces in China for 17 years, this paper investigates the impact of labor transfer on farmers' biomass energy consumption from the national and regional perspectives. The study found that the increase in the number of migrant workers significantly reduced the fuel wood and straw consumption per head in national and western farmers, but decreased the consumption of straw per capita in midland farmers.Moreover,the increase of the ratio of labor force transfer significantly reduced the consumption of fuel wood and straw per head, but decreased the consumption of fuel wood per head in the eastern part of China. Furthermore, the increase of labor migration significantly increased the consumption of methane per head in the western region.

1. Introduction

From 2011 to 2017, the total number of rural migrant workers in China was 252.78 million, 262.61 million,268.94 million, 273.95 million, 277.47 million, 281.71 million and 286.52 million. All accounted for more than 40% of the total number of people in rural areas. The absorbing capacity and the number of migrant workers are rapidly strengthened in the western region[1].The massive transfer of labor force promotes the rational allocation of social labor resources, which will offer great help to the economic development of China's urban and rural areas and find solutions to the problems of "agriculture, countryside and farmers".

Foley points out that when people choose household energy, they usually get materials locally or nearby[2];farmers are engaged in agricultural production for a long time, which leads to high availability and low or even zero cost of traditional biomass energy such as fuel wood and straw. Sources of energy have always been the focus of attention in household energy consumption[3];Weifeng and Yan Jianzhong point out that although the proportion of fuel wood consumption has fallen, it is still widely chosen by farmers as the object of household energy consumption[4].In addition, due to the widespread use of mechanized equipment in agricultural production, farmers directly return the straw from agricultural production to the field, which reduces the energy invested by farmers in agricultural production. Even if there is no mechanized equipment to return the straw to the field in some mountain farming. Farmers will not spend much effort to bring the straw home for their daily consumption. And the energy consumption in the economically underdeveloped areas is dominated by traditional biomass energy[5-6].Wang and others point out that an important reason for changing the use of fuel wood by farmers is means of livelihood[7].Therefore, how to reasonably raise the rate of utilization of rural energy is the issue we need to try to solve.

Based on the analysis, this paper proposes that whether labor transfer has a significant impact on per capita fuel wood, straw and biogas consumption per capita from a national perspective or not. And form the regional perspective, there any differences among the influence of labor transfer in the eastern, central and western areas on the consumption of fuel wood, straw and biogas per head?

2. Data and Methods

2.1 Data sources

The data of this paper comes from the panel data of 29 provinces of China from1997 to 2014(Shanghai and Tibet are not included, the consumption data of fuel wood, straw and biogas in the past years are severe missing).Using the second-hand data of the existing statistical yearbooks to calculate the quantity of labor force transfer in various provinces and cities of China by using the calculation method of Professor Lu Xueyi[8].In addition, this paper takes the biomass energy fuel wood, straw and biogas as the research object. The consumption data of fuel wood, straw and biogas in rural areas from 1997 to 2007 are all derived from the China Energy Statistics Yearbook. Data on consumption of fuel wood, straw and biogas in rural areas from 2008 to 2014 are all from the China Environmental Statistics Yearbook and China Household Survey Yearbook.

2.2 Research method

In this paper, the panel fixed effects model is chosen as the research method of per capita fuel wood and straw consumption of farmers, and the fixed effect Tobit model is selected to analyze the biogas. The use of biogas all accord with the conditions of fixed effect Tobit model. That is, a certain number of farmers' annual energy consumption is zero, in addition, the consumption is continuous and positive.

3. Results and Discussion

3.1 Results

3.1.1 Descriptive results

Table 1 shows that the number of labor migration in the national and regional perspective are all about 1.3.And the data in the western region (1.37) is higher than it in the national, central and eastern regions. The consumption of straw per capita is significantly higher than that of fuel wood (141.44) and biogas (8.57) per capita, and the consumption of fuel wood and biogas per capita in western region is higher than that in middle, eastern and national areas. The per capita straw consumption in the central region is significantly higher than that in the western and eastern regions and the whole country; the proportion of labor force transfer in the national and regional perspective reached 1/3; the per capita income and cultural level of the residents are higher than those in the western and eastern regions. The western region is higher than the whole country, the middle and the eastern region, and the household resident population and the per capita cultivated land area, the western region is lower than the whole country, the middle and the eastern region.

3.1.2 Regression results

Table 2 model 1 shows that the labor migration has a significant impact on the per capita consumption of fuel wood. And the number of labor migration has a significant negative correlation with the average consumption of straw. But a significant positive correlation with the per capita consumption of biogas. The increase on the proportion of labor migration significantly reduced the average straw consumption of farmers（-382.09**）;Models 2 to 5 are based on model 1 and gradually add the variables of per capita household income, household resident population, education level and per capita cultivated land area. And the consumption of fuel wood, straw and biogas per capita has different effects on the consumption of fuel wood, straw and biogas per capita.

Models 6 to 8 in tables 3 study the regression results of the effects of labor migration on farmers' biomass energy consumption in the eastern, central and western regions from a subregional perspective. Models 6'to 8 'are the effects of control variables on the biomass energy consumption of farmers. The increase of labor migration significantly inhibits the consumption of fuel wood and straw per capita of farmers in the central and western regions. And there is a significant positive correlation between the number of workers transferred and the consumption of biogas per capita in the western region(4.34^{+}).There is a significant negative correlation between the proportion of labor

migration and the average consumption of fuel wood in the eastern region.(-532.41**).

3.2 Discussion

Table 2 model 1 shows that there is a significant negative relationship between labor transfer and per capita fuel wood and straw consumption, but little impact on average biogas consumption. Model 2 shows that the per capita household income has a significant negative relationship with the per capita consumption of fuel wood, straw and biogas, which indicates that the non-agricultural transfer of rural surplus labor increased the per capita income of the transferee. At the same time, it does not affect the normal production of rural agriculture, but improve the income level of rural left-behind people, and then promote the significant improvement of the whole household income level, thus affecting household energy consumption choice and consumption. Model 3 shows that the increase of household resident population has significantly increased the per capita fuel consumption and straw consumption of farmers, which indicates that the increase of household resident population will promote the whole household biomass energy consumption increased[9].The elderly left behind are too busy with agricultural production and family daily life to get more fuel wood and straw. Improved economic conditions and improved living standards have led farmers to choose simple sources of energy such as electricity. Model 4 shows that there was a significant negative correlation between education level and per capita straw consumption, but a significant positive correlation for per capita biogas consumption. This shows that with the improvement of the level of people's education and the awareness of a green environment. People's awareness of environmental protection has gradually increased and they are more inclined to use clean energy. That is to say, the labor transfer has a significant negative correlation with the consumption of fuel wood and straw per capita from the perspective of the whole country.

Table 3 provides a significant negative correlation between labor transfer and per capita fuel wood and straw consumption in the western region, but a positive correlation between labor migration and average consumption of biogas among farmers. The influence of labor migration on the consumption of fuel wood, straw and biogas per capita in the western region is greater than that in the central and eastern regions. Because of the economically underdevelopment of the western region, farmers are more inclined to choose traditional biomass energy. The migration of rural surplus labor personnel leads to a decrease in the resident population of households, and the left-behind people do not have enough energy to obtain biomass energy. Compared with the eastern and central regions, the consumption of biomass energy in the western region will decline sharply. So the labor migration in the three regions has the most significant impact on the consumption of biomass energy of farmers in the western region. As a result, the amount of biomass energy available to farmers decreases, and the consumption of biomass energy of farmers decreases. The proportion of labor force transfer in the western region has the greater impact on farmers' biomass energy consumption compared to the central and eastern regions. It is due to the underdeveloped economic level and production mode in the western region.

4. Conclusion

This paper is a study on the impact of labor transfer on farmers' biomass energy consumption from the national and regional perspectives. The study found that labor migration and the number of labor migration have a significant impact on farmers' biomass energy consumption from a national perspective. And from the regional perspective ,labor migration in western regions has greater effect on the fuel wood, straw and biogas consumption per head compared with the central and eastern regions. Household income per capita,household resident population, degree of education cultivated land area per capita have a certain impact on farmers' biomass energy consumption. Nationally, there is a significant negative relationship between household income per capita and biomass energy consumption.

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Table 1 Descriptive statistical analysis of variables

variable	National scope（N=522）				East area (N=180)				Central Region(N=162)				Western Region（N=180）			
	Mean	Sd	Min	Max	Mean	Sd	Min	Max	Mean	Sd	Min	Max	Mean	Sd	Min	Max
Independent variable：																
Labor transfer number (person)	1.34	0.49	0.059	2.27	1.30	0.410	0.059	1.96	1.35	0.55	0.13	2.22	1.37	0.51	0.12	2.27
The proportion of labor transfer	0.32	0.11	0.101	0.54	0.32	0.086	0.11	0.49	0.33	0.12	0.11	0.53	0.33	0.11	0.11	0.54
Dependent variable：																
Farmers' average firewood per capita（Kgce）	141.44	118.41			115.41	129.95			124.02	62.92			183.15	132.89		
Farmers per capita straw（Kgce）	226.62	143.83			179.99	139.21			283.4	145.83			222.14	128.79		
Farmers per capita biogas（Kgce）	8.57	11.03			5.44	.512			6.41	7.01			13.65	13.39		
Control variables：																
Family characteristics																
Per capita income (yuan)	4625.39	3185.59	1185.07	20226	6374.54	3885.12	1820	20226	4212.71	2450.06	1734	10849.06	3247.67	1975.90	1185.07	9411
Family resident population (person)	3.78	0.65	2.7	4.5	3.71	0.63	2.7	4.5	3.79	0.65	2.7	4.5	3.83	0.65	2.8	4.5
Educational level (year)	2.80	0.16	2.54	3.07	2.95	0.070	2.85	3.07	2.82	0.082	2.7	2.95	2.62	0.06	2.54	2.71
Energy availability																
Per capita arable land area (mu/person)	2.29	0.49	1.4	3.1	1.79	0.31	1.4	2.2	2.24	0.17	2	2.5	2.85	0.13	2.6	3.1

Source:See footnote[1]

[1] According to Lu Xueyi's calculation method, the number of labor force transfer is calculated as: "Transfer of rural surplus labor force = (Number of urban employees - Number of urban workers) + (Number of rural employees - Number of agricultural employees). The number of employees in urban employment comes from the "Statistical Yearbook of each province". The "employee" minus "country employee", the number of urban workers comes from the "Statistical Yearbook of the Provinces," the "number of registered unemployed persons" divided by the "registered unemployment rate", the number of rural employees from the "Statistical Yearbook of the provinces" " "Practical workers in rural areas", the number of employees in the agricultural sector comes from "Statistics Yearbook of the provinces" and "primary industry practitioners"; the consumption data of coal, LPG, natural gas, electricity, and other energy sources comes from the "China Energy Statistical Yearbook" over the years, 1997-2007. The annual rural firewood consumption, rural straw consumption, and rural biogas consumption data come from the "China Energy Statistical Yearbook" in the past years, and the rural straw consumption in China in 2008-2014. Rural firewood consumption, rural straw consumption, rural areas Data on biogas consumption comes from the "Yearbook of China Household Survey" "China Environmental Statistics Yearbook", per capita household income, family resident population, education level, per capita arable land, and other data from the "China Household Survey Yearbook"

Table 2 Analysis of Regression of Farmer Household Biomass Energy Consumption by Labor Transfer from a National Perspective (N=522)

variable	Farmers' average firewood per capita					Farmers per capita straw					Farmers per capita biogas				
	model1	model2	model3	model4	model5	model1	model2	model3	model4	model5	model1	model2	model3	model4	model5
Independent variable：															
Labor transfer number (person)	-96.31**	-95.98**	-84.24**	-94.96**	-144.82**	-109.32***	-109.07***	-88.65***	-112.56***	-194.07***	2.29	2.27	2.93+	4.58**	11.77***
The proportion of labor transfer	-490.64***	-468.95***	-346.13*	-375.31**	-715.89***	-382.09**	-365.13**	-151.78	-216.84	-773.56***	66.03	65.26	11.63	6.35	41.06
Control variables：															
Family characteristics															
Per capita income (yuan)		-0.009*	-0.007*	-0.0017+	0.0001		-0.008*	-0.00039*	-0.0027	0.0038		-0.0003**	-0.0001	-0.0002*	0.0001
Family resident population (person)			13.93*	13.60*	-3.351			24.20*	37.21*	20.45			-6.04	-10.47	-10.09
Educational level (year)				-249.06	71.79				-55.47*	-30.98				39.23*	4.58
Energy availability															
Per capita arable land area (mu/person)					80.37***					131.37***					10.65***
Wald Chi2											555.98	556.48	784.56	814.44	854.69
P											0.00	0.00	0.00	0.00	0.00
Constant term	178.79***	177.37***	89.17+	32.95	24.83	211.492***	209.88***	126.7824+	829.91	-825.95	-8.44***	-8.33***	16.61**	127.36	25.28**
R^2	0.129	0.149	0.126	0.097	0.095	0.028	0.081	0.081	0.079	0.098					

Note: ***p<0.001; **p<0.01; *p<0.05; +p<0.1. Data Source: Refer to Table 1.

Table 3 Analysis of Regression Results of Farmers' Biomass Energy Consumption by Labor Transfer from a Regional Perspective

variable	Farmers' fuelwood						Farmers straw						Farmers biogas					
	East area（N=180）		Central Region（N=162）		Western Region（N=180）		East area（N=180）		Central Region（N=162）		Western Region（N=180）		East area（N=180）		Central Region（N=162）		Western Region（N=180）	
	Model 6	Model 6′	Model 7	Model 7′	Model 8	Model 8′	Model 6	Model6′	Model 7	Model 7′	Model 8	Model 8′	Model 6	Model6′	Model7	Model7′	Model 8	Model8′
Constant term	207.20***	114.69^{+}	154.53**	116.15^{+}	194.03***	110.82	265.03***	-1149.0	256.94***	214.34^{+}	214.34***	197.79*	-6.88*	-3.82	-4.17**	-4.86	-12.73***	-156.91
Independent variable:																		
Labor transfer number (person)	-60.98	-68.21	-26.826^{+}	-84.89**	-198.78***	-230.31***	-8.01	-23.16	-87.21***	-126.69**	-216.58***	-270.15***	4.17	2.58^{+}	-1.27	2.42^{+}	4.34^{+}	13.54**
The proportion of labor transfer	-532.41**	-476.59	-211.94**	-410.54***	-786.60***	-1130.7***	-344.58	146.98	-234.64**	-647.97**	-647.69***	-1099.6***	60.36	35.30	29.11	3.56	104.71	67.95
Control variables:																		
Family characteristics																		
Per capita income (yuan)		-0.0069*		-0.0018^{+}		-0.018*		0.0049*		0.0005		0.0059*		0.0001		0.0001		0.002
Family resident population (person)		67.44*		-14.70		46.22*		90.10*		40.50^{+}		151.91*		-1.26		-1.54		-2.79
Educational level (year)		349.56		-413.50		46.22		260.40		46.76		122.38		1.50		16.58		86.54^{+}
Energy availability																		
Per capita arable land area		42.21		82.06^{+}		46.22		46.19*		6.95^{+}		222.34***		-2.54		-1.67		5.44^{+}
R^2	0.139	0.349	0.094	0.176	0.361	0.279	0.078	0.148	0.186	0.249	0.175	0.246						
Wald Chi2													67.85	141.28	354.07	376.09	462.40	674.77
P													0.00	0.00	0.00	0.00	0.00	0.00

Note: ***p<0.001; **p<0.01; *p<0.05; +p<0.1. Data Source: Refer to Table 1