Evaluating Health Shocks on Agricultural Labor Supply of Mid-aged and Older Population in China

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Abstract

The current study used the Heckman two-stage model to analyze the influences of chronic and acute diseases on the agricultural labor participation and time input of middle aged and older rural populations. The data was based on the mid-aged and older rural people from national baseline survey in China Health and Retirement Longitudinal Study (CHARLS) from 2011 and 2013. Results indicated that chronic diseases did not have an influence on the participation of mid-aged and older people in agriculture, but labor time was decreased. Acute diseases decreased both labor time and probability of participation

Keywords: Health Shocks; mid-aged and older rural people; agricultural labor supply; agricultural labor time, Heckman two-stage model

1. Introduction

The characteristics of the agricultural labor supply in China's rural areas are undergoing changes. According to the World Bank, by 2050, more than 40% of the population in China will be over the age of 60. Furthermore, the large-scale transference of jobs within the young labor force from rural areas into non-agricultural industries in larger cities are accelerating, leaving farmland attended by mid-aged and older laborers. There has been a large decline within the rural labor force loss, which aggravates land abandonment and over-cultivation, and may result in a threatened national food security (Cheng et al. 2010). A survey reported that rural labor force within the new generation would prefer to work on secondary or tertiary industry in cities, which would continue to aggravate the rural labor supply (Cai, 2007). Thus, coping with the shortage of rural labor forces and protecting agricultural labor supply has gained attention.

Mu et al. (2012) reported that such shortages could only be resolved by increasing the labor supply of mid-aged and older rural people. However, people in these age groups are relatively more susceptible to diseases due to the deterioration of health in aging, whereas intensive agricultural requires laborers to be of healthy status. When compared to urban residents, mid-aged and older rural people have less social security. Even when these laborers are ill, they must engage in agricultural production in order to offset the loss caused by disease, such as inactivity of agricultural practice,

and the costs of medical. Without sufficient social security and health insurance, the mid-aged and older rural people still have to work like “ceaseless toil” (Benjamin et al, 2003) even when they are suffering health shocks. Thus, the exploration on the influence of health shocks on mid-aged and older rural agricultural labor supply is of great importance.

2. Brief Literature Review

Becker (1965) initially developed the household production theory, which links health and labor productivity. Grossman (1972, 1999) extended this framework by considering health a durable capital stock to analyze the demand for health. Pitt and Rosenzweig (1986) further developed a framework to evaluate the impact of a change in health on productivity, labor supply, and farmers’ income. Under this framework, Antle and Pingali (1994), Cole (2006), and Thomas et al. (2006) empirically reconfirmed that farmer health has a significant positive effect on their productivity. Relevant studies in China are limited, and most of the existing literature focus on the influence on labor participation within the labor force. Liu (2008) and Xie (2011) used the Probit model and the non-continuous time risk model to investigate the influence of health on participation of urban residents in the labor market. They found that improved health had a significant, positive impact on the labor participation rate of Chinese rural residents, and the influence on the older and female labor force was significantly higher than on the young or male labor force. Health deterioration had no significant influence on withdrawing from the urban labor force, but had significant influence on the withdrawal from the rural labor force, particularly in males. Meanwhile, Zhang (2011) found that the urban residents and the male labor force reduced labor participation due to poor health, and rural residents and female labor force labor participation was increased with an improvement in health. The health deterioration on labor participation had influences not only in different regions of China but also within gender and age. There were a few studies that reported on the influence of health on labor time. For example, Tian (2011) used the Tobit model and found that the unhealthy laborers experienced a reduction in labor, and comorbidity had weighty influence on labor. Using the Heckman two-stage model, Qin et al. (2012) found that poor health status significantly reduced the labor time of peasant laborers able to work.

Studies investigating the influence of rural residents’ health status in China on

agricultural labor supply have provided the groundwork for our study. However, The previous studies were limited by available data and mainly focus on the influence of health status on labor participation, and lacks insight of influence on labor time. Some studies only selected samples of participating labor to analyze the influence of observed health indexes and other control variables on labor time, resulting in selection bias. Since observed laborers are not randomly selected, there is biased coefficient estimation. Here, we used the survey data from the national baseline from China Health and Retirement Longitudinal Study (CHARLS) in 2013 and 2011, and used chronic and acute health shocks to indicate the health shocks. The Heckman two-stage model was used to process selection bias and analyzes the influence of health shocks on the labor supply within mid-aged and older rural people in agriculture. In the first stage, the aim was to investigate the influence of health shocks on agricultural participation decisions made by mid-aged and older rural people. In the second stage, selective samples were used to estimate factors influencing the labor time of mid-aged and older rural people. In order to avoid endogenous problems, we used self-evaluated health scores from the same interviewee in the most recent year (2011) to use as an instrumental variable.

3. Methodology

Agricultural labor supply of mid-aged and older rural people is a combination of the two-stage decision process. The first stage is the labor participation decision of mid-aged and older rural people on agricultural labor. Given the decision of participation, the second stage is to decide in how much time to input into agricultural labor supply. Mid-aged and older rural people may have strong self-selectivity on the agricultural labor supply decisions; some factors influencing their participation of agricultural labor (such as character and capacity) that can also affect their decisions on agricultural labor time were unaccounted for. By only using the samples of mid-aged and older rural people participating in agricultural labor to explore the influences of health shocks and other controlled variables within labor time results in bias in the estimated result. The two-stage model proposed by Heckman (1979) can verify and correct the possible selection bias.

The Probit model was first built to estimate the binary choice equation of mid-aged and older rural people participating in agricultural labor, and calculate Mills-Ratio $\hat{\lambda}$ for each sample. Based on the data of mid-aged and older rural people

participating in agricultural labor, the OLS method was then used to estimate the agricultural labor time equation, where Mills-Ratio was introduced as the correction term. If the estimation result of $\hat{\lambda}$ was significant, the selection bias does exist in samples. Thus, Heckman two-stage model should be used to rectify. If the estimation of $\hat{\lambda}$ was not significant, a simple OLS method can be conducted in the second step instead of Heckman estimation.

The Probit model equation for mid-aged and older rural people participating in agricultural labor was:

$$\boldsymbol{P}(\boldsymbol{y}=1 \mid \boldsymbol{H}, \boldsymbol{X})=\Phi(\alpha_0+\alpha_1 \boldsymbol{H}_1+\alpha_2 \boldsymbol{H}_2+\alpha_i \sum_{i=3}^{n} \boldsymbol{X}_i) \tag{1}$$

where y is a binary variable of mid-aged and older rural people participating in agricultural labor. H_1 and H_2 were two health stock variables selected in our study, representing acute health shocks and chronic health shocks. X_i is other control variable vector, that include personal characteristics, family life characteristics, family business characteristics, and external environment characteristics of mid-aged and older rural populations, where α_0~α_i are the estimated coefficients.

The equation for the calculation of Mills-Ratio $\hat{\lambda}$ is based on the estimation results of the Probit model were as follows:

$$\hat{\lambda}=\frac{\varphi(\alpha_0+\alpha_1 \boldsymbol{H}_1+\alpha_2 \boldsymbol{H}_2+\alpha_i \sum_{i=3}^{n} \boldsymbol{X}_i)}{\Phi(\alpha_0+\alpha_1 \boldsymbol{H}_1+\alpha_2 \boldsymbol{H}_2+\alpha_i \sum_{i=3}^{n} \boldsymbol{X}_i)} \tag{2}$$

where $\varphi(\cdot)$ is density function of standard normal distribution, and $\Phi(\cdot)$ corresponds to the cumulative distribution function.

$\hat{\lambda}$ is introduced to the equation of agricultural labor time to build mid-aged and older rural people labor time equation as follows:

$$\boldsymbol{LnT}_j=\beta_0+\beta_1 \boldsymbol{H}_1+\beta_2 \boldsymbol{H}_2+\beta_j \sum_{j=3}^{n} \boldsymbol{Z}_j+\omega \hat{\lambda}+\boldsymbol{IV}+\varepsilon_j \tag{3}$$

where T_j was agricultural labor time of the j^{th} sample; Z_j was the other control variable vector influencing agricultural labor time; β_0~β_j were coefficients that estimated health variables and other control variables; ω was the estimation coefficient of

Mills-Ratio $\hat{\lambda}$; ε_j was the random error term.

We analyzed the time of mid-aged and older rural people through a logarithmic process for a normal distribution. To resolve the endogenous problem, we selected the lagging self-evaluated health scores in 2011 as instrumental variables (IV). Note that, in Heckman two-stage model, Z_j is a strict subset of X_i. That is, there should be at least one variable influencing the possibility of mid-aged and older rural people participating in agricultural labor, but not have the partial effect on agricultural labor time. Here, the decisive variable combination was selected through comparison of imitative effect of model after eliminating different variables.

4. Data and variables

4.1 Data Source

The data used in this study was obtained from the survey data of national baseline from CHARLS in 2013 and 2011. CHARLS was organized and implemented by the China Center for Economic Research at Peking University, which aimed to collect micro-data of health status and aging conditions of Chinese residents. This survey utilized Proportional to Population Size Sampling methods to sample from counties (cities, districts) and residential communities. The individuals and their spouses' aged 45 years old and older were randomly chosen to be the primary interviewees. The survey contents included personal health, family members' health, employment, and income. In total, 23,000 interviewees were enrolled from 12,400 families in 150 counties (cities, districts), and 450 villages or resident communities. The primary data was selected from the baseline survey in 2013, and the samples with key variables missing were eliminated. In order to eliminate the endogenous problem caused by reverse causality, self-evaluated health scores of the interviewee with same ID in 2011 and 2013 were selected as the instrumental variable. There were 6325 samples used in the current model.

4.2 Variables selection

The agricultural labor supply decision and time of mid-aged and older rural people are primarily influenced by personal characteristics, family life characteristics, family business, and external environment characteristics. Thus, we selected variables of these aspects in our study.

4.2.1 Agricultural labor and agricultural labor time

In the CHARLS questionnaire, the agricultural labor participation question was *in the past year, have you worked on production and management of agriculture for at least 10 days?* For agricultural labor time, CHARLS questionnaire designed three questions:

In the past year, how many months did you spend on agricultural production?

In the past year, during the month of agricultural production, how many days did you spend every week?

During the days of agricultural production in the past year, how many hours did you spend daily?

The agricultural labor time in our study was calculated from the answers to the three questions as follows: hours working on agricultural production in 2012=months working on agricultural production ×4× days × hours.

4.2.2 Health shocks variables and health self-evaluation lagged variables

To compensate for the bias seen in subjective self-evaluated health condition as a health index, we primarily used health shocks variable to objectively indicate the health condition of mid-aged and older rural people. In this study, Coile's (2004) classification method was used to classify heart disease, cancer, and stroke into acute health shocks, and hypertension, elevated blood glucose (diabetes), hyperlipidemia, rheuma to idarthritis, and kidney disease were classified as chronic health shocks. 0.8% of the population reported both acute and chronic diseases. Due to interruption caused by sudden illness, these incidences were classified as acute health shocks. Suffering from acute or chronic illnesses could increase over time within the agricultural labor force. There could be compensation for the income decrease caused by the increasing labor time due, to disease. We used self-evaluated health score in 2011 as instrumental variables.

4.2.3 Individual characteristic variables

1) Gender

Gender difference often refers to differences found in physiology, psychology, and social labor division. In Chinese rural society, males generally participate in agricultural labor, and females generally participate in household management.

However, in the case of male laborer working in non-agricultural concurrent businesses, females may take the responsibility for farm work. Due to this, agricultural labor time of rural males may be shorter than females.

2) Age

For mid-aged and older rural individuals working within agriculture, age is an important factor influencing physical qualifications. In general, as individuals age, there is a decrease in physical ability, and may become unable to work. Thus, we expected that age would have a negative influence on the labor force supply. This likely decreases the possibility of participation in labor, as well as decrease the labor time.

3) Education level

Education level is an essential index in indicating human capital stock. Education levels within of mid-aged and older rural people are generally low. The higher the education level is, the higher the opportunity rises outside of agricultural work, increasing the probability that there will be a decrease in the labor force supply. In the CHARLS data, education levels included 11 levels of illiteracy, from semiliterate to doctor. Since the primary age group of the study was mid-aged and older rural people, those with high school or higher education were combined. This was done by recording the original data and dividing it into 5 levels: illiteracy, semiliterate (could listen and read), finished elementary school, graduated of junior high school, and graduated of high school or above.

4) Marital status

Marital status represents if household burdens are shared, as well as if the familial burden is shared.

5) Modes of pension

Modes of pension include endowment insurance and self-reliant pension. For most mid-aged and older rural individuals, their employment in agricultural labor is for both living expenses, and pension reserve. Although some laborers have not drawn the pension, the existence of the pension may decrease their agricultural labor supply. If mid-aged and older rural laborers are the sole providers, their wage is necessary. For these individuals, the opportunity for labor participation is higher, and they may work

more hours. These individuals may also have special concerns about quality of life, which may increase hours worked. The influencing direction of final pension mode on labor supply decision and time is not clear. In the current study, we considered both of these aspects and introduced them into the regression equation in the form of the interaction term.

4.2.4 Family life characteristics

1) Engel coefficient

In our study, the Engel coefficient obtained according to calculations from the answers to living expenses related questions in the CHARLS questionnaire. We predicted the influence of the variable on rural agricultural labor supply of mid-aged and older people would be positive. The higher the Engel coefficient is, the lower the standard of living will be, and the higher the possibility for them to increase their standard of living through agricultural labor.

2) Number of children under 15 year-old in family

The more children in the family, the heavier the burden of the head of house will be. As a result, mid-aged and older household members may need to input more laborer time to achieve financial security. On the opposite side, having more children in the family may also leaving the agricultural jobs unattended or causing a decrease in labor time. Therefore, influencing direction of this variable on agricultural labor supply of mid-aged and older rural people is not certain.

4.2.5 Family management characteristic

1) Per capita arable land area

The larger the per capita arable land area is, the heavier the farming burden on the laborers. This means that the family labor force may be constrained, making the possibility of mid-aged and older rural people participating in labor higher, and further extending the corresponding labor time input. It is expected that the per capita arable land area will have a positive influence on the labor supply of mid-aged and older rural people.

2) Non-farm income proportion

The proportion of non-farm income can reflect the degree of dependency found in the mid-aged and older rural people’s family within agricultural production. The higher

the non-farm income proportion is, the lower the dependency on the agricultural income will be. This may also result in a lower desire to work within agriculture, and the possibility of mid-aged and older individuals retiring from agricultural labor or decrease in working hours will be higher. We predict that the non-farm income proportion will have a negative influence on the labor supply of mid-aged and older rural individuals.

3) Per capita consumer spending

The family per capita consumer spending indicates the spending power of mid-aged and older rural individuals' families. The higher per capita consumer spending is, the higher probability of these individuals participating in agricultural labor will be, and the corresponding labor time may be longer.

4) Possessing agricultural machinery or not

There were four agricultural machines included in the CHARLS questionnaire, (including tractor, thresher, tractor operated machine (tractor seeder, rotary cultivator and water pumper), which was used to indicate the agricultural production investment in mid-aged and older rural families. We expected that having agricultural machinery could decrease the possibility of participating in labor and reduce labor time due to agricultural labor being replaced by agricultural machinery.

4.2.6 External environment

The area dummy variable served to identify different environments of samples. The agricultural labor time of mid-aged and older rural individuals had significant regional difference. In this study, the western area served as the control group, where the eastern and middle served to investigate the influences of the region on agricultural production characteristics, economic development, and technical levels.

Table 1 Variable and descriptive statistical analysis

Variables	Defination	Mean	Std. Dev.	Expected Direction
agrwork	whether to participate in the agricultural labor	0.60	0.49	
agr_total	agricultural working time	1176.36	1000.31	
health shock				
chronic	chronic health shock	0.48	0.50	-

acute	acute health shock	0.10	0.29	-
corporate characteristics				
gender	male=1; female=0	0.53	0.50	?
age	age	60.93	9.76	-
mars	marital status married=1;unmarried or divorced=0	0.86	0.35	+
penm	pension mode	0.43	0.49	?
characteristic variables of family life				
en_coef	Engel coefficient	0.45	0.25	+
num_ch	number of children under 15 years old	0.13	0.42	+
family business feature variables				
avgland	arable land per capita	2.21	4.81	+
nonagr_inc	non-farm income/total income (%)	0.83	0.34	-
avgconsume	family per capita consumer spending	26923.77	33996.13	+
machine	agricultural machinery Yes=1; No=0	0.35	0.48	-

5. Results and discussion

The first step of Heckman two-step uses a Probit equation to analyze the influence of health shocks on agricultural labor participation of mid-aged and older rural individuals, as shown in Table 2. The results indicated that Mills-Ratio was significant ta 1% statistical level, demonstrating the existence of selection bias within the samples. It also demonstrated that acute health shocks had stronger effect on individuals' decisions to enter the labor force. The p-value of DWH test was smaller than 0.05 (p=0.0216 and p=0.0218), chronic shocks can be considered as an endogenous explanatory variable.

Table 2 Influence of health shocks on labor supply decision of mid-aged and older rural people

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
chronic	-0.056	0.038	-1.46	0.145	-0.131	0.019
acute	-0.316	0.113	-2.79	0.005	-0.538	-0.093
gender	-0.210	0.039	-5.35	0.000	-0.288	-0.133

age	-0.026	0.003	-9.71	0.000	-0.031	-0.021
edu1	0.268	0.082	3.27	0.001	0.107	0.429
edu2	0.301	0.082	3.66	0.000	0.140	0.463
edu3	0.222	0.080	2.77	0.006	0.065	0.378
edu4	0.091	0.080	1.14	0.252	-0.065	0.247
mars	0.271	0.057	4.77	0.000	0.160	0.383
penm	0.185	0.043	4.29	0.000	0.100	0.270
en-coef	0.568	0.073	7.83	0.000	0.426	0.711
num_ch	-0.107	0.038	-2.83	0.005	-0.181	-0.033
avgland	0.001	0.004	0.22	0.827	-0.007	0.009
nonagr_inc	-0.381	0.055	-6.96	0.000	-0.488	-0.273
avgconsume	-7.17e-06	1.72e-06	-4.16	0.000	-0.000	-3.79e-06
machine	0.426	0.038	11.31	0.000	0.352	0.500
area_east	-0.056	0.046	-1.22	0.222	-0.145	0.034
area_mid	-0.023	0.043	-0.53	0.596	-0.108	0.062
_cons	1.830	0.211	8.69	0.000	1.417	2.242

The lagging self-evaluated health score was used as the instrumental variables, where the IV-Heckit model was used to analyze the influence of health shocks on labor supply time. According to the requirements of the 2nd stage variable set of the Heckman model, after removing two variables (number of children aged 15 years and whether having agricultural machinery) in the regression process, the imitative effect is good (Table 3).

Calculations show that the influence of chronic diseases on agricultural labor time is stronger than within acute diseases, possibly due to mid-aged and older individuals with chronic diseases not having enough capital to retire, or do not have medical security. The monetary loss due to these chronic illnesses may cause a loss of security and result in the individual staying in the agricultural labor force longer. Within genders, the labor time of the male is significantly less than female, which is contrary with the decision on agricultural labor supply. Similarly, the ability to particulate in agricultural labor decreases with age. However, if they decide to work, the labor time will be extended with age. This possibly indicates the lack of social security, and individuals must work to secure their financial freedom.

Table 3 Influence of health shocks on labor time of mid-aged and older rural people

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
chronic	323.008	118.807	2.72	0.007	90.151	555.865
acute	152.967	108.791	1.41	0.160	-60.259	366.193
gender	-1.330	35.734	-0.04	0.970	-71.366	68.707
age	5.841	3.092	1.89	0.056	-0.219	11.901
edu1	153.857	70.574	2.18	0.029	15.535	292.179
edu2	106.581	71.530	1.49	0.136	-33.615	246.778
edu3	97.272	68.325	1.42	0.155	-36.642	231.186
edu4	7.332	66.458	0.11	0.912	-122.924	137.588
mars	80.334	59.866	1.34	0.180	-37.001	197.669
penm	40.759	38.810	1.05	0.294	-35.307	116.824
en-coef	-123.371	73.913	-1.67	0.095	-268.238	21.497
avgland	15.995	3.153	5.07	0.000	9.815	22.174
nonagr_inc	-202.467	48.571	-4.17	0.000	-297.665	-107.270
avgconsume	0.003	0.002	1.58	0.000	9.815	22.174
area_east	-243.259	41.710	-5.83	0.000	-325.008	-161.509
area_mid	-320.143	35.152	-9.11	0.000	-389.041	-251.246
acute_1year	-0.228	0.098	-2.33	0.020	-0.419	-0.036
lambda	-566.326	160.674	-3.52	0.000	-881.240	-251.411
_cons	1024.220	186.338	5.50	0.000	659.005	1389.435

6. Conclusion

The main force of agricultural production has become “stay-at-home”[i] mid-aged and older individuals, due to the accelerated loss of the rural young labor force. Health levels are not only related to personal welfare, but also influences the agricultural production and even national food security. This study found that under economic pressure, some chronic health shocks such as rheumatic arthritis, hypertension, hyperglycemia, or hyperlipidemia would result in mid-aged and older rural individuals to stop labor within agriculture. Despite these health conditions, they continue to work but for a decreased time. Acute health conditions such as heart disease or cancer has a more intense effect for the individuals. They decrease in both

labor time and labor participation. Additionally, As the individuals age, they are physically unable to keep up with the demand that agricultural labor requires. Adding either a chronic or acute health condition significantly decreases the ability for these laborers to work in agriculture. Within the female group, there were higher instances of either withdrawal from the labor force or a reduction in hours worked than their male counterparts.

Improving the health of Chinese mid-aged and older rural individuals is important in order to increase the amount of laborers within the agricultural labor market, as well as the ensure that the amount of required labor hours is met. Thus, improving the health level is crucial to ensure sustainable agricultural labor supply in China, which would also be beneficial to national food security under the overflow effect.. The government should increase the amount of health human capital in rural areas, particularly in the mid-aged and older rural population. Health education should be provided to this population to improve disease prevention, self-protection consciousness, avoid disease occurrence, and prevent delayed treatment.

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[i] " Stay at home" means except young migrant workers, these seniors who have to stay at home working on a farm as they do not have too much labor skills.