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Big Data Analysis: The Impact of Agricultural Non-point Source Pollution on Household Decision-making

Abstract: Based on intergenerational support theory, a simultaneous equation model is used in this article to analyze the impact of fertilizer loss on household medical and care decisions in rural China. Results of the big data empirical analysis indicate that one kg/ha increase in fertilizer loss alters the medical costs by CNY 35 (USD 5) per year and the opportunity cost of household caring time by CNY 5 (USD 0.7) per year. This is equivalent CNY 760 million (USD 109 million) at nation economic loss. Furthermore, fertilizer loss has a significant lag and cumulative impact on medical expenses.

Keywords: Fertilizer Loss, Medical Cost, Caring Time, Big Data.

I. INTRODUCTION

Pollution plays an important role in determining health capital. In addition to affecting residents' health, industrial pollution can cause economic loss as well, such as reducing housing prices [1,2]. The effects of air pollution on human health are negative. It increases the rates of morbidity and mortality and also increases the costs of medical care [3,4]. Agricultural non-point source pollution has been a growing concern in developing countries due to the extensive use of synthetic organic chemicals. Infants whose maternal and agricultural production cycles overlap have a higher risk of getting sick and dying due to fertilizer pollution in India [5]. In China, pesticide and fertilizer use adversely affect the health of the elderly [6,7] and it is one of the countries with the highest input of agricultural chemicals. Fertilizer overuse causes groundwater contamination and eutrophication of rivers and freshwater. Nitrogen and phosphorus concentrations in river water (mg/l) increase by 1.5% and 1.4% for every 10% increase in nitrogen and phosphorus fertilizer input [8]. Health economists are interested in the economic costs of environmental pollution. In addition to affecting the health of rural elderly people, fertilizer losses pose a serious social issue. Analyzing the economic loss caused by fertilizer requires an empirical method with big data.

China had the most serious aging problems because 70% of elderly lives in rural area and the health status, medical facility and diseases awareness of rural elderly are not as good as those in cities [9,10]. Due to fertilizer losses, rural elderly people's health capital is depreciating quickly, resulting in a decrease in their stock of health capital. Individuals compensate for health losses by purchasing health services when the stock of health capital decreases. During family elderly care, the health level of the elderly affects internal family decisions through intergenerational support, affecting expenditure decisions, time supply, etc. Aging leads to an increase in medical expenses primarily due to the decline in health capital of the elderly, as well as an increase in illness incidence and duration among the elderly [11]. As well as increasing medical expenses, aging also increases caring time, and the burden of care is a direct result of physiological aging and organ damage or weakness in the elderly [12]. Rural elderly people have a higher burden of care due to their living conditions, medical and health resources, and other public resources [13].

The elderly in rural China still rely on their children for economic and care support. Therefore, family decisions are influenced by elderly health levels. There are direct and indirect economic costs associated with health loss [14], where direct economic cost refers to medical expenses. Medical expenditures are used in this article to measure direct economic costs. Indirect economic costs refer to the opportunity costs of illness, and elderly health can affect family time allocation [15,16]. Indirect economic costs will be measured using family caring time in this article. Rural elderly people's household decision-making is examined through an empirical analysis that includes medical costs and family caring time.

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The rest of the paper is organized as follows. Section 2 provides data description and summary statistics. Section 3 presents empirical models and results. Section 4 analysis of cumulative and lagged effects of fertilizer loss and Section5 concludes.

II. DATA AND SUMMARY STATISTICS

A. Data Resource

The individual health, medical costs and family caring time data come from the Chinese Longitudinal Healthy Longevity Survey (CLHLS). The CLHLS was conducted in a randomly selected half of the total counties and cities in 22 provinces, covering 85% of the total population in China. Its eight waves (1998, 2000, 2002, 2005, 2008, 2011,2014 and 2018) surveyed the cohort of 65 years and older. In order to exclude possible health links to waterborne bacteria, we only use the data from 2000 to 2014 because the survey question asking about boiling water only began in 2000. China implemented the "fertilizer reduction" policy in 2015. In order to eliminate this policy effect, we did not use the data after 2015. The survey combines an in-home interview and a basic physical examination. Extensive information was collected on demographic characteristics, family and household characteristics, lifestyles, diet, psychological characteristics, health, disability, socioeconomic conditions, etc. Fertilizer input data come from the China Rural Statistical Yearbook (1999-2015) and other regional variables come from the China Statistical Yearbook (1999-2015). Chemical fertilizer loss index come from data collection of the first national survey of pollution sources (2011).

B. Summary Statistics

The article uses medical expenditure to determine the direct economic impact of health capital loss, and household caring time to determine the indirect medical costs. Through two questions in the CLHLS questionnaire, the above information is obtained: "How much have you actually spent on medical expenses in the past year?" and "How many hours did your family (including your children/grandchildren and their spouses) pay for your care last week? ". According to statistics, the average household medical expenditure is CNY897.05(USD128.15) and the average family caring time is 2.97 hours per week. Table 1 shows a descriptive statistical analysis of all variables.

Table 1: Variable Description and Summary Statistics

Variables	Description	Obs.	Mean	Std.Dev.
Health Variables				
Medica_cost	Medical cost per year(RMB)	22130	897.05	2202.76
Caring_hour	Caring hours per week	22130	2.97	12.40
Household Variables				
ADL	Activities of Darly Living score higher=better)	22130	17.33	1.80
Age	Age in years	22130	85.35	10.63
Gender	Male=1; Female=0	22130	0.45	0.50
Edu	Educational practice	22130	1.87	3.10
Famer	Agricultural producer (1=yes; 0=no)	22130	0.64	0.48
Co_residence	Nursing home=1; Alone or Spouse=2; Child=3; Others=4	22130	2.61	0.58
Chronic	Number of 15 chronic diseases	22130	0.87	1.08
Hospital	The times of hospitalization in two years	22130	0.26	0.74
Income_cost	If income support daily cost (yes=1; no=0)	22130	0.80	0.40
Pub_insu	Participation in public insurance (yes=1; no=0)	22130	0.17	0.38
Com_insu	Participation in commercial insurance (yes=1; no=0)	22130	0.13	0.34
Com_med	Available of community medical (yes=1; no=0)	22130	0.19	0.39
Dietary Pattern				
Water	Source of drinking water (1=surface water; 0=tap water)	22130	0.02	0.14
Boiled_water	If drink water boiled (yes=0; no=1)	22130	0.05	0.21
Meat	he frequency of meat consumption	22130	4.02	1.01
Fish	The frequency of fish consumption	22130	3.54	1.10
Egg	The frequency of egg consumption	22130	3.99	1.01
Vegetable	The frequency of vegetable	22130	2.21	0.91
Fruit	The frequency of fruit	22130	3.41	0.78
Health Behaviors				
Smoke	Currently smoke (Yes=1; No=0)	22130	0.19	0.40
Drink	Currently drink (Yes=1; No=0)	22130	0.20	0.40
Exercise	Currently exercise (Yes=1; No=0)	22130	0.30	0.46
Provincial Variables				
Hospnum	The number of hospital per province (million)	22130	0.02	0.02
LnGDP	Logarithm of Provincial Gross Domestic Product	22130	9.67	0.71
Indpolltion	Index of industrial pollution (lower=better)	22130	1.56	0.54
Floss	Fertilizer loss intensity (kg/ha/year)	22130	7.64	4.02
Finput	Fertilizer input intensity (kg/ha/year)	22130	359.37	88.18
Pinput	Pesticide input intensity (kg/ha/year)	22130	13.31	6.19

C. *Medical cost and Caring Time*

Based on the amount of fertilizer lost by a rural elderly sample, two groups were distinguished: areas with low fertilizer loss and areas with high fertilizer loss. According to the source of their drinking water, the elderly in rural areas were divided into two groups. A sample of elderly people was divided into four groups for fertilizer loss and drinking water: low loss and tap water, low loss and surface water, high loss and tap water, and high loss and surface water. According to intergroup comparisons, there are certain differences in household medical expenses and caring time among different groups of rural elderly people (see Table 2). Household medical costs and caring time are significantly lower in rural areas with low fertilizer loss than in areas with high fertilizer loss. Rural elderly people who drink tap water have lower medical costs and family caring time than rural elderly people who drink surface water, but the difference is not significant. It has been shown that rural elderly living in areas with low fertilizer losses and drinking tap water spend the lowest amounts on medical cost and caring time, at 1488 yuan and 19 hours, respectively. Family medical costs are significantly lower than those of groups 6, 7, and 8, and rural elderly living in areas with high fertilizer loss and drinking surface water have the largest difference in household medical costs. When considering family caring time, there are no significant differences between surface and tap water for rural elderly samples with low fertilizer loss. However, there is a significant difference in family caring time between areas with low and high fertilizer losses.

Table 2 Medical costs and caring time in different fertilizer loss and drinking water

Group	Medical cost	Caring time
All samples	2078.28	10.94
1.low fertilizer loss	1530.29	19.08
2.high fertilizer loss	3061.36	28.05
3.tap water	2308.71	23.89
4.surface water	3290.06	24.16
5.low loss and tap water	1488.19	19.08
6.low loss and surface water	3189.35	19.57
7.high loss and tap water	3057.32	28.01
8.high loss and surface water	3602.79	33.16
Difference between groups		
1-2	-1531.07***	-8.97***
3-4	-981.35	-0.27
5-6	-1701.16***	-0.50
5-7	-1569.13***	-8.94***
5-8	-2114.60**	-14.09**
6-7	132.03	-8.44
6-8	-413.44	-13.59
7-8	-545.47	-5.15

III. PREPARE YOUR PAPER BEFORE STYLING

A. *Empirical Medel and Variables*

The effect of fertilizer loss on household medical expenses and care time for rural elderly is estimated using a three-stage least squares estimation method based on the endogenous relationship between fertilizer loss, health level, and economic cost. Fertilizer loss accelerates health capital depreciation, resulting in poor health among rural elderly, which affects their ability to purchase medical services and allocate family time. When health issues are identified with a single equation, endogeneity is ignored, resulting in inconsistent estimates. By analyzing the endogeneity relationship comprehensively, this article develops a simultaneous equation model to calculate the impact of fertilizer loss on medical expenses and caregiver time among rural elderly. The model settings are as follows:

$$Medical\_cost/Caring\_hour = \alpha_0 + \alpha_1 Fertilizer\_loss + \alpha_2 ADL + \alpha_3 X_{cost} + \varepsilon_{cost} \quad (1)$$

$$ADL = \beta_0 + \beta_1 Fertilizer\_loss + \beta_2 X_{adl} + \varepsilon_{adl} \quad (2)$$

$$Fertilizer\_loss = \gamma_0 + \gamma_1 X_f + \varepsilon_f \quad (3)$$

Among them, equation (1) is the equation for medical costs and family caring time, $Medical\_cost$ represents the medical cost per year, $Caring\_hour$ represents the family caring hours per week, $Fertilizer\_loss$ and ADL represent the intensity of fertilizer loss and the health level of the elderly. X_{cost} are control variables, including personal and family characteristics of the respondents, ε_{cost} is random perturbation terms. Equation (2) describes the impact of fertilizer loss on the health of rural elderly people, while equation (3) describes the estimation equation for fertilizer loss Empirical models and results.

A simultaneous equation model established in this paper is over identified according to the Order Condition and Rank Condition identified by the Simultaneous Equation (SEM). As a result of the three-stage least squares

method (3SLS), the endogeneity of the model and the correlation between the random perturbation terms in each equation can be fully taken into account. To obtain consistent and effective estimation results, this paper uses the three-stage least squares method (3SLS) to estimate the parameters of the simultaneous equation.

Table 3: Effect of Fertilizer Loss on Medical Costs

	Medical Cost	ADL	Fertilizer Loss
Fertilizer_loss	35.052**	-0.413***	
	(17.852)	(0.080)	
ADL	-533.854***		
	(146.303)		
Gender	-53.852	0.090***	
	(113.442)	(0.034)	
Age	-24.712***	-0.040***	
	(8.092)	(0.001)	
Edu	7.877	-0.010*	
	(19.274)	(0.006)	
Famer	105.204	0.102***	
	(120.095)	(0.035)	
Co_residence	-460.142***	-0.238***	
	(101.440)	(0.027)	
Chronic	2,112.297***	-2.156***	
	(800.616)	(0.213)	
Hospital	713.873***	-0.228***	
	(76.025)	(0.020)	
Income_cost	228.672*	-0.106***	
	(121.259)	(0.035)	
Income	0.037***	-0.000	
	(0.002)	(0.000)	
Pub_insu	-14.081	0.106***	
	(131.286)	(0.039)	
Com_insu	347.095**	0.021	
	(169.717)	(0.049)	
Com_med	-430.737***	-0.103***	
	(125.776)	(0.037)	
Water	-373.920	0.060	
	(331.349)	(0.096)	
Bolied_water		0.109	
		(0.073)	
Fish		0.030*	
		(0.016)	
Meet		0.009	
		(0.016)	
Egg		-0.033**	
		(0.015)	
Vegetable		-0.027	
		(0.017)	
Fruit)		0.180***	
		(0.020)	
Smoke)		0.075*	
		(0.039)	
Drink)		0.137***	
		(0.039)	
Exercise)		0.502***	
		(0.033)	
Pinput		0.414*	0.420***
		(0.211)	(0.013)
Ind_pollution		0.471**	
		(0.208)	
Hospitalbed	-38.564	-0.075***	
	(49.461)	(0.022)	
LnPerGDP	-104.147	0.484	
	(164.856)	(0.349)	
Finput			0.014***
			(0.000)
Area			0.000***
			(0.000)
Constant	13,104.116***	17.292***	2.256***
	(3,769.421)	(3.118)	(0.054)
Time fixed effect	Yes	Yes	Yes
Regional fixed effects	Yes	Yes	Yes
Observations	13,334	13,334	13,334
R-squared	0.036	0.146	0.999

Note: 1. The parentheses represent robust standard errors; 2. * * *, * *, * * respectively represent significant levels at 1%, 5%, and 10%.

Table 4: Effect of Fertilizer Loss on Caring Hours

	Caring hours	ADL	Fertilizer Loss
Fertilizer_loss	0.002**	0.002	
	(0.001)	(0.019)	
ADL	-0.754***		
	(0.071)		
Gender	0.000	-0.006	
	(0.006)	(0.009)	
Age	0.001*	-0.003***	
	(0.000)	(0.000)	
Edu	-0.001	-0.001	
	(0.001)	(0.001)	
Famer	0.008	0.027***	
	(0.007)	(0.009)	
Co_residence	0.016***	-0.005	
	(0.005)	(0.007)	
Chronic	0.003	-0.122**	
	(0.043)	(0.056)	
Hospital	-0.008*	-0.029***	
	(0.005)	(0.006)	
Income_cost	0.006	-0.001	
	(0.007)	(0.009)	
Income	-0.000*	0.000	
	(0.000)	(0.000)	
Pub_insu	-0.007	-0.021*	
	(0.009)	(0.011)	
Com_insu	-0.006	0.010	
	(0.011)	(0.014)	
Com_med	-0.004	-0.042***	
	(0.008)	(0.011)	
Water	0.000	0.009	
	(0.018)	(0.023)	
Bolied_water		0.001	
		(0.017)	
Fish		0.012***	
		(0.004)	
Meet		-0.004	
		(0.004)	
Egg		-0.001	
		(0.004)	
Vegetable		-0.003	
		(0.004)	
Fruit		0.010*	
		(0.005)	
Smoke		0.009	
		(0.009)	
Drink		0.008	
		(0.009)	
Exercise		0.044***	
		(0.008)	
Pinput		4.537	596.276***
		(50.446)	(12.716)
Ind_pollution		-0.022	
		(0.041)	
Hospitalbed	-0.001	-0.012*	
	(0.003)	(0.006)	
LnPerGDP	-0.003	0.150*	
	(0.009)	(0.082)	
Finput			0.013***
			(0.000)
Area			-0.000
			(0.000)
Constant	13.472***	16.859***	2.835***
	(1.299)	(0.706)	(0.055)
Time fixed effect	Yes	Yes	Yes
Regional fixed effects	Yes	Yes	Yes
Observations	13,334	13,334	13,334
R-squared	0.036	0.146	0.999

Note: 1. The parentheses represent robust standard errors; 2. * * *, * *, * * respectively represent significant levels at 1%, 5%, and 10%.

B. Effect of Fertilizer Loss on Medical Cost

Table 3 analyzes household medical expenditures based on fertilizer loss. In column (1) of the medical costs equation, the key explanatory variable fertilizer loss intensity has a coefficient of 35.05 and is significantly significant at the 5% level, indicating that fertilizer loss has a significant positive influence on rural elderly households' medical costs. Medical costs for drinking surface water increased by about 35 yuan for every one kilogram per hectare increase in fertilizer loss intensity. The medical expenses for drinking surface water of rural elderly households increase by 2.8 yuan for every 1% increase in fertilizer loss intensity. The intensity of fertilizer loss increased by one standard deviation, and the medical expenses of rural elderly households increased by 0.06 standard deviations.

Table 5: The Lag and Cumulative Effects of Fertilizer Loss on Medical Costs

Different hysteresis periods	Lag effect	Different window periods	Cumulative effect	
	(1)		(2)	(3)
1 year before investigation	35.515**	investigation + 1 year before	32.822*	16.411*
	(17.975)		(17.969)	(8.984)
2 years before investigation	36.987**	investigation + 2 years before	34.826*	11.609*
	(17.728)		(17.899)	(5.966)
3 years before investigation	36.408**	investigation + 3 years before	35.113**	8.778**
	(17.649)		(17.841)	(4.460)
4 years before investigation	40.400**	investigation + 4 years before	36.353**	7.271**
	(17.411)		(17.764)	(3.553)
5 years before investigation	38.365**	investigation + 5 years before	36.982**	6.164**
	(17.429)		(17.722)	(2.954)
6 years before investigation	41.677**	investigation + 6 years before	37.709**	5.387**
	(17.323)		(17.677)	(2.525)
7 years before investigation	38.591**	investigation + 7 years before	37.719**	4.715**
	(16.781)		(17.574)	(2.197)
8 years before investigation	38.634**	investigation + 8 years before	37.691**	4.188**
	(17.452)		(17.572)	(1.952)
9 years before investigation	38.005**	investigation +9 years before	37.416**	3.742**
	(17.645)		(17.591)	(1.759)
10 years before investigation	36.011**	investigation+10 years before	36.502**	3.318**
	(17.816)		(17.623)	(1.602)
11 years before investigation	39.090**	investigation+11 years before	36.384**	3.032**
	(18.821)		(17.728)	(1.477)
12 years before investigation	47.638**	investigation+12 years before	36.914**	2.840**
	(19.434)		(17.865)	(1.374)
13 years before investigation	44.803**	investigation+13 years before	37.291**	2.664**
	(20.811)		(18.067)	(1.290)
14 years before investigation	46.662**	investigation+14 years before	37.838**	2.523**
	(21.223)		(18.264)	(1.218)
15 years before investigation	64.331***	investigation+15 years before	38.673**	2.417**
	(22.481)		(18.502)	(1.156)
Control variable	Yes	Control variable	Yes	Yes
Time fixed effect	Yes	Time fixed effect	Yes	Yes
Regional fixed effects	Yes	Regional fixed effects	Yes	Yes

Note: 1. The parentheses represent robust standard errors; 2. * * *, * *, * * respectively represent significant levels at 1%, 5%, and 10%.

C. Effect of Fertilizer Loss on Caring Time

Table 4 reports the empirical results of fertilizer loss on household caring time, which are consistent with medical costs. According to the estimated coefficient of fertilizer loss intensity, which is 0.002 and significant at 5% levels, for each kilogram per hectare increase in fertilizer loss intensity, household caring time for rural elderly drinking surface water increases by 0.002 hours per week, increasing by 0.1 hours per year. The average salary for on-duty employees in China in 2021 is RMB 100512, according to the China Labor Statistics Yearbook for 2021. RMB 50 hourly wage can be calculated with 250 working days and 8 workers per day. The loss of fertilizer increases by 1 kilogram per hectare, and the opportunity cost of family care time is 5 yuan per year. As fertilizer loss intensity increases by 1%, rural elderly care costs rise by RMB yuan. Fertilizer loss intensity increases by 1 standard deviation and 0.0007 standard deviation.sdsd

According to the estimation results of the simultaneous equation model, it can be seen that an increase of one kilogram per hectare in fertilizer loss intensity leads to an overall increase of RMB 40 per year in household medical costs, including an increase of RMB 35 per year in medical expenses and RMB 5 in household caring costs. According to the sixth national census, the rural elderly population (aged 65 and above) is about 190 million, which

means that the loss of one kilogram per hectare of fertilizer will cause direct economic losses of RMB 6.65 billion, accounting for 0.01% of the GDP and 0.13% of the agricultural GDP.

IV. Analyzing Scalability Within Different Window Periods: Lags and Cumulative Effects

A. Empirical Medel and Variables

As explanatory variables, the average fertilizer loss intensity and the first two years of the survey period were used to analyze the impact of fertilizer loss on elderly medical costs and care decisions. According to the previous text, fertilizer loss affects rural elderly people's health lag and cumulatively, and it may also affect medical and family caring time over the long term. There is an important lag and cumulative effect of fertilizer loss on elderly medical expenditures and family care decisions in this article. A comparison of the impact of fertilizer loss intensities on medical costs and family caring time for rural elderly at various periods was conducted using equations (1), (2), and (3). Additionally, the cumulative effects of fertilizer loss are estimated with a distributed lag model. The specific model is as follows:

$$Medical\_cost_{it}/Caring\_hour_{it} = \alpha_0 + \alpha_c \sum_{c=0}^{k} Fertilizer_{loss_{p,t-c}} + \alpha_2 ADL_{it} + \alpha_3 X_{it}^{cost} + \varepsilon_{it}^{cost} + \varepsilon_{it}^{adl} \quad (4)$$

$$ADL_{it} = \beta_0 + \beta_c \sum_{c=0}^{k} Fertilizer\_loss_{p,t-c} + \beta_2 X_{it}^{adl} + \varepsilon_{it}^{adl} \quad (5)$$

$$Fertilizer\_loss_{p,t-c} = \gamma_0 + \gamma_1 X_{it}^{f} + \varepsilon_{it}^{f} \quad (6)$$

Among them, equation (4) is the equation for medical costs and family caring time, $Medical\_cost_{it}$ represents the medical costs in the current period,$Caring\_hour_{it}$ represents the family caring hours in the current period, $Fertilizer_{loss_{p,t-c}}$ represents the fertilizer loss with a lagging of c years, with a maximum lag period of k ($1 \leq c \leq k$), ADL the health level of the elderly. The other variables are the same as before. a_c represents the cumulative effect of fertilizer loss on the health of rural elderly at different stages. $\sum_{c=0}^{k} Fertilizer_{loss_{p,t-c}}$ indicates the accumulation of fertilizer loss over a period of time. Due to the availability of data on fertilizer loss, this article selects 15 ($k = 15$) as the longest lag period to study the lag and cumulative effects of fertilizer loss on the health of rural elderly in different time windows from the first 15 years to the current year of the health survey.

Table 6: The Lag and Cumulative Effects of Fertilizer Loss on Family Caring Hours

Different hysteresis periods	Lag effect	Different window periods	Cumulative effect	
	(1)		(2)	(3)
1 year before investigation	0.002**	investigation + 1 year before	0.002**	0.0010**
	(0.001)		(0.001)	(0.0005)
2 years before investigation	0.002**	investigation + 2 years before	0.002**	0.0007**
	(0.001)		(0.001)	(0.0003)
3 years before investigation	0.002**	investigation + 3 years before	0.002**	0.0005**
	(0.001)		(0.001)	(0.0002)
4 years before investigation	0.002**	investigation + 4 years before	0.002**	0.0004**
	(0.001)		(0.001)	(0.0002)
5 years before investigation	0.002**	investigation + 5 years before	0.002**	0.0004**
	(0.001)		(0.001)	(0.0002)
6 years before investigation	0.002**	investigation + 6 years before	0.002**	0.0003**
	(0.001)		(0.001)	(0.0001)
7 years before investigation	0.002**	investigation + 7 years before	0.002**	0.0003**
	(0.001)		(0.001)	(0.0001)
8 years before investigation	0.003***	investigation + 8 years before	0.002**	0.0003**
	(0.001)		(0.001)	(0.0001)
9 years before investigation	0.003***	investigation +9 years before	0.002**	0.0002**
	(0.001)		(0.001)	(0.0001)
10 years before investigation	0.003***	investigation+10 years before	0.002**	0.0002**
	(0.001)		(0.001)	(0.0001)
11 years before investigation	0.003***	investigation+11 years before	0.002**	0.0002**
	(0.001)		(0.001)	(0.0001)
12 years before investigation	0.003***	investigation+12 years before	0.002**	0.0002**
	(0.001)		(0.001)	(0.0001)
13 years before investigation	0.003***	investigation+13 years before	0.003**	0.0002**
	(0.001)		(0.001)	(0.0001)
14 years before investigation	0.003**	investigation+14 years before	0.003**	0.0002**
	(0.001)		(0.001)	(0.0001)
15 years before investigation	0.004**	investigation+15 years before	0.003**	0.0002**
	(0.001)		(0.001)	(0.0001)
Control variable	Yes	Control variable	Yes	Yes
Time fixed effect	Yes	Time fixed effect	Yes	Yes
Regional fixed effects	Yes	Regional fixed effects	Yes	Yes

Note: 1. The parentheses represent robust standard errors; 2. * * *, * *, * respectively represent significant levels at 1%, 5%, and 10%.

B. Estimated Results

The lag and cumulative effects of fertilizer loss on medical costs and household care decisions are presented in tables 5 and 6. According to the model results, fertilizer loss has both a long-term and short-term impact on rural elderly households' medical costs and household caring decisions. A significant lag effect of fertilizer loss on medical costs and household caring time is evident from the significant negative estimation coefficients for different lag periods. The estimated results of the mean in columns (2) of Table 5 and (2) of Table 6, as well as the estimated results of the cumulative value in column (3), show that fertilizer loss has a significant cumulative effect on elderly medical costs and family caring time. Due to the dependent variable being the amount of time spent on family care per week, Table 6 estimates coefficients that are relatively close. Therefore, when paying attention to the impact of fertilizer loss on healthcare, we should not only pay attention to the short-term effects, but also pay attention to the long-term effects. Additionally, when reducing fertilizer loss, it is important to take into account not only the short-term effects, but also the long-term benefits of reducing fertilizer loss.

V. CONCLUSION

This article is based on the China Health Database and uses big data empirical analysis methods to estimate the impact of fertilizer loss on rural elderly health damage on family medical decision-making and time allocation. Based on the endogenous relationship between medical costs, fertilizer loss, and health levels, a simultaneous equation model is developed. The impact of fertilizer loss on medical expenses and family care time for rural elderly people is estimated using a three-stage least squares estimation method. In summary, fertilizer loss has a significant positive impact on medical expenses and care time for rural elderly households. By increasing fertilizer loss by one kilogram per hectare, household medical costs increase by 35 RMB per year and household care costs increase by 5. According to the sixth national census, the rural elderly population (65 and older) is estimated to be approximately 190 million, with a total economic loss of RMB 7.6 billion, which is 0.01% of domestic GDP and 0.13 percent of agricultural production. Furthermore, fertilizer loss has a significant lag effect on rural elderly people's medical costs and caregiving time.

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