The impact of the old-age digital divide on household financial vulnerability

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Abstract: With the aging of society and the development of the digitalization process, people are more and more concerned about the issue of household financial risk, focusing on the digital divide and financial vulnerability. Based on the Probit model, this paper explores the impact of the old-age digital divide on household financial vulnerability and urban-rural differences using the (CFPS) database panel data from 2014-2018, and puts forward corresponding policy recommendations. The study shows that the existence of the old-age digital divide and the deepening of the degree of old-age digital divide increase the probability of household financial vulnerability, in which the reduction of the degree of old-age digital divide has a significant impact on urban households. The Government should address this issue by strengthening digital training for the elderly, improving the level of financial services in rural areas and raising the income level of low-income groups in urban areas, so as to strengthen financial systemic risks and promote sustainable social development and stable economic growth.

Keywords: Population ageing, Digital divide, Household financial vulnerability

1. Introduction

In recent years, scholars have increasingly focused on the issue of household financial risk, recognizing its pivotal role in shaping economic stability and prosperity. The surge in household indebtedness, particularly notable in China, has heightened concerns regarding financial vulnerability among micro-households. The Financial Statistics Report 2022 released by the People's Bank of China revealed a staggering debt-to-income ratio of 124.4% by 2022, nearly doubling since 2013, with a significant portion facing overdue payments, indicative of deepening financial distress (Peoples Bank of China, 2022). This alarming trend underscores the imperative of addressing household financial vulnerability to safeguard economic resilience and stability. As scholars increasingly focus on household financial risk, demographic shifts and digital financial inclusion emerge as pivotal factors influencing vulnerability. Population aging exacerbates financial risk (Fan Mang et al., 2022) [1], with China transitioning into a notably aged society, posing socioeconomic challenges such as increased demand for elderly services and strained labor markets due to rising pension expenditures. Simultaneously, the digital divide widens, particularly among older demographics, hindering internet access, usage, and literacy. This divide intensifies household financial vulnerability, with rural areas disproportionately affected. Despite efforts to bridge this gap, disparities persist, affecting information verification and exacerbating financial risks among the elderly.

Among the myriad factors contributing to household financial vulnerability, demographic shifts and digital disparities have emerged as key determinants. Population aging, a phenomenon exacerbated in China, presents profound challenges to household financial stability (Cai Fang et al., 2020) [2]. As the elderly population grows, the demand for specialized services and resources intensifies, while labor markets contend with escalating pension expenditures, exacerbating financial strain. Concurrently, the digital divide, particularly pronounced among older demographics, amplifies financial vulnerability by restricting access to crucial information and financial services (Huang Chenxi, 2022) [3]. Rural areas, in particular, face significant barriers due to inadequate digital infrastructure, exacerbating disparities in financial resilience (He Zongyue et al., 2020) [4].

The concept of financial vulnerability, initially elucidated by Minsky, has evolved to encompass various dimensions of household financial distress (Minsky, Year; Helei, 2022) [5]. This broader understanding acknowledges the intricate interplay of debt repayment difficulties, consumer arrears, and economic shocks in shaping household vulnerability. Efforts to mitigate financial vulnerability have emphasized enhancing financial literacy and promoting digital financial inclusion (Meng Defeng et al., 2019; Siti Nurazira Mohd Daud et al., 2018) [6-7]. Strengthening financial literacy empowers households

to navigate complex financial landscapes, while digital financial inclusion extends access to vital financial services, particularly in underserved rural areas.

Empirical analyses underscore the significant impact of the digital divide on household financial vulnerability, highlighting the urgent need for targeted interventions to bridge this gap (Ronia Hawash et al., 2019) [8]. Research suggests that while urban areas may have better access to digital resources, rural communities, especially the elderly, face significant challenges due to limited infrastructure and digital literacy (He Zongyue et al., 2020) [4]. Therefore, tailored strategies are required to address these disparities effectively, ensuring that all households have equitable access to financial services and information. In conclusion, addressing household financial vulnerability is imperative for fostering economic resilience and inclusive growth. By comprehensively understanding the multifaceted drivers of vulnerability, policymakers can develop targeted interventions to mitigate risk and promote financial well-being. Through concerted efforts to bridge digital disparities, enhance financial literacy, and promote inclusive financial systems, stakeholders can work towards building a more resilient and equitable financial landscape for households across diverse socioeconomic contexts.

Therefore, the marginal contribution of this paper lies in the innovative selection of the perspective of aging digital divide to analyze household financial vulnerability and explore the extent of its impact, and further in-depth comparative study of the differential impact of aging digital divide on financial vulnerability in urban and rural households. Against the background of deepening population aging and unbalanced development between urban and rural areas in China, this paper provides a theoretical basis for the prevention and resolution of household financial risks and the maintenance of social and financial security.

2. Theoretical analysis and research hypotheses

In the context of the current era of intelligence, the elderly are in a marginalized position in the "digital society", and there are different degrees of differences in the involvement and use of digital technology between them and younger groups. The digital divide in the family and the elderly may be caused by the following two reasons: first, at the access level, the digital infrastructure is not sound, the regional distribution of resources is not balanced, the coverage rate of digital devices in economically developed regions is higher than that in less developed regions, and the "digital divide" in infrastructure construction is that the digital infrastructure construction in rural areas is obviously lagging behind that in urban areas; by narrowing the gap between urban and rural areas, the digital infrastructure construction in rural areas will be reduced. The "digital divide" in infrastructure construction is that the digital infrastructure construction in rural areas is obviously lagging behind that in urban areas, and the "digital divide" in the development of inclusive finance can be filled by narrowing the digital infrastructure gap between urban and rural areas (Xing Yan, 2021) [9] ; moreover, the current development of intelligent science and technology focuses on the universality of the benefits and ignores the specificity of the elderly group. Secondly, at the level of use, the elderly themselves have physical and psychological limitations, and there is a gap between their use of digital technology and that of the younger groups (Lu, J. et al., 2021) [10] ; therefore, the deepening of population aging and the increase in the proportion of the elderly population will inevitably deepen the extent of the digital divide among the elderly (Zhang, F. et al., 2021) [11] .

The occurrence of household financial vulnerability is affected by the combination of disposable income, unanticipated household expenditures, household liquid assets, and household liabilities. On the one hand, the soundness of digital infrastructure can improve household income, and it is found that digital infrastructure construction has a positive moderating effect on the role effect of digital inclusive finance for common wealth (Liu Xinyi et al., 2022) [12] , easing household liquidity constraints, and it is found that digital infrastructure construction can constrain rural household offspring by cracking the constraints of educational resources as well as high levels of social capital (Fang Fuqian et al. 2023) [13] , reduce the probability of household financial vulnerability, so households with poor digital infrastructure and a large digital divide have relatively lower incomes and a higher probability of financial vulnerability. On the other hand, population aging reduces households' current labor income. Population aging leads to the aging of the rural labor force population, it is difficult to meet the demand for rural labor in the restructuring of the modern agricultural industry, and population aging slows down the rate of increase in the income of the rural labor force (Li Jujun et al., 2008) [14] . At the same time, with the deepening of aging, the health risks faced by households increase, and people's demand for protection against health risks will be strengthened (Yang Bo et al., 2018) [15] , and the current unanticipated expenditure of households increases. Under the combined effect of the above two influences, the increase in the

proportion of older people in households will itself increase the probability of household financial vulnerability.

In summary, the following two hypotheses are proposed:

Hypothesis 1: The existence of a digital divide in old age increases the probability of household financial vulnerability.

Hypothesis 2: The deeper the degree of digital divide in old age, the higher the probability of household financial vulnerability.

Compared with rural households, urban households have a better digital infrastructure, and mitigating the digital divide at the utilization level can significantly increase the income level of urban households, ease household liquidity constraints and reduce the financial vulnerability of urban households. However, for rural households, the mitigation of the usage gap cannot reduce the probability of financial vulnerability of rural households when the digital infrastructure is not well developed. Therefore, the following hypothesis is proposed:

Hypothesis 3: Mitigating the digital divide in old age by increasing the frequency of Internet use among the older population significantly reduces the probability of financial vulnerability for urban households, but has little effect on rural households.

3. Empirical design

3.1 Data sources and variable construction

3.1.1 Data sources

The data used in this paper come from the China Family Panel Studies (CFPS) conducted by the China Social Science Survey Center (ISSS) of Peking University, which covers 25 provinces and includes all members of the household, and has become the most important source of data for the study of Chinese families. Given the need to explore the financial vulnerability of households, panel data are constructed and empirically analyzed using data from 2014, 2016, and 2018. The database includes cognitive ability tests, personal subjective attitudes, cell phone and internet usage, household assets and liabilities, and other relevant information for adults over 16 years of age, which provides a clear picture of the elderly's use of cell phones and the internet, as well as the income, assets, and liabilities that construct household financial vulnerability. In this paper, the data were processed as follows: first, samples with serious missing values and outliers were excluded. Secondly, continuous variables have been subjected to a 1% reduction of tails.

3.1.2 Variable construction

(1) Explained variables

My explanatory variable is Household Financial Vulnerability (HFV), which is a dummy variable indicating whether the household has household financial vulnerability. Referring to the study of Brunetti (2016), we adopt "financial margin" to measure household financial vulnerability, which is defined as the surplus of funds after meeting the cost of living, debt payments and other financial obligations, and this paper constructs a dummy variable for household financial vulnerability (fragility2), which takes the value of 1 when income is greater than or equal to This paper constructs a dummy variable for household financial vulnerability (fragility2), which takes the value of 1 when the income is greater than or equal to the expected expenditure, and the dummy variable takes the value of 0 when it does not satisfy the above conditions when the liquid assets are less than the unanticipated expenditures, based on the research of Li Bo, which takes the value of 1 when the sum of the household income and liquid assets is less than the sum of the expected expenditures and unanticipated expenditures and takes the value of 0 when it does not satisfy the above conditions, and conducts the robustness test.

(2)Core explanatory variables

The digital divide mainly refers to the differences in the opportunities and abilities of different people to approach and use new information technologies, and the situation in which inequality is further widened due to the differences in the access, use and knowledge of the Internet. Existing literature mostly uses the gap between the elderly group and other groups regardless of Internet access, use and knowledge to measure the digital divide mainly refers to the difference in the opportunities and abilities of different people to approach and use new information technology, and the situation in which inequality is further

widened due to the differences in the access to the Internet trench, the use of the trench, and the knowledge of the trench. The digital divide in the elderly mainly targets the gap between the elderly group and other groups regardless of their Internet access, use and knowledge, and the access divide refers to the gap in terms of access to digital infrastructure and the digital transformation of traditional infrastructure. Based on whether the elderly use the Internet or not, the existence of the digital divide among the elderly was constructed based on the questionnaire's "Do you access the Internet", the answers of "yes" and "no", and the age of 65 or older ("Divide"). The variable "Divide" was constructed by answering "Yes" and "No" to the questionnaire "Do you go online?" and age 65 or above, which indicates that there is a digital divide in the family; based on the frequency of using the Internet among the elderly, we constructed a variable of "Divide" based on the questionnaire "How often do you use the Internet for study/work/socialization/entertainment/commercial activities" by adding up the frequencies of the above questions. Based on the frequency of using the Internet, we constructed the variable of the degree of digital divide (Oldinter) by summing up the frequencies of the above questions, in which the smaller the value of the degree of digital divide means that the degree of digital divide among the elderly is very deep.

(3) Control variable

Scholar Zhang Zhengping found that there are differences between different levels of education, health level, and family type (urban and rural),[16] In addition, scholars Siti Nurazira Mohd Daud et al. found that the important determinants of financial vulnerability are the level of income, marital status, age, level of education, and financial behavior in the management of funds[7]. So in this paper, based on the existing studies and the main characteristics of the household, age, gender, number of people going out to work in the household, marital status, education level, health status, old age dependency ratio and teenage dependency ratio are used as control variables.

3.1.3 Descriptive statistics of variables

Table 1: Descriptive statistics of variables

variable	sample size	average value	standard deviation	minimum value	maximum values
fragility2	40379	0.403	0.490	0	1
fragility3	40379	0.061	0.239	0	1
Divide	40379	0.265	0.441	0	1
Oldinte	40379	0.649	6.772	0	176
age	40379	49.773	14.931	11	95
gender	40379	0.520	0.500	0	1
workout	40379	0.515	0.500	0	1
marry	40379	0.831	0.375	0	1
edu	37446	7.607	4.789	-9	23
health	40377	0.824	0.381	0	1
oldfuyang	36332	0.137	0.347	0	3
youngfuyang	36332	0.022	0.122	0	3

According to the results of descriptive statistics in Table.1, the mean value of financial vulnerability of households (Fragility2) is 0.4026 and this figure indicates that about 40.26% of the households in the sample are financially vulnerable. The standard deviation is 0.4904.The mean value of the presence of digital divide in old age (Divide) is 0.2649, which indicates that the probability of a household having a digital divide in old age is about 26%, with a standard deviation of 0.4413.The mean value of the sample's gender (gender) is 0.5195, which is an average of male and female numbers. The mean value of the sample old age dependency ratio is 0.1373, with a minimum value of 0 and a maximum value of 3, indicating that each household supports a maximum of three elderly persons, with some households having no elderly persons to support.

3.2 Econometric modeling

In order to explore the impact of the digital divide in old age on the financial vulnerability of households, and to test the hypotheses 1 and 2 proposed in the previous section.The following Probit model is set up for empirical analysis, and the econometric model is set up as follows:

$$\Pr(\text{fragility2}_{it} = 1 | x_{it}) = \emptyset\ (\beta_0 + \beta_1 \text{Divide} + \varphi X_{it} + \delta_c + \gamma_c\ ) \tag{1}$$

$$\Pr(\text{fragility2}_{it} = 1 | x_{it}) = \emptyset\ (\beta_0 + \beta_1 \text{f\_oldinter}{\sim}1 + \varphi X_{it} + \delta_c + \gamma_c\ ) \tag{2}$$

where subscript i denotes the ith household sample and t denotes the sample time. The explanatory variable fragilty2 is an indicator of household financial vulnerability, with fragility2 = 1 indicating the presence of household financial vulnerability. The core variable in the modelDivide is a measure of the digital divide in old age, whereDivide = 1 indicates the presence of an old-age digital divide in the household;Oldinter is a measure of the extent of the digital divide in old age, with smaller values indicating greater severity.X_{it} is the matrix of control variables, including a series of characteristic variables, andφ is the corresponding matrix of regression coefficients.δ_c is the area dummy variable, andγ_c is the time dummy variable. When model (1)β_1 is significantly positive and model (2) is significantly negative, hypotheses 1 and 2 are tested.β_1 are significantly negative, Hypotheses 1 and 2 are tested.

4. Empirical analysis

4.1 Model estimation results

This paper estimates the regression coefficients of model (1) using the CFPS database, 2014-2018 panel data, to examine the effect of the digital divide in old age on the financial vulnerability of households, and to verify the hypothesis 1 proposed in the previous section. The estimation results are shown in Table 2. To ensure the robustness of the regression results, this paper utilizes the stepwise regression method to estimate the model coefficients. In Table 2, column (1) shows the regression results obtained after adding individual-level control variables, which are age, gender, number of workers outside the home, marital status, education, and health status; column (2) continues the regression results obtained after adding household-level control variables, and adds the old-age dependency ratio and the juvenile dependency ratio to (1); column (2) continues the regression results obtained after adding household-level control variables, and adds the elderly dependency ratio and The regression coefficients are estimated in column (3) after adding the control variables at the social level.

Table 2: Impact of the digital divide in old age on household financial vulnerability

variable	fragility2		
	(1)	(2)	(3)
Divide	0.024***	0.049***	0.049***
	(3.734)	(4.584)	(4.576)
age	0.001***	0.002***	0.002***
	(8.838)	(9.626)	(9.585)
gender	-0.023***	-0.022***	-0.022***
	(-4.227)	(-3.776)	(-3.784)
workout	-0.003	-0.007	-0.007
	(-0.475)	(-0.877)	(-0.904)
marry	0.010	0.0100	0.010
	(1.417)	(1.283)	(1.222)
edu	-0.016***	-0.015***	-0.015***
	(-24.58)	(-22.54)	(-22.51)
health	-0.133***	-0.135***	-0.135***
	(-20.36)	(-19.05)	(-19.04)
oldfuyang		-0.027**	-0.027**
		(-2.249)	(-2.261)
youngfuyang		0.031	0.030
		(1.524)	(1.481)
west			0.143
			(1.480)
east			-0.119*
			(-1.676)
observation	37428	33555	33555

Note: t-statistics in parentheses, ***, ** and * denote 1%, 5% and 10% significance levels, respectively, as in the table below.

Table.2 presents the results of the Probit model estimation of the presence or absence of the digital

divide in old age on household financial vulnerability. The stepwise regression process has the same sign and significance of the core explanatory variables, indicating that the regression results for the core explanatory variables are robust. After controlling for all variables, the marginal effect of the digital divide in old age is 0.024, and the probability of financial vulnerability of households will increase by 2.4 percentage points when a digital divide exists in the household, which is a significant economic effect. This means that the effect of the old-age digital divide on the increase of financial vulnerability of rural households is obvious, and the presence of the old-age digital divide, the presence of household financial vulnerability of households increases. Verify hypothesis 1. sound digital infrastructure can increase household income, ease household liquidity constraints, and reduce the probability of household financial vulnerability, so households with poor digital infrastructure and a large digital divide have a relatively low income and a higher probability of financial vulnerability, and the eastern region is more economically developed and has a higher rate of digital equipment, and the regression results are significant in the eastern region, and the regression results are not significant in the western region.

The empirical results above show that the existence of the digital divide in old age significantly increases the probability of household financial vulnerability, and the following further explores how the severity of the digital divide affects the existence of household financial vulnerability. The results of regression coefficient estimation based on model (2) are shown in Table.3.

Table 3: Impact of the extent of the digital divide in old age on household financial vulnerability

variable	fragility2		
	(1)	(2)	(3)
Oldinter	-0.002***	-0.002***	-0.002***
	(-4.157)	(-2.719)	(-2.758)
age	0.002***	0.002***	0.002***
	(11.71)	(9.879)	(9.838)
gender	-0.023***	-0.021***	-0.022***
	(-4.220)	(-3.759)	(-3.768)
workout	-0.002	-0.007	-0.008
	(-0.318)	(-0.993)	(-1.019)
marry	0.008	0.010	0.010
	(1.171)	(1.294)	(1.232)
edu	-0.015***	-0.015***	-0.015***
	(-24.37)	(-22.61)	(-22.57)
health	-0.133***	-0.134***	-0.134***
	(-20.27)	(-18.96)	(-18.95)
oldfuyang		0.018**	0.018**
		(2.250)	(2.228)
youngfuyang		0.032	0.031
		(1.544)	(1.502)
west			0.146
			(1.504)
east			-0.120*
			(-1.696)
observation	37428	33555	33555

Table.3 presents the results of the Probit estimation of the degree of digital divide in old age on household financial vulnerability. The sign and significance of the core explanatory variables are the same whether or not control variables are included, indicating that the regression results for the core explanatory variables are relatively robust. After controlling for all variables, the marginal effect of the degree of digital divide in old age is -0.00172, which means that for every 1-unit decrease in this index, household financial vulnerability will rise by 0.172 percentage points, which is equivalent to 0.172% of the degree of financial vulnerability of rural households in the current year (see Table.3), and the economic effect is obvious. This means that the deepening of the degree of old-age digital divide has an obvious effect on the increase of rural household financial vulnerability, and the deepening of the old-age digital divide increases the case of household financial vulnerability, which verifies Hypothesis 2. Population aging reduces the household's current labor income, and with the deepening of the degree of aging, the household faces an increase in health risks, the household has an increase in current

unanticipated expenditures, and the increase of the old-age dependency ratio will inevitably deepen the Household financial vulnerability, old age dependency ratio regression results are significant, column (2) shows that the old age dependency ratio increased by 1 unit, the household financial vulnerability increased by 0.0179 units, therefore, the deepening of population aging, the proportion of the elderly population increases will deepen the degree of the digital divide in old age.

4.2 Robustness check

In order to prove the robustness of the benchmark model and subsequent analysis results, this paper uses both replacement of the main explanatory variables and replacement of the regression coefficients estimation method to conduct the robustness test of the regression results.

4.2.1 Substitution of explanatory variables

Household financial vulnerability can be measured by multiple indicators, keeping other variables different, replacing the household financial vulnerability measure in the regression. According to Li Bo (2020), we define household financial vulnerability as when the sum of household income and liquid assets is less than the sum of expected and unanticipated expenditures, and the variable is taken as 1. The following equation is constructed.

$$\Pr(\text{fragility3}_{it} = 1|x_{it}) = \emptyset \ (\beta_0 + \beta_1 \text{Divide} + \varphi X_{it} + \delta_c + \gamma_c) \tag{3}$$

$$\Pr(\text{fragility3}_{it} = 1|x_{it}) = \emptyset \ (\beta_0 + \beta_1 \text{Oldinter} + \varphi X_{it} + \delta_c + \gamma_c) \tag{4}$$

The robustness regression results after replacing the explanatory variables are shown in Table.4, where columns (1) and (2) show the regression results of "the existence of the digital divide in old age" and "the extent of the digital divide in old age" on the financial vulnerability of households after replacing the household financial vulnerability measures, respectively. Robustness test regression results.

Table 4: Robustness regression with replacement of explanatory variables

variable	fragility3	
	(1)	(2)
Divide	0.013***	
	(4.120)	
Oldinter		-0.001**
		(-2.448)
age	-0.000*	3.79e-05
	(-1.680)	(0.389)
gender	-0.007***	-0.007***
	(-2.725)	(-2.672)
workout	0.064***	0.065***
	(15.22)	(15.32)
marry	-0.001	-0.002
	(-0.307)	(-0.612)
edu	-0.003***	-0.003***
	(-10.14)	(-10.07)
health	-0.035***	-0.034***
	(-11.55)	(-11.39)
observation	37408	37408

The regression reveals that the core explanatory variables have the same sign and significance, indicating that the regression results for the core explanatory variables are still valid. After controlling for all variables, the marginal effect of the digital divide in old age is 0.013, and a 1-unit increase in the index of the existence of the digital divide in old age will increase the probability of the occurrence of household financial vulnerability by 1.3 percentage points, which is equivalent to 1.82% of the probability of the occurrence of household financial vulnerability in the current year (see Table.2), with a significant economic effect. After controlling for all variables, the marginal effect of the degree of digital divide in old age is -0.001, which means that for every 1-unit decrease in the index of the degree of digital divide in old age, household financial vulnerability will rise by 0.1 percentage points, with a clear economic effect. Even after replacing the index measuring household financial vulnerability, the

result is still significant, which means that the increasing effect of the old-age digital divide on the financial vulnerability of rural households is obvious, and the presence of the old-age digital divide and the deepening of the degree of the old-age digital divide increase the situation of household financial vulnerability.

4.2.2 Replacement of regression methods

In the previous section, when estimating the model coefficients of model (1) and model (2), the probit model was used, and in order to verify the robustness of the regression results, the probit model was replaced with the Logit model to regress again, and the model coefficients were estimated as shown in Table 5.

Table 5: Robustness regressions by substitution regression methods

	fragility2
variable	(1)
Divide	0.024***
	(3.714)
age	0.002***
	(8.887)
gender	-0.023***
	(-4.215)
workout	-0.003
	(-0.457)
marry	0.010
	(1.448)
edu	-0.015***
	(-24.60)
health	-0.133***
	(-20.40)
observation	37428

We tested the regression using a logit model, and according to the results shown in Table.5 the results are still significant, indicating that the old age digital divide has a significant impact on household financial vulnerability. After controlling for all variables, the marginal effect of the old-age digital divide is 0.024, which means that for every 1-unit increase in this index, the probability of the occurrence of household financial vulnerability will increase by 2.4 percentage points. This result is almost consistent with the results obtained from the previous probit model regression, indicating the robustness of the study's findings.

4.2.3 Addressing endogenous issues

Since there is a "cohort effect" between families, each family's behavior will have a certain impact on other families, and whether each family uses the Internet and the frequency of using the Internet will have a certain impact on other families, in order to eliminate the impact, so we use the average participation rate of other families in the same county, village and city provinces, in addition to the family as the explanatory variables to solve the endogeneity problem. The instrumental variables regression results are shown in Table.6. Column (1) shows the estimated regression coefficients of "existence of the digital divide in old age" on household financial vulnerability, and column (2) shows the regression results of "degree of the digital divide in old age" on household financial vulnerability.

The regression results show that after addressing the endogeneity of the model using instrumental variables, the regression results remain significant, and that the presence of a household digital divide in old age and a weakening of the digital divide in old age significantly reduces the probability of household financial vulnerability.

Table 6: Treatment of endogeneity issues regarding interactions between families

variable	fragility2	
	(1)	(2)
pingjuncanyu1	0.057***	
	(3.278)	
pingjuncanyu_f1		-0.006***
		(-5.265)
age	0.006***	0.007***
	(9.488)	(12.55)
gender	-0.065***	-0.065***
	(-4.632)	(-4.645)
marry	0.021	0.017
	(1.120)	(0.942)
edu	-0.044***	-0.043***
	(-26.36)	(-25.99)
health	-0.415***	-0.412***
	(-22.77)	(-22.64)
workout	-0.026	-0.021
	(-1.236)	(-1.031)
west	0.297	0.306
	(1.156)	(1.192)
east	-0.297	-0.300
	(-1.487)	(-1.501)
observation	37428	37428

4.3 Heterogeneity analysis

4.3.1 Urban-rural heterogeneity

Table 7: Analysis of urban-rural heterogeneity

variable	Fragility2	
	Urban households	Rural households
Oldinter	-0.002**	0.001
	(-2.406)	(0.55)
age	0.001***	0.004***
	(4.218)	(9.756)
gender	-0.032***	-0.027***
	(-4.241)	(-3.067)
workout	-0.005	0.006
	(-0.425)	(0.549)
marry	-0.012	0.026**
	(-1.147)	(2.133)
edu	-0.015***	-0.011***
	(-16.27)	(-10.66)
health	-0.117***	-0.151***
	(-11.44)	(-15.13)
oldfuyang	0.013	0.017
	(1.127)	(1.506)
youngfuyang	0.065**	0.003
	(2.253)	(0.109)
west	0.085	0.129
	(0.614)	(0.735)
east	0.016	-0.322**
	(0.191)	(-2.227)
observation	16756	16257

At the present stage of China's development, urban and rural areas are unevenly developed, with a

clear dualistic structure, and there is a gap between rural areas and towns in terms of the degree of improvement of digital infrastructure, and there are digital barriers. At the same time, due to the existence of rural migrant workers, a large number of rural labor force outflow, deepening the degree of rural population aging, so there is a significant difference between urban and rural household aging. In order to examine whether there is a difference in the impact of the digital divide in old age on the financial vulnerability of households, this paper is divided into urban and rural households according to the different regions in which the households are located, and regresses the two groups of sample households in accordance with model (1) and model (2), and the results of the regression coefficients are estimated as shown in Table.7.

The regression results reveal that the digital divide in old age significantly increases the likelihood of financial vulnerability of urban and rural households, but the mitigation of the degree of the digital divide in old age is only significant for urban households in the regression results. Compared with rural households, urban households have a more complete digital infrastructure, and alleviating the digital divide at the utilization level can significantly increase the income level of urban households, alleviate the liquidity constraints of households, and reduce the financial vulnerability of urban households. However, for rural households, the mitigation of the usage gap cannot reduce the probability of financial vulnerability of rural households when the digital infrastructure is not well developed. It can thus be shown that the mitigation of the degree of digital divide in old age reduces the probability of financial vulnerability of urban households and has no significant effect on rural households, verifying Hypothesis 3.

5. Conclusions

Taking the old-age digital divide as an entry point, this study explores the impact of the old-age digital divide on household financial vulnerability and examines in-depth the differences in impacts among urban and rural households. Through the literature review and empirical analysis, we find a significant impact of the old-age digital divide on household financial vulnerability, especially in the case of deepening old-age digital divide, the probability of household financial vulnerability is higher. In addition, we find that a reduction in the degree of digital divide has a significant reducing effect on the likelihood of financial vulnerability for urban households, while the effect on rural households is more limited. The significance of this study lies in the fact that it is the first in-depth study of the relationship between the digital divide in old age and household financial vulnerability in China, which fills the research gap in the related field. The results of the study have important theoretical and practical significance for strengthening household financial risk management and improving household financial stability. With the deepening of population aging in China, this study provides an important reference for the government to formulate relevant policies, which can help to better maintain social financial security and improve the financial risk coping ability of the elderly group. At the same time, this study also expands the perspective of household financial vulnerability research and provides new ideas and directions for future in-depth research in related fields. Future research can explore the relationship between the digital divide in old age and household financial vulnerability from more dimensions, providing more comprehensive theoretical support and practical guidance for further improving household financial risk management.

Based on the above research findings, this paper proposes the following policy recommendations. First, strengthen digital training for the elderly to improve their digital literacy and ability to use it, and reduce the extent of the digital divide among the elderly. The government can achieve this goal by conducting free digital training courses in the community and organizing volunteers to provide digital help to the elderly. In addition, it is recommended that the government increase the popularization of digital devices for the elderly, promote the use of cell phones, tablet PCs and other digital devices, and provide convenient Internet access services, so that the elderly can more easily enjoy the convenience and benefits of digitization. Secondly, to address the problem of household financial vulnerability in rural areas, the construction of the rural financial service system can be strengthened and the level of rural financial services can be improved to mitigate the impact of the digital divide on the financial vulnerability of rural households. The Government can achieve this goal by increasing support for rural financial institutions and encouraging new financial organizations such as cooperatives to enter the rural market. In addition, the government can promote the development of rural e-commerce, provide convenient online financial services to help rural residents solve financial financing problems, and strengthen the popularization of financial literacy among rural residents to improve their financial management skills. Finally, for the issue of household financial vulnerability in urban areas, the government can reduce the impact of the digital divide on the financial vulnerability of urban households

by raising the income level of urban low-income groups. The government can promote the implementation of fair employment policies, provide more job opportunities and vocational training, and help low-income groups raise their income levels. At the same time, the government can also encourage financial institutions to innovate financial products and improve the level of financial services, so as to provide urban low-income households with more convenient and high-quality financial services. In addition, the Government can strengthen financial education for low-income families to improve their financial literacy and help them make better financial planning and cope with financial risks.

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