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Earthquake disaster insurance literacy and earthquake insurance purchasing behavior: based on the mediating effect of risk preference

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Abstract
This paper uses the survey data of "Earthquake disaster insurance literacy of Chinese residents" to construct the earthquake disaster insurance literacy index system, and analyzes the mechanism of the influence of earthquake disaster insurance literacy level on residents' earthquake insurance purchasing behavior from the perspective of risk preference. Empirical study shows that the earthquake disaster insurance literacy level of residents can significantly promote their earth-quake insurance purchasing behavior. Further analysis reveals that within the impact of earth-quake disaster insurance literacy on earthquake insurance purchasing behavior, the risk preference of financial investment products plays a positive intermediary role, but the mediating effect is not as large as the direct effect. Therefore, as a critical influencing factor of earthquake insurance purchasing behavior, it becomes crucial and urgent to improve earthquake disaster insurance literacy. We will improve residents' earthquake disaster insurance literacy through multiple channels, focusing on the mediating effect of risk preference. This also provides certain policy references for government authorities and insurance institutions to formulate relevant policies and effectively promote earthquake insurance products.

Keywords Earthquake disaster insurance literacy · Earthquake insurance · Purchasing behavior · Risk preference

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1 Introduction

China is one of the countries in the world where the most serious earthquake disasters occur, with a wide geographic distribution, high frequency, and substantial resulting losses. China Statistical Yearbook on Environment 2022 shows that 279 earthquakes occurred in China from 2000 to 2021, with direct economic losses amounting to 1,163.97 billion yuan, including 859.50 billion yuan in 2008, when the Wenchuan earthquake occurred. China predominantly relies on fiscal appropriations and social assistance for emergency response, relief, and reconstruction after earthquake disasters, with a limited level of marketization and significant fiscal pressure. There is still a big gap with the developed countries' well-established mechanism of disaster loss sharing. According to the Swiss Re Institute's World Insurance sigma report for the first quarter of 2023, the global insurance industry accounted for approximately 45% of economic losses related to natural disasters in 2022. In contrast, China's insurance industry's compensation for the 2008 Wenchuan earthquake disaster is less than 1% of the total losses (Tian et al. 2015). National Emergency Response System during the 14th Five-year Plan Period proposes that "we should strengthen the positive role of insurance and other market mechanisms in risk prevention, loss compensation, recovery and reconstruction, explore the establishment of a multi-channel and multi-level risk sharing mechanism, and vigorously develop catastrophe insurance". However, the current reality reveals that public acceptance of earthquake insurance is less than satisfactory, and promoting insurance faces significant challenges. Field investigations in Yunnan, Sichuan, Hebei, and other regions have shown that while most residents express a strong willingness to purchase earthquake insurance, the majority have not taken concrete actions (Yuan et al. 2022). In recent years, there have been instances of local governments fully subsidizing earthquake insurance for the residents.

The promotion of earthquake insurance is an important guarantee and a key measure to reduce the earthquake disaster loss. Combined with international experience, although the catastrophe insurance system cannot be separated from the government intervention, expanding the public participation is not only an explicit demand to share the financial pressure of the government, but also an essential requirement for insurance to realize the social management function (Tian et al. 2015). Insurance participation in decision-making is undoubtedly a relatively complex economic decision-making behavior. Consumers not only spend a lot of time, but also spend a considerable amount of energy to weigh the premium expenditure and expected income. In this process, they need to have certain insurance literacy to help them make decisions (Li et al. 2020a). It is crucial to improve the public awareness of earthquake disaster risks and earthquake prevention and disaster reduction, enhance the public's awareness of earthquake prevention and disaster reduction and self-rescue ability, and improve the level of earthquake disaster insurance literacy for the reduction of earthquake disaster losses (Lian et al. 2021).

This study, from the perspective of risk preference in the selection of financial investment products, constructs a direct and indirect transmission mechanism formed by variables such as "earthquake disaster insurance literacy—risk preference—residents' earthquake insurance purchasing behavior." It not only reveals the direct impact of earthquake disaster insurance literacy on earthquake insurance purchasing behavior but also delves into the question of whether risk preference mediate the aforementioned influence. This paper expands the theoretical basis and practical cognition of the internal logical relationship between earthquake disaster insurance literacy and the earthquake insurance purchasing behavior of residents, and provides a certain reference idea

for the effective promotion of earthquake insurance products and the construction of multi-level disaster risk sharing mechanism.

2 Literature reviews

2.1 Related research on insurance literacy

The concept of insurance literacy is extended by Huston (2010) from the connotation of financial literacy and extended through Tennyson (2011). Lin et al. (2019) believes that insurance literacy mainly covers three meanings: first, to understand the basic concept of insurance; second, to appreciate the specific risks covered by the insurance policy; and third, to make insurance decisions consistent with the perceived risk. At present, the definition of insurance literacy has not yet formed a recognized and unified standard. Studies on insurance literacy measures are still scarce. Some literature uses interviews or subentry statistics to analyze insurance literacy (Driver et al. 2018). The more concise and standardized insurance literacy questionnaire is the National Association of Insurance Commissioners (NAIC) and the Bristow and Tennyson insurance issue survey, which attempt to comprehensively assess the insurance literacy of adults of all ages (Tennyson 2011).

Earthquake disaster insurance literacy is developed on the basis of financial literacy and insurance literacy. Yuan and Sun (2023) refer to the PISA financial literacy measurement framework and combine with the financial literacy evaluation framework of the People's Bank of China to build an index system of earthquake disaster insurance literacy for Chinese residents.

2.2 Research on the purchasing behavior of earthquake insurance

Most residents of our country still maintain a cautious attitude in participating in insurance. According to the Research Report on the Chinese Household Wealth Index (2020Q1) released by Southwestern University of Finance and Economics in 2020, only 10.8% of China's residents have commercial insurance. Li (2019) specially studied the marketing strategy of earthquake catastrophe insurance products. It is believed that the desire of customers to buy earthquake catastrophe insurance has not been mobilized, and the product innovation strategy and product portfolio strategy are not used enough, and the sales channel is too single. Ding (2013) decomposed the demand for catastrophe insurance in China through questionnaire survey, and believed that the purchase ability of catastrophe insurance is the economic factor that affects the demand, and risk perception and risk communication are the psychological factors that affect the demand. He also believed that foreign earthquake catastrophe insurance has similar characteristics and influencing factors of earthquake catastrophe insurance. Zhao et al. (2020) This paper studied the willingness and influencing factors of residents to buy catastrophe insurance, and analyzed the role of catastrophe insurance on the recovery ability of communities after the disaster. It is believed that the voluntary purchase of catastrophe insurance alone will lead some low-income people to bear greater risks after the disaster due to the lack of insurance.

2.3 Research on the relationship between financial literacy and insurance purchasing behavior

Many scholars have conducted research on the impact of literacy and insurance purchasing behavior. Experience studies of domestic and foreign scholars have shown that consumers with high literacy will significantly increase their demand for commercial insurance (Li et al. 2020a). The specific research is mainly conducted from the following three aspects.

From the point of understanding of insurance products, family commercial insurance participation need consumers need to spend a lot of time to obtain commercial insurance information, fully understand the ginseng process and compensation rules, high literacy residents in the process of insurance information acquisition can effectively reduce time cost, the willingness and behavior may have a certain degree of influence (Zhang and Wang 2023). Hastings and Tejeda-Ashton (2008) believe that the lack of financial knowledge will lead consumers to not make any investments or make wrong investment decisions. Farmers with high financial literacy have more financial knowledge and have a better understanding of the operation mechanism, risk and return of insurance products. They can correctly understand the nature of insurance products and are not easy to be fooled by insurance brokers (Reaearch Group of Jiangxi Finance Society and Zhang 2020).

From the point of personal purchase purpose, high financial literacy of farmers in the pursuit of benefit maximization, tend to buy all kinds of financial products to reduce risk, such as the insurance market spread its longevity risk, major disease risk and accident risk and economic system risk, the purchase intention of insurance products is strong (Reaearch Group of Jiangxi Finance Society and Zhang 2020). Qin et al. (2016) research found that objective financial literacy will significantly affect the family commercial insurance participation in decision-making, financial literacy the higher the rural family members for commercial insurance trust, the stronger the purchase intention, and the stronger the risk judgment ability and risk aversion consciousness, the more actively adopt different types of commercial insurance to prevent possible risk impact.

From the perspective of the economic ability of the family, the stronger the economic strength of the farmers with high financial literacy, the stronger the ability to make financial planning and can purchase financial products to cope with the uncertainty of the family's future finance (Reaearch Group of Jiangxi Finance Society and Zhang 2020). Families with higher subjective financial literacy, the higher the premium expenditure level (Wang et al. 2021). Yang and Liu (2019) found that among residents with higher financial literacy, the consumption expenditure for commercial insurance accounted for a larger proportion in their income, and families with different financial literacy had different consumption preferences for commercial insurance.

Currently, research on the influence of insurance literacy on insurance purchasing behavior primarily focuses on commercial insurance, with limited attention given to disaster insurance literacy and purchasing behavior. Specifically, there is a significant gap in research focusing on earthquake insurance.

3 Theoretical analysis and research hypotheses

A limited number of studies have specifically examined the influence of insurance literacy on insurance decision-making. Uddin (2017), utilizing the insurance literacy survey instrument developed by Bristow and Tennyson, found that insurance literacy significantly facilitates the demand for microinsurance among Indian residents. Li et al. (2020a, b) argued that insurance literacy is a crucial determinant of consumers' demand for commercial insurance, with an increase in insurance literacy leading to a significant 3.1% rise in the probability of farmers participating in commercial insurance. However, the impact of insurance literacy on insurance decision-making is not universally consistent and may vary across regions. Bonan et al. (2017) found no positive effect of insurance literacy on insurance decision-making among residents of Senegal. Domestic surveys have revealed a low willingness among Chinese residents to purchase earthquake insurance, partly attributed to the inflexibility of earthquake insurance and the tendency of residents to overly rely on the government. Critically, the general level of insurance literacy regarding earthquake disaster insurance among residents is found to be low (Yuan and Sun 2023), echoing the consensus on the overall low levels of financial literacy and insurance literacy internationally (Su and Kong 2019; Driver et al. 2018; Tennyson 2011).

Meanwhile, risk preference, as an intermediary variable, plays an indispensable role in the insurance decision-making process. On one hand, residents' financial knowledge exhibits a significant positive correlation with their risk preference. Enhancing financial knowledge can significantly improve residents' risk preference, thereby promoting more effective participation in financial markets by households and influencing their risk investment behavior (Yin et al. 2015; Zhou 2015). Zhu et al. (2016) and Zhao (2018) further pointed out that the richness of financial knowledge is highly correlated with risk tolerance, risk aversion level, and risk preference. Individuals with extensive knowledge typically have stronger risk tolerance, lower levels of risk aversion, and higher risk preference. On the other hand, risk preference significantly influences residents' choices of financial products. Risk-seeking households are more willing to try new financial products (Yan et al. 2018), while risk-averse individuals tend to adhere to traditional consumption patterns, prioritize savings, and hold negative attitudes towards credit consumption and premature consumption (Gao et al. 2021). Li et al. (2020a) concluded from their study the intrinsic relationship between financial literacy, risk preference, and investment choices: the higher residents' financial literacy, the richer their financial knowledge, the deeper their understanding of financial market information, and the stronger their financial capabilities. They can more accurately assess the potential risks and returns of financial investment products, and are therefore more likely to choose investment projects with high risks and high returns. In this process, risk preference plays a crucial mediating role.

Based on the above, study hypotheses 1 and 2 are presented.

Hypothesis 1: Earthquake disaster insurance literacy will directly promote the purchasing behavior of earthquake insurance.

Hypothesis 2: Residents' risk preference plays a mediating role in the impact of earthquake disaster insurance literacy on the purchasing behavior of earthquake insurance.

4 Study design

4.1 Data source

The data of this study are derived from the "residents' earthquake disaster insurance literacy" questionnaire conducted by the research group, which has been published for three years. Taking into account the basic characteristics such as economic level, population distribution, and seismic risk zone distribution in various regions, a nationwide survey was conducted through a combination of field interviews and online surveys, utilizing earthquake systems and other channels. Residents were randomly interviewed. Over the course of three years, the statistical results were screened and cleaned, ultimately confirming 5,228 valid questionnaires collected. Due to data limitations, this study did not discuss the sample distribution in the Hong Kong, Macao, and Taiwan regions. The distribution of samples in the remaining 31 provinces and municipalities is shown in Table 1.

4.2 Variables selection and measurement

1. Interpreted variable: residents' earthquake insurance purchasing behavior (eipb)

The explained variable is a binary variable, which represents whether the resident has purchased earthquake insurance, and the assigned option is 1, otherwise the assigned value is 0.

2. Interpretive variable: earthquake disaster insurance literacy (edil)

Table 1 Number of sample distribution in provinces

Province	Number of samples	Province	Number of samples
Anhui	153	Liaoning	117
Beijing	413	Inner Mongolia	88
Fujian	177	Ningxia	40
Gansu	93	Qinghai	31
Guangdong	496	Shandong	314
Guangxi	104	Shanxi	191
Guizhou	75	Shaanxi	159
Hainan	27	Shanghai	186
Hebei	309	Sichuan	310
Henan	287	Tianjin	170
Heilongjiang	81	Tibet	74
Hubei	261	Xinjiang	71
Hunan	145	Yunnan	150
Jilin	56	Zhejiang	155
Jiangsu	236	Chongqing	140
Jiangxi	119	Amount to	5228

Earthquake disaster insurance literacy derived from financial literacy and insurance literacy development, in the earthquake disaster insurance literacy measurement, the main reference of the People's Bank of China to build specifically for Chinese residents' financial literacy evaluation framework, in the foregoing research (Yuan and Sun 2023; Ji and Ma 2023) on the basis of the AHP, build the earthquake insurance literacy, insurance literacy, earthquake literacy three primary indicators, each level indicators consist of knowledge, ability and attitude under three secondary indicators, build 19 level 3 indicators. The consistency proportion CR of all judgment matrices of this index system is less than 0.1. Finally, the paper determines the weight of each index in the earthquake disaster insurance literacy system, as shown in Table 2.

3. Mediation variable: risk preference (risk)

In previous studies, three types of methods were commonly used to represent risk preference variable. The first category uses a set of tests to measure risk appetite. For example, Cang and Ping (2020) set up five experiments to test the score of risk preference. Zhou et al. (2019) referred to the investor risk preference assessment questionnaire of famous Internet finance enterprises, and designed 9 questions of different dimensions to measure the risk preference of Internet finance of college students.

The second type directly determines the individual's risk preference with the options. Wu and Zhou (2015) according to the respondents to the risk and return attitude answer "not willing to take any risk", "slightly lower risk, slightly lower return", "average risk, average return" and "slightly high risk, slightly higher return", "high risk, high yield" is divided into risk aversion, preference slightly lower risk, risk neutral and risk preference four groups, and generate the corresponding binary variables. Zhu et al. (2016) use "How is your risk willing to take when investing?" Measure the risk appetite of the respondents, Respectively will be "unwilling to take any risk, Slightly lower risk, slightly lower return, Average risk, average return, Higher risk, slightly higher returns, Higher risk, high return" was successively assigned a value of 1 to 5, It shows that the risk preference of residents is gradually increased; It also measured the risk preference variable of the respondents' choice of preferred investment projects, Select the assignment of "high risk, high return item" 5, Select the assignment 4 for "slightly high risk, slightly higher return items", Select the assignment 3 of "average risk, average return", Select the assignment 2 for "slightly lower risk, slightly lower return", Choose the assignment 1 of "unwilling to take any risk", The five types of investors with risk appetite from high to low (Zhu et al. 2015).

The third category uses the index system to determine the comprehensive score for the risk preference or score. Zhao and Shiyun (2023) used risk preference as the intermediary variable to determine the risk preference score through six indicators: investment demand, financial knowledge and risk attitude.

This paper refers to the practice of Chen et al. (2020), according to the effective market hypothesis, individual is assumed as "rational economy", the relevant economic decisions is rational, investment subject can get sufficient market information, and according to the goal of profit or utility maximization investment decision (Qiao and Su 2019). Select investment product type as a proxy variable of risk preference, focus is in financial products this risk assets, investors in the face of different risk size product choice, namely preference investment high risk (relatively high risk) of financial

Table 2 Earthquake disaster insurance literacy index system and its weight

Target layer	Level 1 indicators	Level 2 indicators	Weight	Level 3 indicators	Weight
Earthquake disaster insurance literacy index system	Earthquake insurance literacy: 0.581 6	Earthquake insurance knowledge	0.116 3	Identification degree of seismic insurance products	0.116 3
		Earthquake insurance capacity	0.232 6	Acceptance of seismic insurance products	0.232 6
		Earthquake insurance attitude	0.232 6	Recognition of earthquake insurance	0.232 6
	Insurance literacy 0.309 0	Insurance knowledge	0.061 8	Basic functional awareness of the insurance policy	0.030 9
				Understanding of basic insurance knowledge	0.030 9
		Insurance ability	0.123 6	The ability to vote for insurance	0.041 2
				Ability to deal with insurance consumption disputes	0.041 2
				Insurance coverage and compensation payment experience	0.041 2
		Insurance attitude	0.123 6	Attitudes towards insurance contracts	0.041 2
				Attitude towards Internet insurance	0.041 2
				Attitudes towards insurance education	0.041 2
	Earthquake literacy 0.109 5	Earthquake knowledge	0.021 9	Earthquake knowledge	0.005 5
				Understanding of the earthquake conditions in China	0.005 5
				Earthquake self-rescue knowledge	0.005 5
				Shock absorber knowledge	0.005 5
		Earthquake ability	0.043 8	Earthquake escape training experience	0.021 9
				Sanctuary awareness	0.021 9
		Earthquake attitude	0.043 8	Global earthquake situation attention	0.021 9
				Recognition of the earthquake prevention and disaster reduction courses	0.021 9

products or prefer low risk (relatively low risk) of financial products, select higher risk products give higher score, higher score is more preferred risk type.

For the classification of financial investment products, reference Yin et al. (2014), Zong et al. (2015) the CHFS survey family cash, live deposits and Treasury bonds is defined as risk-free financial assets, and financial risk assets including stocks, local government bonds, corporate bonds, funds, financial derivatives, financial products and Internet financial products (Chen and Huang 2020).

4. Control variables

Based on the existing empirical results, the residents of sex (sex), age (age), residence (dis), education level (edu), occupation (occ), annual household income (inc), earthquake peak acceleration (EPA), the influence of official behavior on individuals (gpro, gsub, ser) were selected as the control variables in this paper.

The specific definitions and assignments of the variables are shown in Table 3.

5 Empirical analysis

5.1 Descriptive statistics

As can be seen from Table 4, the average value of earthquake disaster insurance literacy of residents in the three years is 0.749. According to the separate observation, it is found that the level of earthquake disaster insurance literacy of residents is increasing year by year, and the standard deviation is also increasing, indicating that the fluctuation range of literacy becomes larger. With the same trend of increasing year by year are residents' earthquake insurance purchasing behavior and risk preference. From 2021 to 2023, the sample number of the three years was 1909, 1862 and 1457, respectively, while the mean of eipb increased from 0.046 in 2021 to 0.307 in 2023, indicating that the number of residents who had purchased earthquake insurance was increasing, and residents' risk preference also showed the same trend characteristics.

5.2 Benchmark regression

The focus of this paper is on the influence of earthquake disaster insurance literacy on the purchase of earthquake insurance. When designing the measurement model, considering the discrete variables with the value of purchasing behavior is 1 and 0, Probit model is selected to explore the influence of earthquake disaster insurance literacy on the purchasing behavior of earthquake insurance, and the following measurement model is constructed:

$$eipb = \alpha + \beta edil + \gamma X + \varepsilon$$

Among them, eipb said whether the resident has bought earthquake insurance, if the value is 1, otherwise 0. The edil represents earthquake disaster insurance literacy, X is the control variable, ε represents independent and equally distributed random error terms, contains other unobservable factors, and follows the standard normal distribution.

Model (1) takes residents' earthquake disaster insurance literacy level as the core independent variable, while controlling for residents' personal characteristics such as gender, age,

Table 3 Definition and assignments of variables

Type of variable	Variable name	Variable value assignment and description
Explained variable	eipb	Whether you have bought earthquake insurance. Bought = 1, never bought = 0
Explanatory variable	edil	Earthquake disaster insurance literacy. Continuous variables, with values ranging between 0 and 1.000
Mediation variable	Risk	Risk preference. The degree of risk preference of residents when purchasing financial investment products, the larger value indicates that residents prefer risk, with minimum = 0 and maximum = 15
Controlled variables	Sex	Sex. Male = 1, female = 0
	Age	Age. Continuous variable
	dis	Living in urban or rural areas. City = 1, rural = 0
	edu	Entrance education level. Did not go to school = 1, primary school = 2, junior high school = 3, senior high school (technical secondary school) = 4, junior college = 5, bachelor's degree = 6, graduate student or above (double degree) = 7
	occ	Occupation. Administrative staff = 1, institution staff = 2, enterprise staff = 3, freelancer = 4, unemployed = 5, farmer = 6, retiree = 7, student = 8, other = 9
	inc	Gross annual household income. Below 2w = 2, 2w–5w = 3.5, 5w–10w = 7.5, 10w–20w = 15, 20w–50w = 35, 50w or more = 50
	EPA	Earthquake peak acceleration in prefecture-level cities where residents are located.0.05 g = 1, 0.10 g = 2, 0.15 g = 3, 0.20 g = 4, 0.30 g = 5
	gpro	The government joins the propaganda of earthquake insurance, which tends to buy earthquake insurance = 1, and does not tend to buy = 0
	gsub	The government provides a partial subsidy for earthquake insurance, which tends to buy earthquake insurance = 1, and does not tend to buy the = 0
	ser	Whether the earthquake prevention and disaster reduction department has provided relevant public services. Provided = 1, not provided = 0

Table 4 Descriptive statistics

Variable name	2021 Mean	2021 Standard error	2022 Mean	2022 Standard deviation	2023 mean	2023 Standard error	Full sample mean	Standard deviation of the Full Sample
eipb	0.046	0.210	0.140	0.347	0.307	0.462	0.152	0.359
edil	0.727	0.160	0.742	0.163	0.786	0.143	0.749	0.159
Risk	3.715	3.092	4.454	3.527	5.465	3.282	4.466	3.377
Sex	0.478	0.500	0.436	0.496	0.491	0.500	0.467	0.499
Age	34.871	8.750	34.724	9.340	33.039	7.247	34.308	8.617
dis	0.792	0.406	0.767	0.423	0.849	0.358	0.799	0.401
edu	5.537	1.020	5.402	1.100	5.687	0.912	5.531	1.027
occ	3.744	2.184	3.627	1.920	3.253	1.390	3.566	1.906
inc	16.159	12.892	15.649	12.459	19.169	13.110	16.816	12.884
EPA	2.351	1.177	2.180	1.099	2.577	1.193	2.353	1.165
gpro	0.709	0.454	0.785	0.411	0.844	0.363	0.774	0.419
gsub	0.856	0.351	0.888	0.315	0.935	0.247	0.890	0.313
ser	0.620	0.485	0.916	0.277	0.964	0.186	0.822	0.383

Table 5 Descriptive statistics

	Model (1) P1	Model (2) M1	Model (3) P2	Model (4) M2	Model (5) P3	Model (6) M3
edil	3.177*** (15.501)	0.684*** (15.783)	3.203*** (15.558)	0.681*** (15.863)	2.680*** (12.054)	0.541*** (12.270)
Sex	0.226*** (4.986)	0.049*** (5.003)	0.209*** (4.587)	0.044*** (4.600)	0.231*** (4.906)	0.047*** (4.930)
Age	−0.015*** (−4.997)	−0.003*** (−5.017)	−0.016*** (−5.189)	−0.003*** (−5.210)	−0.014*** (−4.525)	−0.003*** (−4.545)
dis	−0.062 (−1.018)	−0.013 (−1.018)	−0.078 (−1.273)	−0.017 (−1.274)	−0.098 (−1.542)	−0.020 (−1.543)
edu	−0.078*** (−2.947)	−0.017*** (−2.951)	−0.074*** (−2.766)	−0.016*** (−2.769)	−0.080*** (−2.843)	−0.016*** (−2.848)
occ	−0.060*** (−4.153)	−0.013*** (−4.162)	−0.064*** (−4.404)	−0.014*** (−4.416)	−0.056*** (−3.726)	−0.011*** (−3.736)
inc	0.006*** (3.245)	0.001*** (3.251)	0.006*** (3.162)	0.001*** (3.167)	0.005*** (2.840)	0.001*** (2.845)
EPA			0.137*** (7.189)	0.029*** (7.247)	0.145*** (7.325)	0.029*** (7.410)
gpro					0.724*** (7.628)	0.146*** (7.676)
gsub					−0.373*** (−3.119)	−0.075*** (−3.124)
ser					1.086*** (9.009)	0.219*** (9.075)
Number of samples	5228	5228	5228	5228	5228	5228
Pseudo R^2	0.095	0.095	0.106	0.106	0.155	0.155

*, ** and *** represent the confidence levels of 10, 5 and 1% respectively, with Z statistics in parentheses

occupation, income, etc. Model (3) builds upon Model (1) by adding a seismic risk coefficient variable to represent the level of seismic risk in residents' places of residence. Model (5) further adds variables related to public services provided by government departments, such as government promotion of earthquake insurance and subsidies for earthquake insurance. Since the Probit model is a non-linear model, its coefficients do not represent the marginal effect, and only represent the direction of the influence of the explanatory variables without any specific meaning, the marginal effect is also reported in Table 5, and models (2), (4) and (6) are the marginal effect results of models (1), (3) and (5) respectively. From the model (1) (3) (5) can be seen, the explanatory variable earthquake disaster insurance literacy coefficient is significant, this shows that the improvement of earthquake disaster insurance literacy level of the earthquake insurance purchasing behavior has significant positive impact, from the point of the corresponding marginal effect coefficient, each improve a unit of earthquake disaster insurance literacy, the probability of earthquake insurance purchasing behavior will increase significantly, so assume hypothesis 1.

Table 6 Results of the subsample regression

	Model (7) Age1	Model (8) Age2	Model (11) Inc1	Model (12) Inc2	Model (13) EPA1	Model (14) EPA2
edil	0.598*** (11.306)	0.331*** (4.523)	0.356*** (6.022)	0.682*** (10.955)	0.454*** (8.453)	0.687*** (9.014)
sex	0.060*** (5.359)	−0.001 (−0.077)	0.024* (1.691)	0.061*** (4.803)	0.023** (2.083)	0.092*** (5.290)
age			−0.002*** (−2.872)	−0.003*** (−3.385)	−0.002*** (−2.819)	−0.004*** (−3.419)
dis	−0.030* (−1.939)	−0.002 (−0.079)	−0.027* (−1.765)	−0.004 (−0.214)	−0.014 (−0.899)	−0.024 (−1.019)
edu	−0.010 (−1.363)	−0.020** (−2.520)	−0.010 (−1.582)	−0.015* (−1.651)	0.015** (1.993)	−0.050*** (−5.571)
occ	−0.013*** (−3.538)	−0.005 (−1.165)	−0.015*** (−4.297)	−0.005 (−1.037)	−0.009** (−2.443)	−0.015*** (−2.845)
inc	0.001** (2.173)	0.001 (1.232)			0.001** (2.011)	0.001* (1.656)
EPA	0.029*** (6.164)	0.031*** (4.609)	0.035*** (6.298)	0.025*** (4.574)		
gpro	0.144*** (6.479)	0.154*** (3.878)	0.122*** (5.090)	0.164*** (5.797)	0.129*** (5.482)	0.175*** (5.370)
gsub	−0.069** (−2.377)	−0.105*** (−2.587)	−0.030 (−1.007)	−0.119*** (−3.271)	−0.058* (−1.806)	−0.094** (−2.431)
ser	0.248*** (8.272)	0.131*** (3.769)	0.199*** (5.817)	0.227*** (6.851)	0.220*** (6.183)	0.230*** (6.294)
Number of samples	4074	1118	2080	3148	3440	1788
Pseudo R^2	0.143	0.190	0.182	0.138	0.141	0.182

*, ** and *** represent the confidence levels of 10, 5 and 1% respectively, with Z statistics in parentheses

5.3 Heterogeneity test

According to the different characteristics of the residents, the samples were classified and the subsample regression analysis. The results reported in the table are all marginal effects, and the results are shown in Table 6.

In this survey data, the average age of residents in three years is 34.31 years old. In terms of years, the average age of each year fluctuates at about 34 years old, so the residents are divided into the model of 23–40 years old according to their age (7), and the model of 40–60 years old (8). Most of the residents in these two stages have fixed income and residence, and they will have some attention to earthquake insurance. However, according to the results of model (7) (8) in Table 6, the improvement of earthquake disaster insurance literacy of residents aged 23–40 increased the probability of purchasing earthquake insurance more, nearly twice that of residents aged 40–60. In 2020, the average disposable income per capita for residents across China was approximately 32,200 yuan. Calculated based on an average of three laborers per household, the average household income was around 96,600 yuan. In 2021, the average disposable income per capita for residents in China increased to approximately 35,100 yuan, resulting in an average household income of around 105,300 yuan. In 2022, the average disposable income per capita for Chinese residents rose to about 36,900 yuan, leading to an average household income

of approximately 110,700 yuan. Over the three-year period, from 2020 to 2022, the average household income for Chinese residents averaged around 104,200 yuan. Therefore, in Table 6 models (13) and (14), the samples are divided into two categories: annual household income is below 100,000 and above 100,000. The results indicate that for residents with an annual household income exceeding 100,000 yuan, an increase in earthquake disaster insurance literacy leads to a more substantial increase in the probability of earthquake insurance purchasing behavior compared to residents with an annual household income below 100,000 yuan. Finally, the sample is divided according to the earthquake peak acceleration of prefecture-level cities. The earthquake peak acceleration of model (14) is higher than (13), indicating that the residents with higher earthquake peak acceleration of prefecture-level cities, the improvement of earthquake disaster insurance literacy has a greater effect on improving the probability of earthquake insurance purchasing behavior.

5.4 Mediation effect test

Based on Wen et al. (2004) research on the mediation effect model, the model (1)–(3).

$$eipb = \alpha_0 + \alpha_1 edil + \sum control + \varepsilon_1 \tag{1}$$

$$risk = \beta_0 + \beta_1 edil + \sum control + \varepsilon_2 \tag{2}$$

$$eipb = \gamma_0 + \gamma_1 edil + \gamma_2 risk + \sum control + \varepsilon_3 \tag{3}$$

The mediation effect of risk preference needs to meet the following conditions:

(1) the earthquake insurance purchasing behavior variable regresses the earthquake disaster insurance literacy, the regression coefficient needs to reach a significant level; (2) the earthquake disaster insurance literacy of risk preference variable, the regression coefficient needs to reach a significant level; (3) the purchasing behavior of earthquake insurance variable regresses the earthquake disaster insurance literacy and risk preference, and the coefficient of risk preference variable is significant. When the coefficient of the earthquake disaster insurance literacy variable in the earthquake is not significant, the risk preference plays a full mediation effect; when the coefficient of the earthquake disaster insurance literacy variable plays a partial mediation effect.

The regression results of the model (15) in Table 7 show that the earthquake disaster insurance literacy level of residents has a significant positive impact on the purchasing behavior of earthquake insurance, and the next test is conducted. The regression results of the model (16) show that the level of earthquake disaster insurance literacy of residents will significantly improve the level of risk preference. After adding the variable of risk preference in the model (17), the level of earthquake disaster insurance literacy still has a significant positive impact on the purchasing behavior of earthquake insurance, indicating that risk preference plays a partial intermediary role between the level of earthquake disaster insurance literacy and the purchasing behavior of earthquake insurance. Hypothesis 2 is true.

In general, the three-step method defaults to OLS regression. However, since the dependent variable in this study is a binary variable, we employed Probit model for regression. As a result, we can only verify the presence of the mediating effect and are unable to calculate the proportion of the mediating effect. Table 8 presents the calculation of the

Table 7 Test of mediation effect (stepwise test regression coefficient method)

Variable	Model (15) eipb	Model (16) risk	Model (17) eipb
edil	2.680*** (12.054)	3.547*** (12.395)	2.459*** (10.923)
Risk			0.046*** (6.071)
Sex	0.231*** (4.906)	0.172** (2.081)	0.225*** (4.753)
Age	−0.014*** (−4.525)	0.004 (0.762)	−0.014*** (−4.492)
dis	−0.098 (−1.542)	0.685*** (6.666)	−0.126* (−1.960)
edu	−0.080*** (−2.843)	0.521*** (11.809)	−0.109*** (−3.796)
occ	−0.056*** (−3.726)	−0.204*** (−9.818)	−0.047*** (−3.030)
inc	0.005*** (2.840)	0.063*** (16.694)	0.003 (1.398)
EPA	0.145*** (7.325)	−0.118*** (−3.450)	0.156*** (7.771)
gpro	0.724*** (7.628)	0.173 (1.580)	0.715*** (7.489)
gsub	−0.373*** (−3.119)	0.368** (2.408)	−0.392*** (−3.281)
ser	1.086*** (9.009)	0.296*** (2.805)	1.065*** (8.816)
Number of samples	5228	5228	5228
R^2		0.253	

*, ** and *** represent the confidence levels of 10, 5 and 1% respectively, with Z statistics in parentheses

Table 8 Test of mediation effect (generalized structural equation method)

	Coef	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Indirect effect	0.041	0.007	6.19	0.000	0.028	0.054
Total effect	0.388	0.034	11.28	0.000	0.321	0.456

mediating effect proportion using the Generalized Structural Equation Method. The indirect effect is 0.041, and the value of P is statistically significant, indicating the existence of the mediating effect. The total effect is 0.388, with the mediating effect accounting for 10.57% of the total effect.

5.5 Robustness test

In order to verify whether the regression results and the mediation effect test are reliable, the above results were respectively tested for robustness.

Table 9 Robustness test

	Model (18)	Model (19)	Model (20)
	Probit	Logit	OLS
edil	3.291***	5.552***	0.388***
	(19.247)	(12.387)	(13.102)
Sex	−0.042	0.426***	0.047***
	(−0.994)	(5.061)	(4.815)
Age	−0.018***	−0.025***	−0.002***
	(−6.916)	(−4.324)	(−4.787)
dis	0.088	−0.164	−0.011
	(1.616)	(−1.427)	(−0.895)
edu	−0.061**	−0.145***	−0.016***
	(−2.567)	(−2.811)	(−2.919)
occ	−0.034***	−0.102***	−0.009***
	(−3.017)	(−3.576)	(−4.449)
inc	0.007***	0.009***	0.001**
	(3.887)	(2.648)	(2.572)
EPA	0.048***	0.265***	0.030***
	(2.704)	(7.463)	(7.146)
gpro	1.175***	1.500***	0.092***
	(20.397)	(7.345)	(9.625)
gsub	0.471***	−0.693***	−0.064***
	(5.193)	(−2.946)	(−4.583)
ser	0.524***	2.239***	0.106***
	(9.308)	(7.822)	(14.894)
Number of samples	5228	5228	5228
R^2			0.094

*, ** and *** represent the confidence levels of 10, 5 and 1% respectively, with Z statistics in parentheses

1. Test of the impact of earthquake disaster insurance literacy on the purchasing behavior of earthquake insurance

The first approach is to replace the variables. Purchase intention can be regarded as the advance indicator of purchasing behavior, which reflects the individual's cognition and attitude towards future risk and uncertainty, so the purchase intention of insurance can be regarded as a surrogate variable for purchasing behavior. In this paper, the purchase intention is selected as the alternative variable of the purchasing behavior of seismic insurance for the robustness test. The test results are shown in Table 9 model (18), and the significance of the regression coefficient of the core variables is consistent with the results of Table 1 model (5).

The second approach is the replacement estimation method. The explained variable is the earthquake insurance purchasing behavior of residents, and the regression is replaced by Logit method and OLS respectively. The estimated results are shown in Table 9 model (19) and (20), which are basically consistent with the significance and symbol of the Probit estimation results of Table 1 model (5), indicating that the model estimation results of this paper have strong robustness.

Table 10 Test of the robustness of the mediation effect

Dependent variable	Sobel checkout	Bootstrap (95%) Confidence interval	
		Lower limit (P)	Superior limit (P)
eipb	0.041 20***	0.288 766 5	0.405 778 5

*** represents the confidence level of 1%

2. The robustness test of the mediation effect

To further investigate the partial mediating effect of risk preference in the relationship between earthquake disaster insurance literacy and residents' earthquake insurance purchasing behavior, robustness tests were conducted using the Sobel test and Bootstrap method to examine the existence of the mediating effect. The results of these tests are presented in Table 10. The Sobel test indicated a significance level of $P < 0.05$, confirming the existence of the mediating effect. The proportion of the mediating effect, as computed by the Sobel test, accounted for 10.62% of the total effect. Additionally, the results were further validated by examining the confidence interval from the Bootstrap method, which involved 3000 random samples. It was observed that the confidence interval from the Bootstrap method did not include the value of zero, indicating the presence of the mediating effect and providing support for the prior research findings.

6 Conclusions and suggestions

This study utilizes three years of survey data on "Earthquake Disaster Insurance Literacy among Chinese Residents" to construct an indicator system for earthquake disaster insurance literacy. With the perspective of risk preference, it provides a detailed analysis of the mechanisms through which earthquake disaster insurance literacy levels influence residents' earthquake insurance purchasing behavior. Empirical research demonstrates that residents' earthquake disaster insurance literacy levels significantly promote earthquake insurance purchasing behavior. Further analysis reveals that, in the process of earthquake disaster insurance literacy influencing earthquake insurance purchasing behavior, risk preferences for financial investment products play a positive mediating role. However, the mediating effect is smaller than the direct effect. Therefore, as an important influence factor on earthquake insurance purchasing behavior, improving earthquake disaster insurance literacy becomes crucial and especially urgent.

Elevating public earthquake disaster insurance literacy can enhance their understanding and cognition of risks. A solid grasp of insurance literacy aids individuals in more effectively planning and managing personal risks, thereby stimulating residential uptake of earthquake insurance. By collectively enhancing public earthquake disaster insurance literacy, the overall societal resilience against disasters can be further strengthened. Consequently, based on the conclusions drawn in this study, the following specific recommendations are proposed:

Improve the level of earthquake disaster insurance literacy through multiple channels. Firstly, government agencies should collaborate with insurance institutions. Disaster preparedness departments should establish in-depth partnerships with insurance organizations,

actively encourage public engagement in the insurance market, and particularly intensify efforts in disseminating earthquake insurance knowledge, skills, and attitudes, especially in regions with elevated earthquake risk. Secondly, there is a need to expand the reach of financial education. Government agencies and insurance entities can leverage multimedia platforms such as the internet for online financial education and regularly organize offline competitions and activities focused on financial knowledge and skills. Thirdly, consider consumer heterogeneity. Government agencies and insurance institutions should tailor their financial knowledge and skills outreach and promotion efforts to different regions, social strata, and resident groups, with a particular emphasis on reaching out to middle-aged and young adults, as well as higher-income segments of the population.

Emphasis should be placed on harnessing the mediating effects of risk preferences. Although the mediating effect of risk preferences accounts for a relatively small proportion of the total effect, the differential impact of this pathway on public purchasing behavior should not be overlooked. Residents with higher risk preferences are more likely to actively seek and screen information, optimize decisions regarding financial product portfolios, and be more inclined to try and accept innovative insurance products. By engaging in market investments, they can obtain favorable returns, thereby setting a positive example and gradually encouraging other residents to develop proactive financial consumption attitudes and rational investment beliefs. Insurance companies can develop personalized and convenient risk preference assessment tools to help residents accurately identify their own risk tolerance levels and provide scientific basis for choosing suitable insurance products. Governments can timely introduce preferential policies such as tax incentives and premium subsidies to reduce the initial costs of purchasing earthquake insurance for residents, especially for groups with lower risk preferences and less acceptance of new things. Through policy incentives, they can gradually encourage them to accept and purchase earthquake insurance.

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Declarations

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