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Effect of natural hazards on the household financial asset allocation: Empirical analysis based on CHFS2019 data

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Natural hazards are a common challenge to human survival and development. China is a country, that is, prone to natural hazards because of its vast territory and vast area. In fact, China is one of the countries most affected by natural hazards. The impact of natural hazards is often multidimensional, and the occurrence of natural hazards can have a dramatic impact on government finances and household property structures. However, existing research in China has mainly focused on individual factors and the household level, and there are gaps in the impact of natural hazards on the economic status of households. Based on the China Household Finance Survey-2019 (CHFS) data, this paper investigates the impact of natural hazards on household financial asset allocation using the Probit and Tobit models and the propensity score matching method. It is found that: the occurrence of natural hazards significantly reduces the likelihood of households' investment in stocks and risky assets; older, more economically advanced, and better educated household heads are more willing to make risky investments; and households with lower financial literacy are more affected by natural hazards in terms of investment in risky financial assets than those with high financial literacy. Therefore, it is necessary for the government to do pre-disaster prevention and post-disaster reconstruction, and further improve the social security mechanism and optimize the risk management system, so that more households can participate in the financial market and thus obtain higher investment returns.

KEYWORDS

natural hazards, household financial asset allocation, financial literacy, China, CHFS

1 Introduction

Natural hazards refer to abnormal phenomena occurring in nature, including various meteorological and geological hazards, such as earthquakes, floods, typhoons, *etc.* Natural hazards have a significant impact on human society, and they have become one of the most worrisome global problems as the frequency and severity of natural hazards have increased globally. They result in human casualties, economic losses, and environmental

damage (Chen et al., 2020). Due to global climate change and its unique geography, China is affected by major natural hazards. Recently, frequent natural hazards have affected China's production, 2021 natural hazards have caused 107 million victims, 162,000 houses collapsed, 11,739,000 ha of crops affected, and direct economic losses of 334.02 billion yuan.

Existing studies on natural hazards have focused on a single type of hazard. The research mainly includes the causes and spatial and temporal evolution of natural hazards, risk assessment and avoidance, and impact factors and response analysis (Lohmann et al., 2019; Palanca-Tan, 2020). Researchers have conducted relatively in-depth and systematic studies on the impact of natural hazards mainly from various aspects such as economic, agricultural, industrial, and income disparities. However, empirical studies on the impact of natural hazards on household financial asset allocation are scarce. Household financial asset allocation is an important reflection of household property allocation, and the impact of hazards can be measured from an economic perspective.

Therefore, it is essential to understand the impact factors of natural hazards in China, which has witnessed frequent natural hazards. What happens to the economic structure of households when natural hazards hit society and the economy? What precautions do residents take as a family unit? This study aims to investigate whether the occurrence of natural hazards has an impact on household financial allocation in the context of frequent natural hazards. Based on CHFS2019 data, the difference between Chinese households' investment in stocks and risky assets is analyzed. Then, the impact of natural hazards on household financial asset allocation is quantified through various empirical methods based on the idea of quasi-natural experiments. This study not only provides an empirical analysis of the current situation of household financial asset allocation in the Chinese region, but also provides valuable references for decision-making on disaster prevention and promoting financial development.

2 Literature review

2.1 Household characteristics and financial asset allocation

Chinese residents generally have a strong sense of family values, and as economic and social development continues apace, households are moving beyond a "state of scarcity". In particular, the rapid development of financial markets and the increasing abundance of financial products since the reform and opening up have led to a dramatic change in the asset structure of Chinese households, making household asset choice an important issue that affects the welfare of household members and society as a whole (Qiao and Su, 2019).

Household finance is a relatively late start in the field of financial research. Based on a review of the relevant literature, it is found that political background (Ge et al., 2021), household age characteristics (Bertaut and Haliassos et al., 1997), health level of household members (Berkowitz and Qiu, 2006), marital status (Wang and Wu, 2014), educational attainment (Calvet and Sodini, 2014), credit constraints (Yin et al., 2015), urban and rural health insurance (Li and Yang, 2021), financial literacy (Hu et al., 2018; Li, 2021), and art collection (Zhang and Hong, 2017) all influence household financial asset. In addition to this, household economic characteristics have an impact on household risky investments. Household wealth has a significant positive effect on household risky asset investment (Liu, 2015; He and Shilu, 2019), and personally owned capital also affects household risky asset investment (Shum and Faig, 2006). The asset allocation referred to in this study will be based on the amount of financial assets available to households. The asset allocation in this study will be based on the household unit, i.e., the behavior of households in adjusting the type and proportion of assets held according to the market environment and their own status. Due to the dynamic nature of household assets, each household will allocate its assets based on the objectives of safety, profitability and liquidity. The rational allocation of household financial assets is of great significance to the accumulation of wealth and the development and innovation of financial markets.

2.2 Risk assets investment and nature hazards

Under the premise of "rational economic man", households will participate in a variety of asset investments and allocate their assets according to investors' risk preferences. The core objective of household financial asset allocation is to optimize asset allocation by choosing different investment portfolios, thereby continuously increasing household income and consumption (Markowitz H., 1952). The structure of household financial assets has gradually shifted from being confined mainly to cash and savings before the reform and opening up 40 years ago, to a combination of assets such as stocks, financial products and commercial insurance. Financial assets can be divided into non-risky financial assets and risk assets according to their riskiness (among them, bank deposits and cash can be regarded as non-risky financial assets, while stock and funds held by households can be regarded as risk assets).

The development and evolution of financial investment instruments has led to an increasing variety of financial investment channels for households, which in turn has led to a significant change in the structure of household wealth, with financial assets accounting for a significantly higher proportion of household assets (Yilmazer and Lich, 2015). Moreover, the

risky financial assets held by households are growing rapidly, and the financial asset choices made by households will have a significant impact on their future living standards (Zhang, 2020). A large number of real-life experiences from abroad show that a reasonable allocation of household financial assets plays a very important role in increasing the income of households and the wealth of residents, and that differential household financial asset allocation choices are also an important cause of income disparity (Tsoumas and Antzoulators, 2010). The current situation in China shows that the allocation of household financial assets is not reasonable.

The economic consequences of nature hazards have been a hot and difficult issue of concern to all sectors of society, but existing studies have focused on the macroeconomic and personal impacts of nature hazards. However, most of the existing studies have focused on the macro level of the impact of disasters, while the impact of disasters on the micro level of the economy has not been given due attention. The economic characteristics of households, particularly their wealth levels, influence the allocation of financial assets to households (Wachter and Yogo, 2010). In the face of nature hazards, households reduce the impact by, for example, reducing consumption (Eny Sulistyaningrum, 2015; B. N. Porfiriev, 2016). At present, most domestic and international studies on the structure and choice of household asset allocation mainly analyze the impact of household characteristics or financial literacy on household asset allocation, but there is no research from the perspective of nature hazards shocks (Paul, 2015; Huang and Lu, 2021).

2.3 Risk appetite and economic decision making

Attitudes are an important aspect in determining behavior. In general, domestic and international scholars have conducted studies related to household financial asset allocation from various perspectives, such as household characteristics and wealth levels, pointing out the results of these influences, but the conclusions obtained differ due to differences in data, and research subjects. Past literature suggests that catastrophe experiences affect individual risk attitudes and that the impact of a disaster on an individual may affect their risk expectations, i.e., individuals who have experienced a disaster have an increased level of expected risk for possible future disasters (Gallagher, 2014; Brown et al., 2018). According to the "precautionary savings theory", risk expectations of hazards also have an impact on households' precautionary savings, i.e., the higher the expected risk, the higher the households' precautionary savings tend to be. A study of natural disasters in 15 developed countries found a significant positive relationship between disaster experience and saving rate (Skidmore, 2001), but it has also been shown that the effect of disaster experience on

saving rate depends not only on risk expectations but also on the type of risk preferences of consumers (Gunning et al., 2010).

In the present study, it is assumed that individuals who have experienced natural disasters will have very different financial risk intentions, using CHFS2019 data, We focus on the current state of household asset allocation in China's national context and explore the mechanism of nature hazards on household financial asset allocation using the Probit model, Tobit model, and PSM model. The findings of this paper help to further understand the mechanism of the formation of households' financial investment risk preferences, and provide some insights into the value of increasing households' participation in the financial market and guiding them to allocate their financial assets rationally, with a view to providing a new perspective on the impact of nature hazards on financial investment.

The innovation of this paper is that, on the one hand, existing studies on natural disasters tend to focus on the hazards caused by natural disasters, and have not yet studied the changes in household structure economy due to natural disasters by residents as a household unit, which is very important for both individuals and countries, and the changes in household financial asset allocation can, to some extent, measure the severity of disasters in order to make timely and corresponding adjustments to the household asset structure; on the other hand, previous literature on Chinese households' financial asset allocation has mainly focused on exploring the effects of cultural beliefs, financial literacy, health status, credit levels, and certain collective experiences on asset allocation. In conclusion, there is less literature linking natural hazards to Chinese household financial asset allocation, and this paper will explore the relationship between the two from a new perspective using multiple regression models in order to guide the decision making accordingly.

3 Data

3.1 Data Source

All data selected for this study are from CHFS2019 data. In total, the database collected information on 107,008 household members from 34,643 households, including general demographic characteristics, financial status, assets, income, consumption, employment, insurance, and other household information. Household financial assets can be divided into risk-free financial assets and risky financial assets based on whether or not to take risks. Cash and deposits are risk-free financial assets, and stocks, funds, bonds, wealth management products, gold, foreign currency assets, and financial derivatives are risky financial assets.

In this paper, according to the research purpose, CHFS2019 data is processed as follows: First, the household

TABLE 1 Description of each variable and descriptive statistics.

Variable	Definition and measurement	Mean	Sd
Dependent variables			
Stock investment (STI)	Whether to participate in Stock investment (1 = yes, 0 = no)	0.036	0.186
Stock investment allocation (STA)	Share of stock assets in household financial assets	0.001	0.001
Risk assets investment (RAI)	Whether to participate in venture capital investment (1 = yes, 0 = no)	0.091	0.288
Risk asset allocation (RAA)	Proportion of risky financial assets in total household financial assets	0.143	20.182
Explanatory variables			
Natural hazards (HAZ)	Has your home been affected by any natural hazards since 2014 (1 = yes, 0 = no)	0.045	0.207
Control variables			
Gender (GEN)	The gender of the head of the household (1 = male, 0 = female)	0.765	0.430
Age (AGE)	The age of the head of the household	56.350	13.739
Rural (RUR)	Whether it is a rural area (1 = yes, 0 = no)	0.348	0.476
City level (CIT)	City level of the family (1 = tier 3 and below cities, 2 = second-tier cities, 3 = first-tier and new first-tier cities)	1.718	0.878
Education level (EDU)	The education level of the head of the household (1 = no schooling, 2 = primary school, 3 = junior high school, 4 = high school, 5 = technical secondary school/vocational high school, 6 = junior college/higher vocational, 7 = undergraduate, 8 = postgraduate, 9 = PhD student)	3.376	1.630
Marital status (MAR)	The marital status of head of household (1 = married, 0 = others)	0.850	0.357
Health condition (HEA)	Health conditions of the head of the household (1 = very poor–5 = very good)	3.265	1.001
Financial literacy (LIT)	The household head usually pays attention to economic and financial information (1 = never concerned, 2 = little concerned, 3 = middle, 4 = very concerned, 5 = most concerned)	1.790	1.009
Risk appetite (APP)	The risk appetite of the head of household (1 = extreme risk aversion, 2 = risk averse, 3 = middle, 4 = preference for risk, 5 = special preference for risk)	1.574	0.985
Total income (INC)	Logarithm of annual household income	10.616	1.449

head samples in the individual variable database are screened out and correspond to the household variable database one-to-one (the individual variable database and the family variable database both contain ID numbers, So here the sample is matched by the ID number in the databa). Second, blank missing samples in terms of dependent and explanatory variables are removed and interpolation is performed for some of the missing values. Thirdly, the group median processing is adopted for the partial range data in the sample, and the logarithmic processing is carried out on the household income data, and the problem of heteroscedasticity and nonlinearity can be solved. Finally, the study obtained a valid sample of 32,465 households across the country, including those affected and not affected by natural hazards.

3.2 Variable definition and descriptive statistics.

3.2.1 Dependent variables

The variables being explained are household investment in equity assets and total risky financial assets. Investment here contains two levels of meaning, namely participation and allocation. Equity asset participation is taken as 1, indicating that the household has invested in equities, and 0 otherwise; a household's risky asset participation is one if it has invested in any risky assets, and 0 if it has not made any risky investments. The allocation is in terms of the proportion of equity assets in the household's financial assets and the proportion of risky assets in the household's financial assets, so that the values of equity assets and risky financial assets range from 0 to 1.

3.2.2 Explanatory variables

The core explanatory variable of this study is whether the respondents and their households have been affected by natural hazards from 2014 to 2019. In the questionnaire, the interviewer determined whether the respondents and their households had been affected by natural hazards through the following questions. "Has your household been affected by a natural hazard since 2014?" If the respondent answered "yes", a value of one was recorded; otherwise, a value of 0 was recorded.

3.2.3 Control variable

Existing empirical research shows that asset allocation behavior is affected by a variety of factors (Tang and Pan, 2021). Since these factors are mainly focused on the individual level and the household level, the control variables in this study are mainly the personal characteristics and family characteristics of the head of household, including gender, age, education level, health status, marital status, risk preference, *etc.*

The specific variable selection and descriptive statistics are shown in Table 1.

3.2.4 Descriptive statistics

As can be seen from Table 1, the participation rates of my country's household stock assets and risky financial assets are 3.6% and 9.1%, respectively, indicating that households engaged in risky financial asset investment are still a minority in my country, and their asset allocation is relatively unbalanced. In terms of household demographics, households headed by a male account for 76.5% of the total sample, with an average age of 56.35 years; the education level is mostly distributed around 3.376, indicating that the education level of most household heads is at the level of high school or technical secondary school. The degree is generally low; the average value of marital status is 0.850, indicating that 85% are married families. The financial literacy of the head of household is low, and the level of attention to finance is low; the mean value of health water for household heads in the sample is 3.265 and the mean value of risk appetite for household heads is 1.574, indicating that Chinese households as a whole are biased toward risk aversion. In addition, the logarithmic deviation of annual household income in the sample shows that the wealth distribution of Chinese residents is uneven, and the wealth gap is obvious.

4 Methods

To prove whether there are significant relationships between natural hazards and stock assets and risky financial assets, we first use the Probit model to study the participation of stock assets and risky financial assets. The model is set as follows.

$$prob(risk = 1) = \alpha HAZ + \beta X_{1i} + \mu_i \quad (1)$$

where, HAZ indicates whether natural hazards occur, X_{1i} is a series of control variables, and μ_i is a random error term.

Secondly, the Tobit model is used to study the allocation of stock assets and risky financial assets in financial assets. The model is set as follows.

$$risk\_ratio = \alpha HAZ + \beta X_{1i} + \mu_i \quad (2)$$

where, $risk\_ratio$ represents the proportion of stock assets or household risk financial assets to total financial assets, and the rest of the variables are the same as the above formula.

Finally, in order to further strengthen the verification of the impact of natural hazards on household financial asset allocation, we consider eliminating the endogeneity problem that may be caused by sample selection bias and omitted variables, and then adopt the propensity score matching method. PSM is a non-linear estimation method proposed by Rosenbaum and Rubin 1982) that overcomes the problem of selection bias and allows for more effective evaluation of treatment effects. In this study, propensity score matching was conducted using a two-step approach. Households affected by

TABLE 2 Regression of the impact of natural hazards on stock investment and risk asset investment participation and allocation.

	(1)	(2)	(3)	(4)
	STI	RAI	STA	RAA
	Probit	Probit	Tobit	Tobit
HAZ	−0.882***	−0.291***	0.000***	−19.022***
GEN	−0.126***	−0.199***	0.000***	−10.141***
AGE	0.012***	0.011***	0.000***	0.648***
RUR	−0.808***	−0.498***	0.000***	−27.121***
CIT	0.287***	0.216***	0.000***	10.967***
EDU	0.129***	0.140***	0.000***	7.487***
MAR	0.236***	0.135***	0.000***	7.539***
HEA	0.007	0.019	0.000	2.209**
LIT	0.308***	0.285***	0.000***	14.281***
APP	0.228***	0.188***	0.000***	9.448***
INC	0.100***	0.242***	0.000***	12.097***
_cons	−5.887***	−6.511***	−0.003***	−372.340***

The t-test indicates whether the difference between the treatment and control groups is significant.

***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

natural hazards were identified as the treatment group ($HAZ = 1$) and households not affected by natural hazards were identified as the control group ($HAZ = 0$). The above 10 factors, including the personal characteristics of the household head, were selected as control variables, and by matching members of the treatment and control groups with similar individual characteristics, the self-selection problem of the sample was able to be eliminated to a certain extent, and the differences between the two groups in terms of stock assets and risky financial assets were further analyzed. As different matching methods apply different matching values and weights, the matching results may differ. Therefore three methods, nearest neighbor matching ($k = 1, k = 4$) and kernel matching, are applied. The calculation of nearest neighbor matching can be formalised as:

$$C(P_i) = \min \|P_i - P_j\| \quad (3)$$

where, P_i and P_j are PS values of ith "treatment group" and j^{th} "control group" respectively. $C(P)$ refers to the neighborhood relationship between i and j.

The average treatment effect (ATT) is used to calculate the impact of natural hazards on the stock assets and risky financial assets.

$$ATT = E(Y_i - Y_j | T_i = 1) = E(Y_i | T_i = 1, P(X_i)) - E(Y_j | T_j = 0, P(X_j)) \quad (4)$$

where, Y is the outcome variable, other variables and parameters are the same as the above formula.

5 Results and discussion

5.1 Main regression analysis

The results of regression 1) in Table 2 show that the occurrence of natural hazards reduces the odds of households making stock investments and is significant at the 1% level. Since the coefficient of the Probit model regression result itself has little economic meaning, the analysis also sought the average marginal effect, which is the amount of change in the dependent variable for each unit change in the independent variable. The average marginal effect is calculated to be about −0.0504, indicating that the occurrence of a natural hazard reduces the odds of household stock investment by 5.04%. Corresponding to regression result 2), natural hazards have a disincentive effect on households to invest in financial risk assets, with a mean marginal effect of about −3.45%, which is significant at the 1% level. It can be seen that along with the increase in natural hazards, households tend to invest less in equities or other risky financial instruments.

Regression 3) and regression 4) show the regression results of the effect of natural hazards on the allocation of stock assets and risky financial assets, respectively. The results show that the occurrence of natural hazards is negatively related to households' risky financial asset allocation, and this effect is significant at the 1% level in both cases. It indicates that the occurrence of natural hazard events reduces the household's weight in risky financial investments, which is consistent with the results of risky financial assets participation.

In addition, observing the regression results of the control variables shows that the gender of the household head has a significant effect on the investment behavior of the household, as male household heads are more conservative than females and relatively rational in making investment decisions. The increase in the age of the household head effectively promotes the household's investment in stocks and other risky financial assets, which may be due to the fact that most of the household heads in the sample are approaching their old age, have accumulated more wealth and are not under greater financial pressure. The higher the education level of the household head, the more willing he or she is to engage in riskier investments. Married households are more likely to invest in equities and other risky assets because of their wider sources of household income and more stable family structure than those living alone, and because they are able to bear the corresponding risks. Heads of households with higher financial literacy and more attention to financial information usually use their financial knowledge in a comprehensive manner to allocate their assets rationally to achieve the optimal asset mix, minimize the risk caused by information asymmetry through their own financial knowledge, and increase their investment in high-risk financial assets by virtue of their confidence in their investment philosophy. Investors with a higher degree of risk appetite, who usually have a higher risk tolerance, tend to invest in stocks and other high-risk assets. Households living in urban areas are

TABLE 3 Heterogeneity analysis of financial literacy levels.

	Low level		High level	
	(1)	(2)	(3)	(4)
	STI	RAI	STA	RAA
HAZ	−0.257**	−19.302**	−0.348	−0.073
GEN	−0.197***	−11.482***	−0.168	−0.030
AGE	0.012***	0.774***	0.008***	0.005***
RUR	−0.437***	−26.758***	−0.778***	−0.346***
CIT	0.202***	11.799***	0.331***	0.145***
EDU	0.167***	10.123***	0.151***	0.059***
MAR	0.135***	8.496***	0.187	0.063
HEA	0.030**	3.124***	0.036	0.023
APP	0.239***	14.029***	0.237***	0.085***
INC	0.259***	14.825***	0.215***	0.087***
_cons	−6.386***	−414.671***	−5.441***	−2.359***

The t-test indicates whether the difference between the treatment and control groups is significant.
***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

significantly more likely to make stock and risky investments than rural households; and the higher the urban level, the higher the likelihood of participating in risky financial markets, with both variables significant at the 1% level of significance. The main reason for this status quo is that the level of financial development in cities and towns is relatively developed, the allocation of financial resources is more efficient, and there are more physical outlets of various financial institutions, so residents can easily access investment information and learn about financial products in many ways, while rural areas usually have fewer physical outlets and less convenient access to information; secondly, the higher the urban level, the higher the wealth level of households tends to be, and they have more funds to try risky investments. While rural and below third-tier households will be relatively conservative. At the 1% significance level, households with higher total income are more likely to invest in equities and risky assets, indicating that households with higher wealth levels usually keep more idle funds and can afford to take a certain range of risks. With their standard of living secured, they are more willing to invest part of their idle funds in financial markets to achieve wealth appreciation.

5.2 Heterogeneity analysis of financial literacy levels

The level of financial literacy of household heads is one of the important indicators of household investment decisions. When households invest in risky financial assets, household heads with different levels of financial literacy will exhibit different household investment behaviors under the same natural hazard conditions.

TABLE 4 Balance test results of propensity score matching (PSM).

Variable	Unmatched	Mean			%Reduction	t -test	
	Matched	Treated	Control	%Bias	|bias|	t	$p > t$
GEN	U	0.82276	0.75283	17.2		6.06	0.000
	M	0.82276	0.84155	−4.6	73.1	−1.35	0.176
AGE	U	55.952	56.368	−3.3		−1.13	0.259
	M	55.952	56.029	−0.6	81.3	−0.17	0.862
RUR	U	0.70621	0.33107	81.0		29.71	0.000
	M	0.70621	0.70776	−0.3	99.6	−0.09	0.927
CIT	U	1.2641	1.7392	−63.2		−20.26	0.000
	M	1.2641	1.2555	1.1	98.2	0.39	0.694
EDU	U	2.66	3.4091	−54.1		−17.18	0.000
	M	2.66	2.6384	1.6	97.1	0.52	0.603
MAR	U	0.86345	0.84901	4.1		1.50	0.133
	M	0.86345	0.86776	−1.2	70.1	−0.34	0.734
HEA	U	2.9331	3.2808	−34.5		−12.96	0.000
	M	2.9331	2.9574	−2.4	93	−0.64	0.523
LIT	U	1.7283	1.7929	−6.2		−2.38	0.017
	M	1.7283	1.6912	3.6	42.6	0.97	0.334
APP	U	1.5083	1.5772	−7		−2.60	0.009
	M	1.5083	1.4731	3.6	48.9	0.98	0.327
INC	U	10.12	10.639	−37		−13.38	0.000
	M	10.12	10.161	−3	92	−0.81	0.421

To test the above hypothesis, all households are divided into two groups according to the level of financial literacy of the household head. The first group has relatively low financial literacy, with < = 3 , and pays relatively little attention to financial information; the second group has a financial literacy level index of four or more, and the regression results are shown in Table 3.

The results show that for the group with lower levels of household financial literacy, natural hazards significantly inhibit households' participation and allocation of risky financial assets at the 5% level; while for households with higher levels of household financial literacy, natural hazards do not have a significant impact on investment in risky financial assets, and relatively few factors can influence households' risky investment decisions, this reflects that households with higher levels of financial literacy are more willing to experiment with risky investments and have a certain level of risk tolerance.

5.3 Propensity score matching analysis

The effectiveness of the *PSM* method depends on two prerequisites. One is the balance test and the other is the common support test. Since test results of different matching methods are mostly consistent, only the robustness test results

of nearest neighbor matching ($k = 4$) are shown in this section.

The test of balance requires that the treatment and control groups do not differ systematically in terms of matching variables after completion of matching. Rosenbaum (1985) tested for balance before and after matching by standardized deviations. Thus, whether balance passes the test is determined primarily by the change in covariate bias and the change in t-statistical significance level before and after matching (Caliendo and Scheel-Kopeinig, 2008). According to the findings in Table 4, it can be concluded that the standardized deviations of all covariates after matching are less than 5% and the t-test statistics of most control variables before matching are significant. In addition, the p-values of the t-test statistics for the control variables after matching were large, indicating that the control variables were not significant after matching. Thus, propensity score matching significantly reduced the differences in the distribution of explanatory variables between the treatment and control groups, and the overall matching effect was good.

The kernel density plots for stock investment and risk asset investment are shown in Figure 1, respectively. The kernel density plots show the fitted conditions for the density distribution of P-scores before and after matching between the treatment and control groups. It is clear that there is a significant difference in the *PS* probability density distribution between the
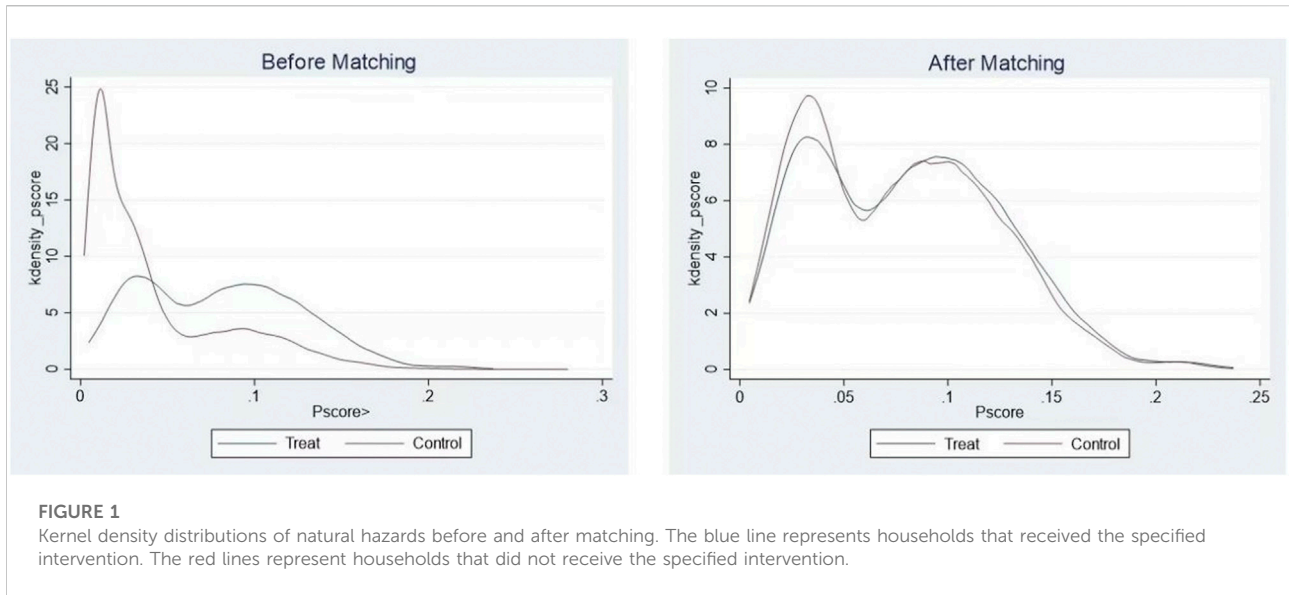
FIGURE 1
Kernel density distributions of natural hazards before and after matching. The blue line represents households that received the specified intervention. The red lines represent households that did not receive the specified intervention.

TABLE 5 Comparisons of average treatment effect (ATT).

Matching method	Dependent variables	Stock investment	Risk assets investment
Nearest neighbor matching (k = 1)	ATT	−0.014482759***	−0.017241379***
	T-stat	−4.03	−2.88
Nearest neighbor matching (k = 4)	ATT	−0.008793103***	−0.013448276***
	T-stat	−5.08	−3.22
Kernel matching	ATT	−0.016507801***	−0.033880854***
	T-stat	−11.07	−8.90
	Mean ATT	−0.013261221	−0.021523503

The *t*-test indicates whether the difference between the treatment and control groups is significant.
***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

two groups after matching. That is, there was significant coverage between the two groups, and the *PS* probability distributions of the two groups gradually converged. Therefore, it is proved that the matching variables and matching methods selected in this study are more reasonable, which can reduce the differences in the distribution of explanatory variables between the two groups to a certain extent and are conducive to reducing the bias of sample selection.

Estimation based on multiple matching methods can improve the robustness and reliability of the results. Therefore, several different matching methods are used in this section to estimate the *ATT* of natural hazards on stock investment and risky asset investment, including nearest neighbor matching ($k = 1$, $k = 4$) and core matching. The *ATT* results for the treatment groups after matching using different matching methods are shown in Table 5.

Although the calculated results of different matching methods were slightly different, their overall trends were

consistent. First, the impact of natural hazards on household stock investment is analyzed. As can be seen from Table 5, the average $ATT = -0.0133$, indicating that natural hazards have a significant negative impact on household stock investment. In other words, under the same conditions, household investment in stocks is lower in the treatment group than in the control group by 0.0133. Similarly, households in the treatment group invest less in risky assets than in the control group. This means that natural hazards significantly reduce households' investment in risky financial assets (mean $ATT = -0.0215$). Thus, the previous findings are validated.

In conclusion, we find through *PSM* that natural hazards are significantly and negatively associated with households' investment in equities and risky assets. In addition, it is worth noting that the impact of natural hazards on investment in risky assets is greater than the impact on stock investment (0.0215 > 0.0133).

6 Conclusion and recommendations

Using CHFS2019 data to examine the relationship between natural hazards and household financial asset allocation, the results show that 1) natural hazards significantly reduce household investment in stock assets and risky financial assets, and natural hazards have a greater impact on total risky financial assets than stock assets. 2) Compared to households with high household financial literacy, households with lower financial literacy are more affected by natural hazards in terms of investment in risky financial assets. 3) Older, more economically advanced and better educated household heads are more willing to make risky investments.

Almost all countries have experienced the effects of various types of natural hazards, so based on the above findings, the following policy recommendations are made.

1) The government should do a good job in hazard prevention and reconstruction, actively explore local characteristics, drive local economic development and narrow the gap between the rich and the poor. And to encourage families to reasonably participate in the financial market, it should simultaneously promote the construction of public mental health, promote the development of psychological resilience, create a good investment environment, and enhance residents' confidence in investment. While promoting the rapid development of the financial market, optimize the risk management system, establish a risk early warning mechanism, clarify risk management objectives, effectively maintain the smooth operation of the financial market, and promote a sound long-cycle assessment mechanism for investors in various professional institutions, so that residents can participate more in financial investment.

2) Improve the financial literacy and education level of residents. Through education and learning to improve the residents' investment level and establish the correct investment concept. Residents should keep up with the times, change the traditional investment concept of avoiding risks by saving and giving up high returns, take the initiative to learn financial knowledge, improve financial literacy, and make reasonable allocation of family financial assets to obtain higher investment returns.

3) Encourage financial institutions to innovate financial products, accelerate the innovation of financial instruments to meet the diversified needs of family financial assets, innovate and develop various types of securities, bonds and notes, *etc.*, and encourage financial institutions to develop innovative insurance varieties around the needs of residents.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: https://chfs.swufe.edu.cn.

Author contributions

TL designed the research, collected data, revised and polished the article. JL constructed empirical models and obtained the results. DL drafted the paper and conducted the data interpretation. All authors have read and agreed to the published version of the article.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementarymaterial

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fenvs.2022.963465/full#supplementary-material

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