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Influence of risk perception and policy support on the deviation of rural households' demands and adoption behavior of the forestry socialized service

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This study explores the impact mechanism of risk perception and policy support on the deviation of rural households' demands and adoption behavior (RHDAB) of the forestry socialized service (FSS). It provides a decision-making basis for promoting the construction of a collective FSS system and realizing the value of ecological products. Survey data from 787 rural households in Zhejiang, Fujian, and Jiangxi provinces were used to quantify the influence of risk perception and policy support on the deviation of RHDAB of the FSS using the Mv-probit model and Poisson model. The results revealed that: 1) there were deviations between RHDAB for different types of FSS, with 57.71% and 66.20% for good seeds and cultivation technology services and product collection and marketing services, respectively. 2) Risk perception accelerated the deviation and degree of deviation between RHDAB of the FSS, particularly the technology risk perception. Meanwhile, policy support was shown to mitigate the effect of risk perception on rural households' deviation and deviation degree. 3) Business risk perceptions had a more significant impact on the deviation of RHDAB in middle and high-economic development areas compared to technology risk perception and financial risk perceptions in low-economic development areas. Additionally, business risk perception was found to have a significant positive effect on the deviation of small and large operation-scale rural households, while technology risk perception significantly impacted the deviation of small operation-scale rural households. Consequently, this study suggests the need for a sound forestry risk management system to address the variability of the deviation of RHDAB across different regions and operation scales, as well as to improve the service quality of forestry insurance, accelerate the speed and benefit of inclusive rural finance, and cultivate new supply bodies of socialized services, thereby promoting the construction of collective FSS system and realizing the value of ecological products.

KEYWORDS

adoption behavior, risk perception, ecological product realization mechanism, China, forestry socialized service

1 Introduction

The Reform of the Collective Forest Property Rights System (RCFPRS) in China began in 2003 as a pilot project and was implemented nationally in 2008. It attempted to establish a set of management and development mechanisms designed to promote forestry and enrich the populace by "clarifying property rights, liberalizing management rights, implementing disposal rights, and guaranteeing revenue rights" (Liu et al., 2017; Hyde and Yin, 2018). The RCFPRS aimed to provide better security of ownership of forestland, and a more clear and harmonized property rights system, to increase farmers' motivation to manage forests, and enhance the productivity of forest ecosystems. It sought to incentivize farmers to cultivate forest land, thus increasing their household income in the context of a rural land property rights system that promotes income growth. However, as the RCFPRS process advances, irregular transfers of forest rights and an imperfect supporting policy system have emerged, hindering the development of forestry modernization. Therefore, accelerating and perfecting the FSS system is an important content of deepening the RCFPRS and an inevitable requirement for comprehensively improving the level of collective forestry management modernization. In response, the Chinese central government has implemented a series of supportive policies, such as stressing in the No. 1 Central Document the need to improve the socialized agricultural service system, enhance the supply capacity and level of agricultural socialized services, and accelerate the development of socialized agricultural services. Additionally, the Fourth Plenary Session of the 19th Central Committee of the Communist Party of China put forward the significant task of further deepening the RCFPRS in rural areas. In this context, the FSS system plays an irreplaceable and essential role in consolidating the achievements of the RCFPRS. Moreover, in 2021, the Opinions on Establishing and Improving the Mechanism for Realizing the Value of Ecological Products highlighted the necessity of establishing and improving the mechanism for realizing the value of ecological products in forestry.

FSS has been identified as an important mode to enhance the value realization of ecological forestry products, thereby accelerating the cultivation of ecological product market operators, also conducive to ecological and environmental protection (Du et al., 2022). However, despite the implementation of the RCFPRS, Chinese forestry production continues to face the fundamental contradiction between small-scale family operations and large markets. Numerous problems persist, such as high labor costs, low efficiency of forest product production and management, forestland fragmentation, restricted logging, lack of information regarding market supply and demand, and weak ability to resist market risks and natural disasters. These issues have hindered the effective improvement of forest farmers' enthusiasm (Yin et al., 2013a; Yin et al., 2013b; Xie et al., 2014; Liu et al., 2016). There is an urgent need for FSS to resolve various risks and resource constraints in the process of realizing forestry ecological products. A study of 1,400 surveyed households found that 75.26% had an urgent demand for the FSS, yet 87.6% had not adopted the service (Liao et al., 2016). This discrepancy between demand and adoption, or the obstacles in the process of transforming demand into adoption behavior, has significantly impeded the progress of improving the FSS system, limited the advancement of collective forestry operation development levels, and slowed the construction of forestry modernization (Kong et al., 2017). As such, it is necessary to further explore the inner mechanism of the deviation of RHDAB of the FSS, which has important practical implications for deepening the RCFPRS.

Deviations between RHDAB are due to various complex factors influencing rural households' demands during the transformation into adoption behavior, resulting in a discrepancy between their final behavior and initial demands. This may convey incomplete information to policymakers, harming the implementation effect of relevant policies and leading to policy failure and inefficiency. On the surface, the deviation may be attributed to factors on the supply side of the service, such as the ability of the service to solve rural households' practical problems in household management. However, it is mainly caused by factors on the demand side of the service, such as risk perception in the forestry management process. Different types of risk perception can modify the RHDAB of socialized services. However, the academic community has not yet been able to give a definite answer to how risk perception factors affect RHDAB of the FSS and what is the specific impact mechanism. Therefore, this paper utilizes a standard econometric analysis method to investigate the influence of risk perception on the RHDAB of the FSS and explore the moderating role of policy support to provide suggestions to further improve the FSS system.

The marginal contribution of this study lies in the in-depth analysis of the impact of risk perception on the deviation of RHDAB for FSS, and the policy support is placed under the same research framework to further investigate the role of government support, which makes the research content more perfect. In addition, the Mv-Probit model and Possion model were selected for empirical analysis, which not only took into account the interaction between different types of FSS but also analyzed the influence on the degree of deviation, which is conducive to improving the accuracy of research results.

2 Literature review

Land scale operation refers to the mode in which the optimal combination of various production factors (land, labor, capital, technology, etc.) operates effectively under certain environmental and socio-economic conditions and achieves the best economic benefits. There are two ways to realize land scale management, and two views on scale management have been gradually formed in academic circles: one is land scale management by new agricultural operators through land transfer to change the management pattern of dispersed small-scale farmers in China, to improve the efficiency of resource allocation (Yao, 2017). However, the national land transfer situation is not optimistic, and there is a gap between academic theory and reality, but this does not negate the significance of "land scale management." The other is that economies of scale are derived from the economy of the division of labor. The production efficiency of factors can be improved by the specialization of production links (Youno, 1928). The subdivision of farmers' management rights and the division of labor in society can help promote service scale operation in agriculture, which can significantly improve the external division of labor and economies of scale in agriculture, and thus promote the

transformation of agricultural scale operation from "land scale" to "service scale." (Luo, 2017), and this is especially true for forestry scale management.

As one of the essential ways to innovate large-scale management, the FSS has received much attention from scholars and government departments. After the RCFPRS, rural households' demand for the FSS has diversified. The demand for production and marketing services is robust (Martell et al., 2016). Demand intensity is positively correlated with the proportion of the total household income related to technical service and whether the rural households have encountered technical problems in production. Household resource endowment significantly affects the RHDAB of technical services, such as the increase in labor cost due to household labor transfer (Schmook and Radel, 2008; Xie et al., 2014), which promotes the capitalization of rural households' forestry input structure (Haas, 2006; Hull, 2007). However, this promotion effect is regulated by the supply level of the FSS, the plots' location, and the forest resources' endowment (Zhang et al., 2001). The difference in household factor allocation, production mode, and production purpose will also lead to the heterogeneity of social service demand (Skoufias and Olivieri, 2013). Land size is one of the most important factors in determining the productive investment patterns of rural households. Still, existing studies have not reached a consistent conclusion. Some studies suggest a negative relationship between the two (Xie et al., 2014), with the fragmentation of forest land increasing the cost of implementing technology services and thus discouraging the adoption of new forestry technologies by rural households. Some studies suggest a positive relationship between the two, with small-scale rural households investing in machinery production and processing not being a rational choice, leading to a higher demand for outsourced machinery services (Olmstead, 1975). There is an inverted "U" shaped relationship between the two and an inflection point between the scale of forest land management and rural households' productive outsourcing behavior (Luo et al., 2016). Therefore, the factors related to the scale of operation are important factors affecting the adoption of services. This study will then analyze the operation scale and regional economic development level heterogeneity.

The above studies examined the influence of different factors on rural households' social service adoption behavior. The large investment and long cycle of forestry production, the coexistence of natural risk, social risk, and business risk perception, and the high probability of occurrence during the business cycle have an important impact on rural households' social service adoption behavior (Duan et al., 2021). Still, the existing studies have not paid enough attention to rural households' risk perception. Prospect theory suggests that individual decision-making behavior is determined by a combination of risk preferences and subjective judgments of objective probabilities. Socialized service adoption behavior has the effect of resisting natural, social, and business risk perceptions (Kahneman and Tversky, 2013). Therefore, rural households' risk perceptions are closely related to social service adoption behavior. Domestic and foreign scholars have widely studied the influence of risk perception and rural households' decision-making behavior. Roumasset (1977) and Scott (1977) were the first to suggest that farmers are risk averters. Then, Just and Pope, (1979) introduced the risk aversion effect into the agricultural input-output model for the first time. Howard et al. (1991) further pointed out that producers need to analyze farmers' decision-making behaviors under different risk perceptions. In the study on risk perception and farmers' decision-making behavior, it is found that reducing the risk perception of termination of property rights contract will increase farmers' marginal willingness to pay for contract (Qin et al., 2011), which also indicates that their decision-making behavior is constrained by risk perception (Liu and Huang, 2013). The stronger the risk perception, the more willing to take measures to avoid risks (Botzenetal et al., 2009). In recent years, China has taken some supportive policy measures to encourage agricultural production, mainly in the form of various agricultural subsidies, which have been found to promote agricultural production behavior and increase rural households' motivation to produce food (Kurkalova et al., 2006; Ji et al., 2017). However, some studies believe subsidy policies have little effect on promoting farmers' behaviors. For example, agricultural input subsidies can reduce agricultural production costs and improve agricultural productivity in early. Still, they cannot guarantee farmers' economic benefits with increased agricultural input factor prices (Dorward and Chirwa., 2011). The above research literature indicates that academics consider risk perception and policy support to be important factors in studying demands or behavior. Risk perception can be an important reason for the deviation of RHDAB.

In summary, the existing researches have conducted fruitful explorations of the demand and adoption behavior of FSS and their influencing factors, but there is still room for further research. Firstly, there are few existing studies on the deviation of RHDAB of FSS. Meanwhile, in terms of research methods, more binary Logit and Probit models are used; there is no in-depth consideration of the interaction between different types of services. Secondly, more studies only study the FSS from the perspective of demand but do not deeply explore the inconsistency between demand and adoption behavior, which may lead to policy failure. Because of this, this paper uses the survey data of farmers in Zhejiang Province, Fujian Province, and Jiangxi Province, and based on the heterogeneous perspective of regional economic development level and operation scale, uses the Mv-Probit model and Possion model to analyze the influence of risk perception on the deviation of RHDAB of FSS. It also examines whether the government support policy can alleviate the regulatory effect of risk perception and puts forward countermeasures and suggestions to improve the FSS system.

3 Theoretical basis and variable selection

3.1 Theoretical analysis

According to the theory of rural household behavior, rural households' decision-making behaviors, including production behavior, operation behavior, and purchasing behavior, all have economic attributes. As a boundedly rational economic man, rural households will aim at maximizing personal or family income, evaluate the results of decisions or choices based on their values and preferences, and finally choose the conclusion that they think

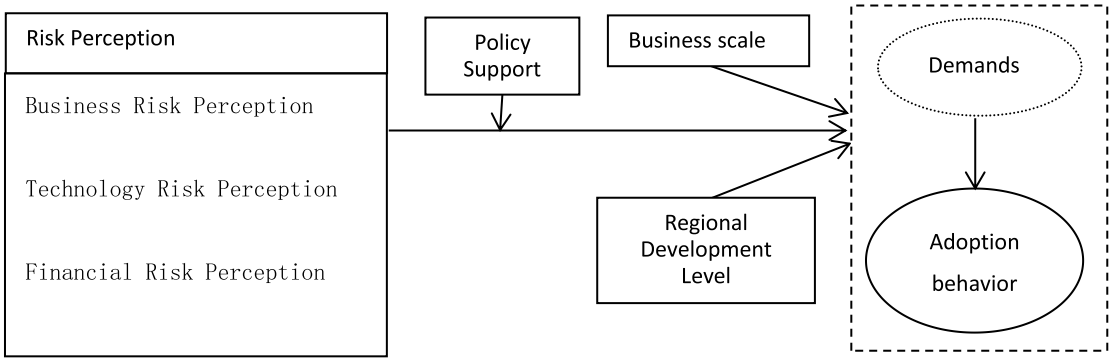

FIGURE 1
Demand-behavior model of forestry socialization services.

can maximize the utility of their desired goals. According to the theory of the small peasant economy, rural household production in modern China is in a stage of rural economic transition, with agricultural products and labor gradually entering the market, showing the characteristics of commercialization of agricultural products and part-time work. Therefore, the behavior of rural households is subject to the constraints of product market, technology, and capital factors, and uncertainty risks arise with fluctuations in product market price and production cost. Under the combined effect of constraints on relevant factors and risk perception, rural households constantly modify their business objectives and production behavior to maximize their business returns. Risk perception refers to farmers' judgment and assessment of the risks of strange things according to their own experience (Slovic, 1987). It is expressed as the perception of the uncertainty of future benefits or costs. Risk perception largely influences decision-making when decision-makers change, postpone, or cancel behavioral decisions (Kotler and Armstrong, 1994). Numerous studies have concluded that risk perception is a more robust explanation for decision behavior than expected benefits (Mitchell, 1999). This means that the study of risk perception is more important than the expected benefits in accurately grasping and understanding decision-maker's behavior. The stronger the rural households' risk perception is, the more likely they will adopt risk-resistant behavior to avoid risks (Lusk and Coble, 2005).

In the deviation of RHDAB of the FSS, risk perception refers to the fact that forestry operations may also encounter technology use risk, operation risk, and fund-raising risk in adopting FSS. Unlike agricultural production, the cycle of forestry production and operation is longer. Once a socialized service is adopted in the operation process, a long cycle is needed, such as good seed service, which starts from the selection of suitable seeds to cultivation and fertilization, branch pruning, pest control, and so on, until maturity, all of which cannot be separated from the good seed service provider. The longer the adoption cycle, the higher the degree of risk perception and the higher the risk cost that must be borne, directly affecting the transformation from demands to adoption behavior. The state subsidy policy effectively alleviates the hesitant attitude of adoption behavior or reduces the risk cost and compensates for the risk loss in the operation process, which plays an essential moderating role in the deviation of RHDAB of the FSS. Based on this, this paper investigates the direction, extent, and mechanism of the influence of risk perception on the deviation of RHDAB of FSS and clarifies whether this influence is moderated by policy support. It is shown in Figure 1.

3.2 Variable selection and hypothesis

3.2.1 Explained variables

This paper mainly investigates the influencing factors and mechanisms of RHDAB of FSS. The explained variables focus on the most urgent socialized services in rural households' forest land management: forestry seed and cultivation technology services (FSCTS), pest control services (PCS), and forest products collection and marketing services (FPCMS). In this paper, we study the deviation of RHDAB of FSS, which is divided into two parts: 1) the deviation of RHDAB of FSS. There are two patterns of deviation between demands and behavior, one is they have demands of FSS but no adoption behavior, i.e., "demands without behavior"; the other is they have no demand of FSS but adoption behavior, i.e., "no demand but behavior," but in the actual research, there is no such situation. Therefore, the deviation of RHDAB of FSS in this paper refers to "demand without behavior," which is assigned a value of 1; the opposite is 0. The same is done for FSCTS, FPCMS, and PCS. 2) To further quantify the deviation level of RHDAB of FSS in the whole process of forestry production activities, this paper takes the number of behavior deviations as the measurement index and sums the deviation number of the FSCTS, the PCS, and the FPCMS.

3.2.2 Core explanatory variables

The field research revealed three categories of rural households' risk perceptions that are most evident. Firstly, business risk perception in forestry. Business risk refers to the loss caused by poor management of forestry, the loss caused by the lack of necessary management experience or unscientific management,

TABLE 1 Definition of variables and descriptive statistics.

	Variable name	Variable definition	Mean	SD
1) Explained variables				
Types of behavior deviations	The FSCTS	0 = no deviation, 1 = deviation	0.571	0.495
	The PCS	0 = no deviation, 1 = deviation	0.277	0.448
	The FPCMS	0 = no deviation, 1 = deviation	0.662	0.473
The degree of behavior deviation	The degree of deviation of the three types of services	0 = no deviation, 1 = 1 deviation, 2 = 2 deviations, 3 = 3 deviations	0.848	0.766
2) Explanatory variables				
Risk Perception	Business risk perception	1 = low risk, 2 = average risk, 3 = high risk	1.967	0.511
	Technology risk perception	1 = low risk, 2 = average risk, 3 = high risk	2.241	0.767
	Financial risk perception	0 = own funds risk, 1 = borrowed funds risk	0.783	0.413
Policy support	Forestry subsidies	0 = no forestry subsidy, 1 = forestry subsidy	0.102	0.302
3) Control variables				
Householder characteristics	Age	1 = 0–30 years old, 2 = 31–40 years old, 3 = 41–50 years old, 4 = 51–60 years old, 5 = ≧ 60 years old	3.628	0.975
	Education level	1 = Elementary school and below, 2 = Elementary school, 3 = Junior high school, 4 = High school, 5 = College and above	1.571	0.698
	Whether he/she is a village cadre	0 = No, 1 = Yes	0.156	0.363
	Forestry motivation	1 = declining, 2 = no change, 3 = raising	2.704	0.510
Woodland elements	Forest land management area	Actual operating area (mu)	48.704	89.715
	Forest land fine fragmentation	Woodland area/number of woodland blocks	9.441	20.710
Workforce Factors	Number of laborers	Number of household laborers	2.962	1.210
Funding Elements	Forestry revenue share	Share of forestry income in total household income (%)	19.229	26.191
	Share of non-farm income	Share of non-farm income in total household income (%)	27.472	32.091
Location factors	Regional economic development level	1 = low, 2 = medium, 3 = high	2.503	0.761
	Terrain conditions	1 = Plain, 2 = Hill, 3 = Mountain	2.868	0.339

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TABLE 2 Results of the model of farm households' demands of the FSS.

	Variable name	Mv-probit model			Poisson model
		Model (1): FSCTS	Model (2): PCS	Model (3): FPCMS	Model (4): Degree of deviation
Risk perception	Business risk perception	0.418***	0.041	0.553***	0.184***
		(0.105)	(0.102)	(0.107)	(0.063)
	Technology risk perception	0.118*	0.166**	0.222***	0.106***
		(0.064)	(0.066)	(0.064)	(0.041)
	Financial risk perception	0.100	0.029	0.252**	0.066
		(0.124)	(0.127)	(0.123)	(0.082)
Policy support	Forestry subsidies	−1.375***	−1.072***	−1.078***	−1.443***
		(0.176)	(0.228)	(0.157)	(0.223)
Householder characteristics	Age of householder	0.031	0.013	−0.058	0.018
		(0.057)	(0.059)	(0.057)	(0.036)
	Education level of the householder	0.158*	0.095	0.079	0.094**
		(0.081)	(0.079)	(0.080)	(0.047)
	Whether he/she is a village cadre	−0.628***	−0.137	−0.347**	−0.312***
		(0.142)	(0.146)	(0.137)	(0.108)
	Forestry motivation	−0.240**	−0.121	−0.196*	−0.126***
		(0.098)	(0.097)	(0.100)	(0.041)
Woodland elements	Forest land fine fragmentation	0.006*	0.007**	0.005	0.004***
		(0.004)	(0.003)	(0.004)	(0.001)
	Forest land management area	−0.000	−0.002**	−0.000	−0.001
		(0.001)	(0.001)	(0.001)	(0.000)
Funding Elements	Forestry revenue share	0.226	0.647***	0.047	0.329***
		(0.202)	(0.196)	(0.204)	(0.116)
	Non-farm income share	−0.270	0.112	−0.182	−0.090
		(0.171)	(0.172)	(0.171)	(0.113)
Workforce Factors	Number of laborers	−0.055	0.039	−0.029	−0.011
		(0.042)	(0.043)	(0.042)	(0.026)

(Continued on following page)

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TABLE 2 (*Continued*) Results of the model of farm households' demands of the FSS.

Variable name	Mv-probit model			Poisson model
	Model (1): FSCTS	Model (2): PCS	Model (3): FPCMS	Model (4): Degree of deviation
Regional development level	−0.153**	−0.097	0.080	−0.095**
	(0.071)	(0.072)	(0.070)	(0.043)
Terrain conditions	−0.381**	0.111	−0.065	−0.131
	(0.149)	(0.152)	(0.150)	(0.087)
Constant	1.230*	−1.167	−0.430	0.094
	(0.703)	(0.718)	(0.701)	(0.439)
atrho21		0.524*** (0.069)		
atrho31		0.812*** (0.073)		
atrho32		0.359*** (0.066)		
Wald value		203.19		112.63
Log-likelihood		−1,247.817		−855.4326

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% statistical significance levels, respectively, and the standard errors are in parentheses corresponding to the regression coefficients.

such as the destruction of young trees, theft of trees, low afforestation survival rate, artificial fires, rising labor costs, etc. Secondly, technology risk perception in forestry. Certain risks accompany the adoption of each technology. Technology risk refers to the forestry risk brought by the limitation of technical conditions in cultivating forests, including the adaptability of technology, such as mechanical damage to above-ground and below-ground parts caused by tilling the soil, death of seedlings due to excessive use of pesticides, etc. Adopting new technologies can reduce the risk but may also increase the risk of forestry, but generally, mature new forestry technologies will reduce the risk. Thirdly, financial risk perception of forest management. Suppose the rural households' forestry operation funds come from borrowing. In that case, they need to bear a greater financial risk perception. As rational economic men, they will be more cautious about using forestry funds, which will easily produce a deviation between the demands and adoption behavior of the FSS. Rural households' judgment of forestry business risk, technical risk, and financial risk will directly affect the deviation of their demands and adoption behavior of the FSS, so the risk perception in this paper is measured from three aspects: business risk, technical risk, and financial risk.

3.2.3 Moderator variables

Policy support refers to the government's formulation of financial subsidies, subsidized loans, technical training, and other related policy measures to stimulate rural households' enthusiasm for forestry production and operation and to promote rural households' choice of the FSS to a certain extent. Forestry subsidies are the main and important form of policy support, which is to give certain subsidies to the main body of artificial afforestation, renewal, and transformation, including afforestation subsidies, forest nurturing subsidies, forest tree seed subsidies, etc. Subsidies can reduce the comparative cost of afforestation, improve the comparative income, and reduce all risks. Therefore, the policy support referred to in this paper is mainly measured by "whether the rural households receive forestry subsidies." 1 is assigned if the household has received forestry subsidies and 0 if not.

3.2.4 Control variables

According to the existing relevant studies, other factors that affect the deviation of RHDAB of the FSS are selected as control variables: 1) Production and operation characteristics. As a category of economics, production factors include all social resources needed for production and operation activities, mainly labor, land, and capital. 1) Labor factor: the more labor force a household has, the more labor resources it can allocate and the slighter the possibility of deviation. The labor factor is set as the number of household laborers. 2) Forest land factor: the area of forest land is an important production factor that determines the forestry operation of rural households and the choice of social services. Within a specific area of forest land, the larger the area of forest land operation, the higher the production factor allocation capacity requirement, and the slighter the possibility of deviation. Land fragmentation will increase the cost of the FSS, thus inhibiting the selection behavior of rural households' socialized services and

TABLE 3 Analysis of the moderating effect of policy support.

Variable name	Mv-probit model			Poisson model
	Model (4): FSCTS	Model (5): PCS	Model (6): FPCMS	Degree of deviation
Business Risk Perception	0.476***	0.050	0.583***	0.193***
	(0.110)	(0.105)	(0.114)	(0.064)
Technology Risk Perception	0.121*	0.176**	0.226***	0.111***
	(0.067)	(0.069)	(0.069)	(0.041)
Financial Risk Perception	0.127	0.092	0.367***	0.084
	(0.134)	(0.133)	(0.134)	(0.084)
Policy Support	0.737	0.705	1.044	0.497
	(1.020)	(1.247)	(0.895)	(1.432)
Business risk perception x policy support	−0.713*	−0.076	−0.355	−0.396
	(0.385)	(0.494)	(0.336)	(0.511)
Technology risk perception x policy support	−0.151	−0.443	−0.286	−0.297
	(0.225)	(0.298)	(0.200)	(0.277)
Financial risk perception x policy support	−0.287	−1.014*	−0.932***	−0.565
	(0.391)	(0.534)	(0.358)	(0.446)
Control variables	Controlled			
Constant	1.088	−1.189*	−0.526	0.063
	(0.708)	(0.722)	(0.709)	(0.440)
atrho21	0.522*** (0.069)			
atrho31	0.806*** (0.074)			
atrho32	0.353*** (0.066)			
Wald value	212.36			117.02
Log-likelihood	−1,239.932			−854.097

increasing the possibility of deviation (Xie et al., 2014). 3) Financial factor: the higher the proportion of forestry income, the greater the dependence of rural households on forestry, the greater the forestry input, and the slighter the possibility of deviation. The proportion of non-agricultural income reflects the degree of rural households' departure from agriculture. The greater the value of non-farm income, the greater the possibility of deviation. 2) Rural households' characteristics. As forestry operators, rural households' characteristics influence their demands and adoption behavior of socialized services, including age, education level, whether they are village cadres, and enthusiasm for the forestry business. 3) Location factors: the location factor is an important indicator of economic quality (economic, geographical condition). The production environment and living standards differ in locations and geographical conditions, resulting in differences in RHDAB in the FSS (Liao et al., 2016). This has been the consensus of academic and governmental sectors. This paper measures the location conditions by two indicators: regional economic development and topographic conditions.

4 Model specification, data, and variable descriptions

4.1 Model specification

4.1.1 Mv-probit model

The deviation of RHDAB on the FSS is a binary choice problem, and the binary Probit model is usually adopted, but the assumption is that the alternative options are independent. Rural households may have several service options in the production process, and these services are not exclusive to each other, so the simple binary Probit model cannot solve the correlation between service choice behaviors. In contrast, the Mv-Probit model (Multivariate Probit) can not only estimate the regression results of rural households' single service choice behavior but also give the likelihood ratio test of the regression results of each service. Then the likelihood ratio can determine the interrelationship among the services, which improves the estimation accuracy and efficiency.

Therefore, the Mv-Probit model is adopted in this paper to analyze the factors influencing rural households' adoption behavior

TABLE 4 Heterogeneity analysis of different levels of economic development.

Variable name	Low level of economic development			Economic development level in			High level of economic development		
	Model (7): FSCTS	Model (8): PCS	Model (9): FPCMS	Model (10): FSCTS	Model (11): PCS	Model (12): FPCMS	Model (13): FSCTS	Model (14): PCS	Model (15): FPCMS
Business Risk Perception	0.393	−0.199	1.070***	0.450*	0.397*	0.714**	0.356***	−0.023	0.4072***
	(0.276)	(0.247)	(0.296)	(0.267)	(0.237)	(0.290)	(0.132)	(0.137)	(0.1349)
Technology Risk Perception	0.330**	0.426***	0.338**	0.036	0.071	0.044	0.062	0.071	0.1582*
	(0.161)	(0.165)	(0.149)	(0.184)	(0.171)	(0.178)	(0.081)	(0.086)	(0.0820)
Financial Risk Perception	0.855**	0.261	0.778**	−0.396	−0.446	0.026	0.134	0.118	0.2875*
	(0.340)	(0.311)	(0.308)	(0.311)	(0.280)	(0.312)	(0.163)	(0.177)	(0.1621)
Policy Support	−1.708***	−5.591	−1.408***	−1.789***	−1.220***	−1.497***	−1.060***	−0.913***	−0.8087***
	(0.473)	(119.873)	(0.415)	0.450*	0.397*	0.714**	(0.236)	(0.333)	(0.2128)
Control variables	Controlled			Controlled			Controlled		
Constant	1.485	−2.117	−1.033	−0.191	−2.007*	−0.148	1.113	−0.796	0.5057
	(1.749)	(1.508)	(1.605)	(1.305)	(1.152)	(1.295)	(0.693)	(0.722)	(0.6958)
atrho21	0.954*** (0.265)			0.753*** (0.205)			0.323*** (0.078)		
atrho31	1.434*** (0.377)			0.895*** (0.193)			0.685*** (0.082)		
atrho32	0.853*** (0.298)			0.947*** (0.281)			0.310*** (0.078)		
Wald value	74.11			67.87			95.85		
Log-likelihood	−150.582			−168.220			−868.825		

in the FSS under the differences in production factor endowments. The specific form of the model is as follows.

$$y^{\star} = \partial_0 + \sum_i \partial_i x_i + \varepsilon \tag{1}$$

$$y = \begin{cases} 1, y^{\star} > 0 \\ 0, \text{else} \end{cases} \tag{2}$$

In both equations, $y^{\star}$ is the latent variable, y is the observed variable of the dependent variable, x_i is the explanatory variable, and i is the number of explanatory variables. It can be seen from Equation 2 that if $y^{\star} > 0$, then $y = 1$, indicates that there is a deviation between rural households' demands and adoption behavior of services; ∂_i , β_i are estimated parameters and ε is a random disturbance term that follows the mean of 0, a multivariate normal distribution of covariance which is ψ , i.e., $\varepsilon \sim MVN(0, \psi)$. The simulated maximum likelihood estimation of Equation 3 can be used to obtain the estimated value of the model parameters.

4.1.2 Poisson model

The degree of deviation of RHDAB on FSS is to count the number of deviations between rural households' demands and adoption behavior in a production cycle by the Poisson Model. The dependent variable Y denotes the number of behavior deviations of the FSS following a Poisson distribution with expectation u. The expression is.

$$P = \{Y = n|\mu\} = \frac{e^{-\mu}\mu^n}{n!} \tag{3}$$

Where $E(Y) = Var(Y) = \mu$. n denotes the number of outsourcing links ($0 \le n \le 3$), while assuming that X_{hl} denotes the matrix of observations obtained from h independent variables after l observations, the Poisson regression model can be obtained by introducing the linkage function $\ln(\mu)$.

$$\ln(E(Y|X)) = \ln(\mu) = X\alpha = \sum_h \alpha_h x_h \tag{4}$$

The estimated value of α_h the equation indicates that the expected value becomes a multiple $\exp(\alpha_h)$ when the independent variable x_h is changed by one unit.

4.2 Data

The data in this paper come from the subject group's research of 787 farm households in 6 counties (cities) in Zhejiang, Jiangxi, and Fujian provinces. The reason why we choose to investigate the farmers of forestry production and operation in Zhejiang, Jiangxi, and Fujian is that these three provinces are all important forestry provinces in south China, with forest coverage rates above 60%. They are also important timber and bamboo forest production areas

TABLE 5 Heterogeneity analysis of different forestry operation scales.

Variable name	Smallholder rural household			Scale households		
	Model (16): FSCTS	Model (17): PCS	Model (18): FPCMS	Model (19): FSCTS	Model (20): PCS	Model (21): FPCMS
Business Risk Perception	0.404***	0.055	0.579***	0.418**	0.010	0.511**
	(0.127)	(0.125)	(0.128)	(0.198)	(0.188)	(0.203)
Technology Risk Perception	0.131*	0.153**	0.190**	0.074	0.207	0.284**
	(0.075)	(0.078)	(0.075)	(0.128)	(0.134)	(0.127)
Financial Risk Perception	0.216	0.179	0.222	−0.206	−0.292	0.297
	(0.153)	(0.159)	(0.153)	(0.238)	(0.228)	(0.221)
Policy Support	−1.332***	−1.052***	−1.129***	−1.523***	−1.269***	−1.089***
	(0.220)	(0.284)	(0.192)	(0.306)	(0.406)	(0.271)
Control variables	Controlled			Controlled		
Constant	0.618	−1.150	−0.383	1.889*	−0.693	−1.034
	(0.787)	(0.799)	(0.784)	(1.113)	(1.080)	(1.063)
atrho21	0.461*** (0.081)			0.523*** (0.136)		
atrho31	0.794*** (0.083)			0.836*** (0.157)		
atrho32	0.320*** (0.077)			0.567*** (0.147)		
Wald value	137.01			98.44		
Log likelihood	−901.509			−327.558		

in China. Therefore, it is more representative to investigate the influence of the deviation of RHDAB there, which can also be used as a reference for other provinces. The research team selected the samples strictly following the stratification principle of random sampling. According to the forestry production in each region, two counties (6 in total) were selected in each sample province, three townships were randomly selected in each county according to the level of economic development, three villages were randomly selected in the selected townships, a total of 54 villages were obtained, and then 10–16 farm households were randomly selected in each village according to the size of the villages. A total of 850 questionnaires were distributed to the rural households, 820 of which were returned, and 787 valid samples were obtained by excluding those with missing key variables and major logical errors, with an effective rate of 92.59%.

4.3 Statistical description of variables

The definitions, descriptions, and descriptive statistics of all relevant variables are shown in Table 1. The mean value of the deviation of RHDAB of the FSCTS and FPCMS in the sample area was high, 0.571 and 0.662, respectively. The mean value of business risk perception was 1.967, indicating that most rural households considered the business risk perception average. Still, the technology risk perception was relatively large, and the source of funds was mainly borrowing. The average age of the sample household heads is around 50 years old, the education level is low, the percentage of village cadres is relatively small, the average number of household laborers is 2.962, the degree of forest land fragmentation is 9.441, the plots are relatively scattered, and the average household operation scale is 48.704 mu.

5 Empirical results

5.1 The influence of risk perception on the deviation of RHDAB of the FSS

This paper empirically analyzed the effects of risk perception and policy support on the deviation of RHDAB of the FSS using Stata 16.0 software. The regression results are shown in Table 2. The Wald and atrho values of the Mv-probit model passed the significance test at the 1% level, indicating that the deviation of RHDAB of each link is not independent, indicating that the model's overall estimation results are good. Model 1), model 2), and model 3) are the regression results of the Mv-probit model on the deviations of RHDAB of the FSCTS, the PCS, and the FPCMS, respectively, and model 4) is the regression results of the degree of deviations of the three services above.

From the empirical results of the model in Table 2, rural households' business risk perception has a significant positive effect on the RHDAB of the FSCTS and the FPCMS. The reason may be that rural households usually consider both profit maximization and risk minimization in the production decision

TABLE 6 Robustness tests of the replacement model.

Variable name	Binary probit model			Probit model
	Model (16): FSCTS	Model (17): PCS	Model (18): FPCMS	Degree of deviation
Business risk perception	0.437***	0.042	0.567***	0.252***
	(0.101)	(0.101)	(0.100)	(0.088)
Technology risk perception	0.115*	0.157**	0.206***	0.140***
	(0.063)	(0.067)	(0.063)	(0.053)
Financial risk perception	0.111	0.036	0.220*	0.072
	(0.125)	(0.133)	(0.123)	(0.108)
Policy support	−1.436***	−1.077***	−1.068***	−1.359***
	(0.189)	(0.238)	(0.167)	(0.164)
Control variables	Controlled			
Constant	1.294*	−1.018	−0.362	
	(0.686)	(0.716)	(0.701)	
Wald value	119.17	42.97	96.84	121.11
Log likelihood	−467.695	−437.604	−450.736	−779.018

TABLE 7 Results of Heckman's two-stage endogeneity treatment.

Variable name	Model (19) whether to deviate		Model (20) degree of deviation	
Business risk perception	0.524***	(0.118)	0.122*	(0.067)
Technology risk perception	0.275***	(0.068)	0.060	(0.041)
Financial risk perception	0.093	(0.135)	−0.048	(0.075)
Policy support	−1.138***	(0.159)	−0.969***	(0.146)
Control variables	Controlled		Controlled	
Constant	−0.250	(0.721)	0.562**	(0.284)
Inverse mills ratio (λ)			0.516***	(0.142)

process, the forest products market is a buyer's market because of the long production cycle, and the market risk is uncontrollable. Therefore, they are more inclined to adopt conservative production and management behaviors before and after production to avoid risks, making the consistency of demands and adoption behavior of the FSS lower and prone to deviation. The perception of technical risk has a significant positive effect on the RHDAB of the FSCTS, the PCS, and the FPCMS, which indicates that the higher rural households' perception of technical risk of the FSS, the more likely they are to reduce the adoption of the FSS and avoid the production risks brought by the adoption of the FSS. Thus the deviation occurs. The perception of financing risk only has a significant positive effect on the deviation of RHDAB of FPCMS, probably because FPCMS directly affects rural households' operating income. When rural households' forestry operating funds come from borrowing, they need to bear greater financing risk compared with their own funds, so to reduce financing risk, rural households are more willing to choose sale by themselves rather than choosing FPCMS, which leads to the deviation. On the other hand, in terms of the degree of deviation between the demands and adoption behavior of the FSS, it is found that the perception of operational risk and technical risk significantly contribute to the degree of deviation between the demands and adoption behavior of the FSS, probably because when rural households are not optimistic about their operational expectations and the quality of socialized services, they are willing to adopt socialized services, but they still choose to produce on their own to reduce operating costs out of the consideration of cost-benefit.

Policy support has a significant negative effect on the deviation of RHDAB of the FSCTS, the PCS, and the FPCMS, i.e., government subsidies for rural households' forestry operations can help promote their adoption behavior of the FSS and promote rural households to

convert their demands of the FSS into adoption behavior. At the same time, it can significantly reduce the degree of deviation of RHDAB of the FSS. Government subsidies help rural households alleviate the financial constraints of forestry operation, reduce production costs, and stimulate their enthusiasm for forestry production and operation, increasing the probability of choosing the FSS and reducing the possibility of deviation. Among the control variables, whether he/she is a village cadre significantly reduces the deviation of RHDAB of the FSCTS and FPCMS and also has a suppressive effect on the degree of deviation, possibly because village cadres have a better understanding of the FSS and choose to adopt the FSS in order to reduce labor constraints, making the demands and adoption behavior consistent. The large share of forestry revenue has a positive effect on the deviation of the PCS, while forestry enthusiasm, forest land area, regional development level, and topography all have a suppressive effect on the deviation of RHDAB of the FSS to some extent.

5.2 Analysis of the moderating mechanism of policy support

The results of the above study show that risk perception has a positive and significant effect on the deviation of RHDAB of the FSS, while policy support significantly reduces the deviation. Therefore, we will further analyze the moderating effect of policy support on the impact of risk perception on RHDAB of the FSS. After adding the interaction term of risk perception and policy support to the baseline regression, the model results are shown in Table 3. After controlling other factors, the interaction term of business risk perception and policy support have a positive and significant effect on the deviation of demands and adoption behavior of the FSCTS at the 10% statistical level with a negative coefficient. This indicates that policy support can alleviate the inhibitory effect of business risk perception on RHDAB of the FSCTS. Government subsidies for rural households' forestry operations increase the marginal expectation of rural households' adoption of the FSCTS and mitigate the negative effect of business risk perception. The interaction term of technology risk perception and policy support did not have a significant effect, i.e., government subsidies did not improve the effect of rural households' technology risk perception on behavior deviation. The effect of the interaction term of financial risk perception and policy support on behavior deviation of the PCS and FPCMS was significant at the 10% and 1% levels, respectively. While the interaction term of financial risk perception and policy support also had a significant inhibitory effect on the degree of deviation. The cause maybe is that government financial subsidies, to a certain extent, alleviate the constraints of rural households' operating funds and make them more willing to optimize resource allocation through the FSS, thus reducing the deviation.

5.3 Heterogeneity analysis

5.3.1 Heterogeneity analysis of economic development levels

China has a vast territory, and different regions have differences in capital endowment, such as physical capital, human capital, and social capital, and differences in factors, such as economic development level, resulting in obvious regional imbalance. The demands and adoption behavior of FSS is not only influenced by risk perception and policy support but also rooted in the local economic environment. Therefore, there may be regional differences in RHDAB of FSS. To further explore the differences among different levels of economic development, this paper conducted group regressions according to low, medium, and high levels of economic growth, and the results are shown in Table 4. Compared with the low economic development level area, the effect of business risk perception on the deviation of RHDAB of the FSS is more prominent in the medium and high economic development level area. The reason is that rural households in low economic development level areas are more involved in the forestry business and have more in-depth knowledge of forestry business risk perception. Still, more rural households are part-time and mainly non-farm work in high economic development areas. This quickly reduces the adoption behavior of the FSS due to business risk perception and hinders the conversion of demands into adoption behavior. In contrast, the technology risk perception and the financial risk perception have a more significant positive effect on the deviation of RHDAB of the FSS in areas with low economic development. i.e., it prevents rural households in areas with low economic development from converting their demands into adoption behavior on the FSS. This may be because rural households in low economic development areas do not have timely access to information, do not know enough about forestry technology, are also influenced by financial constraints, and tend to rely on family businesses rather than adopting the FSS in order to avoid risks.

5.3.2 Heterogeneity analysis of forestry operation scale

The continuous promotion of collective forest rights reform, forest land transfer, and moderate scale operation make the main forestry production body present the *status quo* of scale operation main body, and small rural households co-exist. Farmers of different operation scales have differences in resource endowment and production conditions, which may lead to different response levels to risk perception and policy support, and ultimately affect the deviation degree of RHDAB of FSS. In view of this, this paper regressed the forestry operation area in groups according to the mean value, and the forestry operation area of small-scale households was less than the mean value of 48 mu. In comparison, the large-scale households were greater than 48 mu. The regression results in Table 5 show that the business risk perception significantly promotes the deviation of RHDAB of the FSCTS and FPCMS for both small and large scale households. This indicates that both small-scale and large-scale households, when their business risk perception is large, will reduce the probability of outsourcing, which easily affects the output and operating income level. The technology risk perception only has a significant positive effect on the deviation of demands and adoption behavior of the FPCMS for large-scale households. However, it has a significant promoting effect on the deviation of all three segments of the FSS for small-scale households, indicating that the technology risk perception has a more significant effect on the deviation for small-scale households than for large-scale households. It may be that small-scale households have a low level of knowledge about forestry production technology and have a path dependence on traditional forestry management. So they will choose to operate their business by themselves to ensure that forestry output will not be affected when unsure about the technology risk perception, which will be more likely to have the deviation of demands and adoption behavior.

5.4 Robustness test

5.4.1 Replacement model

The previous analysis concluded that risk perception significantly promotes the deviation of RHDAB of the FSS. This paper further replaces the estimation method for validation to test the robustness of the findings. Specifically, a binary probit model was used to explore the effect of risk perception on the deviation of RHDAB of the FSS in different segments. From the results in Table 6, we can see that business risk perception has a significant positive effect on the deviation of RHDAB of the FSCTS and the FPCMS. In contrast, technology risk perception has a significant positive effect on the deviation of RHDAB of the FSS in the three segments. Financial risk perception only has a significant positive effect on the deviation of RHDAB of the FPCMS. Regarding the effect on the degree of deviation, both the business risk perception and the technology risk perception significantly promote the degree of deviation. On the other hand, policy support has a significant inhibitory effect on both the deviation of RHDAB of the FSS in each segment and the degree of deviation, contributing to the consistency of demands and adoption behavior. This is consistent with the previous study's findings, which verifies the validity of the analysis.

5.4.2 Heckman's two-stage approach to test and deal with endogeneity

Rural households follow two steps in making decisions about the deviation of demands and adoption behavior of the FSS: the first step is whether to deviate, and the second step is the degree of deviation. Therefore, direct estimation of the deviation of RHDAB of the FSS may have the sample bias of "focusing on the outcome but neglecting the choice." In order to accurately analyze the effect of risk perception and government support on the deviation of RHDAB of FSS, this paper uses the Heckman two-step method to eliminate the endogeneity problem caused by sample selection and enhance the robustness of its findings. As shown in Table 7, the inverse Mills coefficient passes the significance test, indicating that there is a certain selection bias in the sample. Still, the results of the Heckman two-step method show that the business risk perception and the technology risk perception have a significant positive effect on the deviation of RHDAB of FSS and the deviation degree. In contrast, government support significantly negatively affects the deviation and the deviation degree. The results are generally consistent with the above analysis, indicating that although there is some endogeneity, the baseline regression results are still reliable.

6 Conclusions and policy recommendations

Based on the rural households' behavior theory and a survey of 787 rural households, this paper constructs a theoretical framework for the deviation of RHDAB of the FSS and the individual response mechanism of the deviation degree. The Mv-probit and Poisson models empirically analyze the risk perception and policy support on the deviation. Findings indicate that: 1) There is a large deviation of RHDAB of different types of FSS, with 57.71% and 66.20% for forestry seed and cultivation technology services and forestry product collection and marketing services, respectively. 2) Risk perception accelerates the deviation of RHDAB of FSS and the deviation degree. Technology risk perception is found to have a significant effect on the deviation of all three services, while financial risk perception only has a significant positive effect on the deviation of the forestry product collection and marketing services. Policy support is effective in significantly reducing the deviation of RHDAB of FSS and the deviation degree. 3) Policy support attenuates the influence of operational risk perception on the deviation of RHDAB of FSCTS, while policy support also moderates the deviation of financial risk perception on the deviation of the PCS and the FSCTS, with a significant negative moderating effect. 4) Heterogeneity analysis reveals that business risk perception has a more significant effect on the deviation of RHDAB in areas with medium to high economic development levels, while technology risk perception and financial risk perception have a positive effect on the deviation of RHDAB mainly in areas with low economic development levels. For rural households of different forestry business scales, business risk perception has a significant positive effect on the deviation of RHDAB for both small and large scale rural households. However, technology risk perception has a more significant effect on the deviation for small rural households.

In light of the research findings, this paper provides several policy recommendations: First, a sound forestry risk management system is needed to reduce farmer management risk reasonably. To expand the coverage of forestry insurance, adjust and improve the forest insurance system, encourage all localities to carry out insurance of forest products with advantages and characteristics according to local conditions, and accelerate the extension of forestry insurance to the whole forestry industry chain. We should give full play to the guiding role of reinsurance, establish a risk-sharing mechanism, prevent and resolve systemic risks in the forestry operation process, and strengthen the strategic layout and forward-looking plan of forestry risk management. Second, accelerate the development of inclusive finance in rural areas and increase policy support for forestry. Solve the problem of farmers' loans through multiple channels, and dissolve the financial constraints of farmers' purchase of services, such as establishing a special fund, reducing the loan interest rate, or implementing financial policy discounts. Promoting the allocation of financial resources to farmers in remote forest areas, and ensuring that total credit to farmers in forest areas continues to increase and the proportion of loans to farmers is not reduced. Third, establish a regional forestry socialized service platform to strengthen the function of the FSS system. More attention should be paid to the socialized service supply in forestry production and marketing links. Exchanges between service subjects, between service subjects and rural households, and between rural households on the supply of good seed, forestry cultivation techniques, and forest product sales experience should be carried out from time to time to improve rural households' rational decision-making ability in the demand for FSS and guide and stimulate the conversions of rural households' demand to adopt behavior with high-quality and efficient services.

Data availability statement

The datasets used during the current study are available from the corresponding author on reasonable request.

Author contributions

WL: writing, methodology, software; RY: data curation, writing—original draft preparation; XZ: validation, investigation. NL: software, validation. CZ: writing—reviewing and editing. All authors contributed to the article and approved the submitted version.

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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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