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Farmers' willingness to accept compensation for ginkgo conservation: evidence from rural Taixing, China

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Numerous potential socioeconomic benefits provided by ginkgo resources have been identified but these have been threatened due to insufficient conservation over recent decades. Economic compensation is essential to induce enthusiasm for conservation. This paper examines the farmers' willingness to accept ginkgo conservation compensation as well as other influencing factors based on survey data from 208 households. The results show that: first, the compensation amounts for the three different ginkgo conservation values are 820.86, 249.03, and 71.29 yuan per tree, respectively. Second, the overall compensation value is 388.17 yuan per tree with an average of 8430.83 yuan per household. Third, factors that influence the conservation compensation values are size-specific. Specifically, for large ginkgoes, a given respondent's age, gender, job, household income, the number of large ginkgoes and arable land area are the most important factors. For medium ginkgoes, the area of arable land and farmers' willingness to protect ginkgo trees are the key determining factors. By contrast, the requisite factors are different for small size ginkgo trees. A given respondent's job, the arable land area and farmers' perception of the importance of conducting conservation for local development are found to have significant impacts. These findings provide a useful base for assessing the conservation value for this endangered and valuable forest resource. Furthermore, the results also indicate that a size-based payment for farmers' ginkgo conservation behaviors can be a useful economic tool to induce and deepen the latter's conservation efforts.

KEYWORDS

willingness to accept, ginkgo resource, conservation value, compensation value, rural China

1 Introduction

Forestry resources have been identified as playing a crucial role both in biodiversity maintenance and carbon concentration (Shyamsundar and Kramer, 1996; Davis and Rausser, 2020; Duffield et al., 2021). One of the essential spices is ginkgo, which is called a "living fossil forest resource." It is documented that ginkgo has many ecological functions, including greening the environment, purifying the air, conserving water and soil, controlling pests, regulating temperature, fixing carbon, and so forth (Liu et al., 2020). In addition, ginkgo resource also has an economic and cultural values and currencies and is widely used in gardening as well as medicine in many countries (Lin et al., 2022; Li et al., 2023; Sirotkin et al., 2023). More importantly, it is an important strategy for farmers' livelihoods. For instance, income earned from ginkgo-based rural village tourism accounts to almost 90 percent in the famous ginkgo village in Tengchong county, Yunnan province in China (Zhang, 2020). It is also the case that ginkgo is widely planted in rural regions of China such as Gansu, Yunan and Jiangsu and so forth and acts as an important income resource for local small households. Therefore, it is of crucial significance to conserve ginkgo resources, particularly in relation to large old ginkgo tress (Wang et al., 2023).

The Chinese central government has emphasized sharply the ecological value of forest resources (including ginkgo) and has made tremendous efforts for resource protection and conservation since the slogan of "lucid waters and lush mountains are invaluable assets" (*Lvshui qingshan jiushi Jinshan Yinshan*) was initially promoted in 2005. These efforts include, for instance, the Law on Environmental Protection in 2015, the Regulations on the Protection of New Varieties of Plants in 2019, and the first ecological protection supervision plan "The 14th Five-Year Plan" in 2020, etc. These policies are stipulated in order to create an adequate institutional environment for forest resource conservation.

Strikingly, the over-exploitation and degradation of forest resources (including the ginkgo) is prevailing (Hosonuma et al., 2012; Kahlil et al., 2017). Take the ginkgo species as an example, a substantial area of large and old ginkgo trees are cut down due to its unique value in terms of medicine, food, timber, etc. This economic value-based use leads to unstable planting. For instance, according to our field observation in the search region Taixing city in Jiangsu province in late 2018, it was found that the planting area by small households has decreased significantly, particularly in the last 5 years due to the fluctuating price of ginkgo-related products. This decrease of planting area potentially threatens the conservation of its cultural, ecological, and economic value.

A large body of literature has been devoted to assessing the ecological value of forest resources (including the ginkgo) and to explaining the determining factors on small households' decision-making in forest trees, however, a consensus has not yet been reached. It is found that sustainable utilization and protection is an important subject of scientific research in the fields of forest economics and environmental protection. In order to induce forest households to balance economic benefit with environmental protection motivations, some scholars have studied the willingness of small forest households to engage in forest protection from the perspective of ecological compensation (Lindhjem and Mitani, 2012; Habesland et al., 2016). In the context of China, numerous studies were conducted in order to explore the ecological compensation value as well as its determining factors. Generally speaking, such research focuses mainly on protected areas (Chen et al., 2017), farmland (Sun and Yin, 2014), and ponds (Tang et al., 2012).

Based on these available analysis, it can be found that, first, a general consensus is that the overall value of forest resources is based on economic, social and ecological perspectives. Second, the non-market ecological protection value for forest resources by small forest households as a key component in overall values has been identified but also has been paid relatively little attention. Third, in the context of China recent studies focus mainly on the assessment of the economic value of forest resources (Liu et al., 2008; Xiao et al., 2014; Sun et al., 2019; Zhang et al., 2019). By contrast, studies on the ecological protection value (particularly the value of endangered ginkgo species) from the small forest household perspective are limited (MacMillan et al., 2004; Bandara and Tisdell, 2005; Eppink and Wtzold, 2009).

This study investigates ginkgo-planting households' willingness to accept (WTA) on the conservation value of ginkgo based on a household survey data set collected in Taixing in Jiangsu province, China. In addition, we also explore the determining factors that influence ginkgo planting households' WTA values. It is noteworthy that we assess the conservation compensation value based on a micro household perspective. This is because small households are the main investors in terms of ginkgo planting, protection and conservation on the ground. Thus farmers should be the key stakeholders who need to be compensated. The possible innovations of this analysis are twofold. First, the assessment is conducted from the micro ginkgo planting farmers' WTA perspective focusing particularly on the non-forest economic products' relevant value. Our conclusions can provide a deep understanding of the composition of the overall value for a certain specific type of forest resource given that the available analyses are conducted mainly from a market stakeholder perspective. Second, we estimate the key influencing factors on the assessed conservation value by distinguishing three sizes of ginkgo trees among ginkgo planting households. Relevant findings are useful for uncovering the potential reasons for the degradation of ginkgo planting area, thereby providing a useful reference for ginkgo resource conservation policymaking. More importantly, by distinguishing different types of rural households and exploring different influencing factors, our conclusion can provide a feasible reference point for the effective on the ground implementation of ginkgo resource conservation policies.

The rest of this research is organized as follows. Section 2 outlines the conceptual framework. Section 3 introduces the research area and data set collection. Section 4 presents the methodology of empirical analysis including model specification, variable definition, which is followed by the results in section 5. Section 6 presents the conclusions and policy implications.

2 Conceptual framework: structuring the conservation value of ginkgo resource

Ginkgo is called the "duck palm tree" or "white fruit." It is an ancient dioecious tree dating from the Mesozoic Era. It has been proven to be the earliest legacy in China following the Quaternary Ice Age (Zhao et al., 2010; Hohmann et al., 2018). This kind of tree species has been widely planted throughout China due to the suitable natural geographical conditions (Cao et al., 2007).

Analysis on the assessment of the ecological value for forest resources (including the ginkgo) is available. Some researchers point out that the overall value of forest resources can be summarized in two categories, namely market and non-market values (Amadu et al., 2021). Ginkgo has tremendous value in terms of culture, medicine, and ecology. Both the cultural and ecological values can be grouped as non-market values and its additional medicinal value can be grouped as its market value. Theoretically, the overall values should be jointly included in the formulation of conservation assessment. First, from the cultural value perspective, ginkgo is found to play an important role in the history and culture of Buddhism and Taoism. Second, from the medical value perspective, as an ancient species it also possesses special genetic and scientific values and has curative effects in relation to various cardiovascular diseases. For instance, it is a famous disease- and insect-resistant therapeutic ingredient given its power of antibiosis. Third, from the ecological value perspective, it has an unique value in relation to its capacity to absorb sulfur dioxide.

Based on available analysis, in terms of conservation compensation value, in this paper this is referred to as the means of direct forest product economic value deducted from the total economic value. Thus we specify the ginkgo conservation value as: ginkgo conservation value = hereditary value + ecological value + scientific value + historical and cultural value as detailed in Figure 1.

3 Research area and data set

3.1 Research area

Our research site is in Taixing city. It is a county-level city in the middle of Jiangsu province in China located on the north shore of the lower stretch of the Yangtze River (N: 31°58′-32°23′, E: 119°54′-120°21′). Taixing is in the Yangtze River Delta alluvial plain with a topography inclining gradually from the northeast to the southwest. This region comprises a total area of 1,172 km^2. The mean temperature is about 14.9°C during the year. The moderate annual rainfall amounts to 1,027 mm. The annual level of sunshine is 2,125 h with an average of 220 frost-free days.

There are two typical soil types, namely fluvo-aquic and paddy soils. The combination of good natural conditions in terms of light, water, temperature, and soil makes it an ideal region for ginkgo planting. As a matter of fact, Taixing is one of the most representative ginkgo planting bases in China. Its ginkgo planting heritage can be traced back to the ancient era. The cultivating area in 2012 amounted to 18,270 ha (amounting to 82.32% of Taixing's forestry area) and increased sharply to around 20,000 ha in 2019. Thus, ginkgo relevant production and tourism is developing rapidly and contributes substantially to local economic growth. For instance, the so-called "white fruit" product produced in our research region is famous and this place is known as the "home of ginkgo" in China. For instance, one third of total "white fruit" output throughout China is produced from this region. The location of the study area is shown in Figure 2.

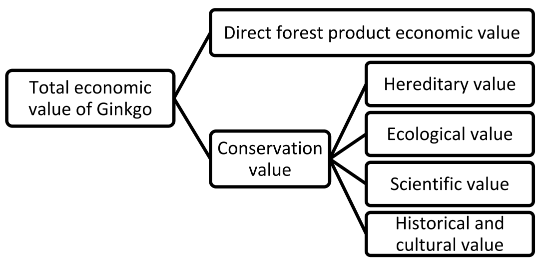

FIGURE 1
Components of gingko's overall value.

3.2 Data set

Technically, in order to collect the information of farmers' willingness to accept (WTA) compensation value for ginkgo species conservation, we innovatively applied an open-ended bidding game method by using the format of a payment card. There are several advantages of this bidding game-based method compared with the traditional household questionnaire. First, the ginkgo planting history is long and its market is relatively well-developed. Therefore, the values given by bidders are more likely to be close to the real value under a competition situation. More importantly, ginkgo production has been an essential livelihood strategy in our research site as mentioned above. Thus, most of the respondents have experience of ginkgo planting and almost all of them are familiar with the market situation. Both ginkgo planting experience and market-related knowledge are helpful for reducing the bias of respondents' subjective cognition in terms of their WTA compensation values. Second, the bidding game is conducted by asking if the WTA of ginkgo can reduce directly the possibility of producing a relatively higher WTA by farmers due to the potential existence of a "substitution effect" of similar forest plants. For instance, poplar and its relevant products also feature in our research site and this is a substitute plant for ginkgo. Third, the double-bounded dichotomous choice question method designed for WTA compensation values is widely used in the current literature (Veronesi et al., 2011). This traditional method has its defects because the dichotomous choice method can easily induce respondents to answer "yes" in questionnaires, consequently producing positive response bias (Dong et al., 2011). From this perspective, a larger sample is usually required to derive statistically reliable results in the double-bounded dichotomous choice questionnaire method (White and Lovett, 1999; Pearce et al., 2002; Ao et al., 2016).

In addition, it is notable that one of the most difficult tasks in exploring WTA compensation values is that it is hard to design the starting point, intervals and the range of bidding (Veronesi et al., 2011). In order to reduce potential bias, the questionnaire method is also used as a supplemental method.

The questionnaire comprised three major sections. The first section focuses mainly on the respondents and their families' social economic and demographic characteristics. The detailed information includes the household head's age, gender and education, as well as the household characteristics in terms of job, family income, and ginkgo planting (such as the number of large, medium and small ginkgo trees planted). The second section is designed to collect information on attitudes and subjective perceptions in relation to ginkgo conservation, including general knowledge of biodiversity and specific knowledge of the overall value (economic and ecological values) of ginkgo and so forth.

The third section is designed mainly for collecting the information on respondents' WTA compensation value for ginkgo conservation. The size (large, medium, and small) of ginkgo is distinguished in our questionnaire and three levels of WTA values are obtained according to the actual local situation. A large tree is defined as one with a diameter of more than 26 cm. A medium tree is defined as one with a diameter between 18 cm and 25 cm. Small trees refer as those with diameters of less than 18 cm (but with a minimum height of 2 m). Specifically, the information on WTA values are obtained by using two major steps. First, we read the following message to each respondent:

Ginkgo, with the local name "white fruit," has been one of the most ancient gymnosperms to survive since the Quaternary Ice Age. It is also

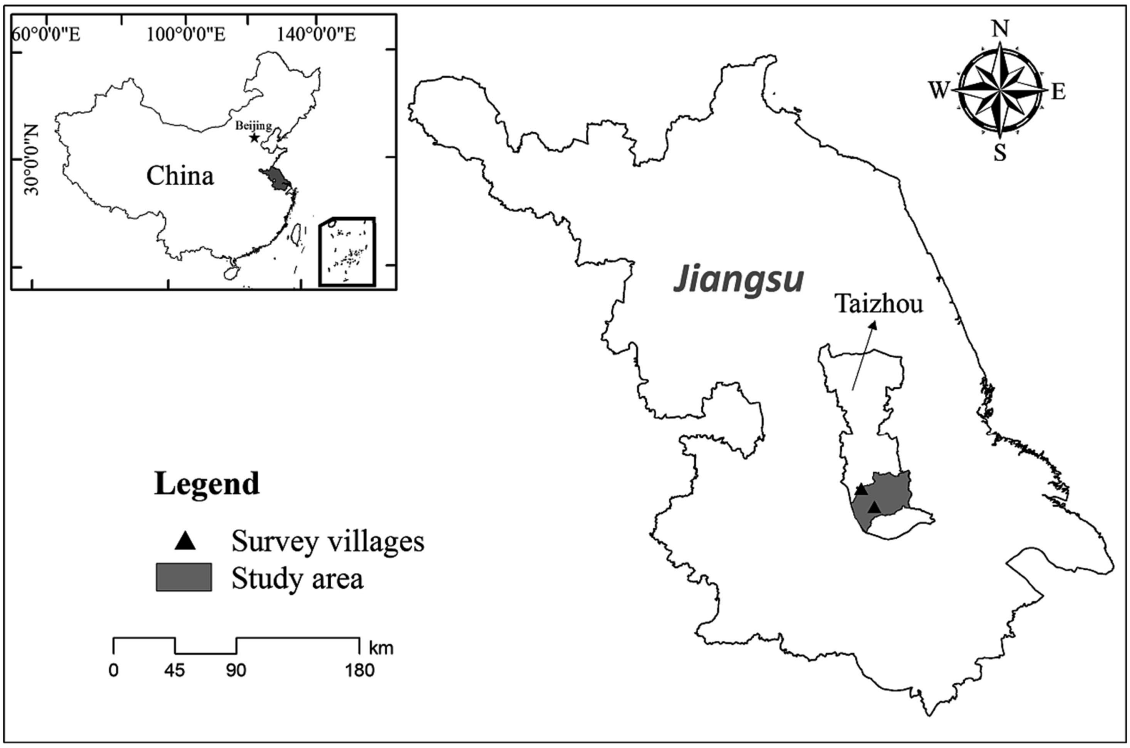

FIGURE 2
Location of the study area.

called the "living fossil and the giant panda in the plant kingdom." It is one of the most precious plants in the world, which is endowed as a first class protection and conservation plant in contemporary China. Ginkgo can be used in many fields and productions, thus it is believed to be a treasure. For instance, it not only provides forest products, such as fruits, leaves, pollen, seed coats, nursery-grown plants, and bonsai for direct sale, it also provides raw materials for industrial productions, such as pharmaceuticals, foods, and health protection products. More importantly, it has special and tremendous hereditary value including historical and cultural, scientific, and ecological values.

Second, we asked each respondent the following questions:

(1) *Would you agree that the ginkgo trees you planted can be cut down and/or be removed to somewhere else to derive some economic compensation in return?*

(a) Yes (b) No.

(2) *If you agreed that your ginkgoes can be cut down and/or removed, how much do you think you can accept as the compensation value per tree? The specific value for each type of the ginkgo tree: Large tree__________, Medium tree__________, Small tree_________. (Note: large tree: diameter ≥ 26 cm; medium tree: diameter 18-26 cm; small tree: diameter < 18 cm and height ≥ 2 m).*

Each respondent was asked to write down their answers. Table 1 shows the space provided or select from a certain set of options.

The selection of farmer samples is based on combining stratified and random sampling strategies, respectively. First, stratified sampling is carried out by using the endowment of cultivated forest land and the level of economic development. Three to four towns are selected from each county and one to two villages are further selected according to their ginkgo planting history. Finally, two villages (Zhanghe and Xiqiao) were selected. Farmer households were finally drew randomly according to a list provided by the local village committee. Two rounds of surveys, including a pre-survey of approximately 40 questionnaires and an official survey of 270 questionnaires were conducted in late 2013. By removing those questionnaires with missing information and non-responses, a total of 208 questionnaires are used to develop our estimations.

It is noteworthy that a follow-up household survey was conducted in late 2018 by our research group. This was based on semi-structured interviews. One of the main purposes of this survey was to investigate the attitudes of ginkgo farmers toward the conservation of ginkgo trees and their corresponding behaviors including their inputs in ginkgo planting, market transactions as well as the perceived WTA compensation values. According to observations based on this survey, we found that the stated WTA compensation values by our respondents were approximately the same as the values stated by respondents in 2013 by removing the impacts of inflation. This observations rreflected that our data obtained previously is reliable to a large extent.

4 Methodology

4.1 Ginkgo conservation value calculation

In this paper the conservation compensation value means the value deducted from the total economic value, i.e., including

TABLE 1 The reported range of compensation WTA values by respondents.

Size	Reported values (unit: Yuan)					
Large	3,000–4,000	4,000–5,000	5,000–8,000	8,000–10,000	10,000–12,000	Over 12,000
Medium	1,000–1,200	1,200–1,400	1,400–1,800	1,800–2,200	2,200–2,600	2,600–3,000
Small	50–100	100–200	200–400	400–600	600–800	800–1,000

Data source: authors' field observation.

hereditary, ecological, scientific, historical and cultural values, etc. The WTA value actually reflects the total value to a large extent. Specifically, the conservation compensation value is calculated using the following equations:

$$V_i = E\left(WTA_i - Price_i\right) \quad (1)$$

$$E\left(\mathrm{WTA}_i\right) = \sum X_{ij} * P_{ij} \quad (2)$$

where V_i is the conservation compensation value of ginkgo i (divided into three categories: large, medium, and small), and the conservation compensation value of the three kinds of ginkgo can be indexed as V_b, V_m, and V_s, respectively. $Price_i$ is the market price of ginkgo i, and the three kinds of ginkgo prices are indexed as $Price_b$, $Price_m$, and $Price_s$, respectively. X_{ij} denotes the bid value of WTA j of ginkgo i; P_{ij} denotes the probability of WTA j of ginkgo i. WTA_i can be replaced by WTA_b, WTA_m, and WTA_s respectively for the three kinds of ginkgo trees.

The respondents showed different levels of willingness to protect the different ginkgoes. For instance, they prefer to protect larger and more ancient trees by stating different bid values. In our analysis the conservation compensation value can be calculated by using the following formula:

$$V_{ginkgo} = \sum \frac{n_i}{N} * V_i \quad (3)$$

where $n_i = n_b$, n_m, and n_s are the sample size of large, medium, and small trees, respectively, and $N = n_b + n_m + n_s$.

The conservation compensation value per household can be calculated using the following equation:

$$V_{\mathrm{household}} = \sum V_i * E\left(ginkgo_i\right) \quad (4)$$

where $V_{\mathrm{household}}$ = conservation compensation value per household, $E\left(ginkgo_i\right)$ = the amounts of ginkgo i holds by per household.

4.2 Model specification for detecting the influencing factors

Theoretically, the factors that potentially affect farmers' conservation compensation value should include household or personal income, the quantity and quality of resources held, personal preference and cognition, and demographics based on the available literature. That is:

$$V_i = f\left(I, Q, R, S\right) \quad (5)$$

where I is household or personal income, Q is a set of quantity and quality factors of resources held by a given household. R is a set of personal preference and cognition relevant factors. S is the aggregation of demographic factors. We propose that V is a function of I, Q, R, and S in Equation (5).

Specifically, we constructed the conservation compensation value model for three sizes of ginkgo as follows in Equation (6):

$$\begin{aligned} V_i = {} & \beta_0 + \beta_1 \mathrm{age} + \beta_2 gender + \beta_3 job + \beta_4 edu \\ & + \beta_5 inc + \beta_6 \mathrm{ginkgo}_i + \beta_7 farmland + \beta_8 familiar \\ & + \beta_9 willingness + \beta_{10} bioloss + \beta_{11} importance + \mu \end{aligned} \quad (6)$$

where $gender$, job, $willingness$, $bioloss$, and $importance$ are the dummy variables. $farmland$ relates to the area of farmland a household holds (Specific variable definition is included in Table 1).

4.3 Variable definition and descriptive analysis

Generally speaking, the WTA values can be affected by individual characteristics such as gender, age, job, education, income, perception and moralities (Anderson et al., 2000; Biel et al., 2011; Kumar De and Devi, 2013). Analysis demonstrated that the WTA can also be affected by the alternatives offered (Shogren et al., 1994; Hildebrand et al., 2023), land resource endowment (Isoni et al., 2011), and other uncertainties such as natural risk and climate changing (Okada, 2010; Davis and Reilly, 2012; Kingsley and Brown, 2013). Therefore, the influencing factors are individual-specified (Ebert, 2013). Based on these studies, we focus on the impacts of household characteristics including family income, amount of ginkgo family holdings, and farmlands of family holdings. According to our field observations, it can be found that rural China currently has a large number of leftover women, elderly and children, with many young men being migrant workers. Likewise, it is commonly found that in our study region, a large number of respondents are elderly and women. The mean age of the respondents was 61.72 years, and there were slightly more females than males (53.37 and 46.63% respectively). Almost 74.04% of the respondents had primary and secondary education (43.75 and 30.29% respectively). By contrast, respondents who are illiterate or attended high school are much fewer, with the percentages being 17.31 and 8.65%, respectively.

The mean household size is 4.42. The mean household income is 70.4 thousand yuan, which is higher than the regional average level of 61.9 thousand yuan. This suggests that the surveyed villages are relatively rich villages. There were 134 persons engaged in agricultural production, amounting to approximately 64.42% of all respondents. The average number of ginkgo trees planted per household is 28.10, consisting of 6.55 large size trees, 8.54 medium size trees, and 13.01 small size tress.

Regarding the economic values, it is found that almost all of the respondents have a general knowledge on the values of the different sizes of ginkgo tree. Meanwhile, it is a widely accepted perception that ginkgo is a valuable forest species in terms of its economic, social and ecological aspects. Of the respondents, 87.98% believe that ginkgo could be directly sold as fruits, leaves, pollen, and other forest products. By contrast, 78.37% believe that ginkgo could be processed for foods, medicine, healthcare products, and other industrial goods. Fewer respondents (68.27%) know that ginkgo is an ancient tree and 71.63% know that ginkgo has other names such as "descendants tree" and/or "white fruit tree." In total, 46.15% of respondents know its functions in terms of air purification, water and soil retention. A total of 55.29% of the respondents know that ginkgo can be used for greening and regeneration. However, only a few (26.44%) know its scientific functions such as extracting substances from the ginkgo's seeds and leaves. Table 2 displays the descriptive statistics of our defined variables.

4.4 Estimation method

The contingent valuation method (CVM) has been one of the most widely used techniques for the assessment of both non-use value as well as use value for forest resources (Venkatachalam, 2004). Guided by welfare economics and expected utility maximization theories, this method first designs a survey questionnaire by assuming a hypothetical market situation. Second, the household respondents' are asked either about their willingness to pay (WTP) values or their willingness to accept (WTA) values. Given that the CVM method is more suitable for non-market valuation (Mao et al., 2012), it has been widely applied in many developed countries (Venkatachalam, 2004).

It is notable that the WTA is an important technique used in the CVM method. For instance, the National Oceanic and Atmospheric Administration (NOAA) reports that the WTP is a reliable and feasible method in value assessment analysis (Venkatachalam, 2004). Strikingly, only a limited literature uses the WTA technique in forest value assessment in the context of rural China. In contrast, the WTP method is widely used in this field (Zong, 2014). Carson et al. (2001) emphasize that whether the method of the WTP and/or the WTA is appropriate or not depends largely upon the relevant property right to the good. However, other scholars (Bishwanath and Smita, 2001) have stated that the WTP method may lead to pernicious bias in contingent valuation assessment. Thus they suggest that WTA is a relatively more accurate measurement than WTP as long as the questionnaires are designed reasonably and are treated cautiously in the survey.

Indeed, there is no consensus regarding the accuracy of CVM because of various possible biases, such as hypothetical bias, strategic bias, inducing bias, embedding bias, as well as the sampling bias (Messonnier et al., 2000; Hensher, 2010; Tunçel and Hammitt, 2014). This analysis uses the WTA technique. In order to test the validity of the questionnaire and to reveal the starting point for the bidding range, we performed a thorough pre-test questionnaire. We revised the questionnaire repeatedly according to the pre-test and collected a considerable amount of local ginkgo market information to reduce hypothetical bias in the questionnaire design.

In order to handle the potential autocorrelation or multicollinearity issues, several tests are conducted. It is found that there are no autocorrelation or multicollinearity issues (all of the VIFs are between 1.02 and 1.64). However, given that there may exist potential heteroskedasticity issues, we use the weighted least squares method for the assessments.

5 Results

5.1 Conservation value

Given that the bided WTA values reported by respondents are interval values, we calculated the WTA values by using the median of each interval value according to statistical rationality based on available analysis (Liu et al., 2008). We obtained the distribution and the mean value of three sizes of ginkgo trees according to Equations (1) and (2). It is found that five of the respondents expressed their willingness to sell their large size ginkgo trees at below market prices. A total of 19 respondents stated that they were willing to sell at market prices. For the remaining respondents, they stated their compensation value can be accepted when it is higher than the market price. Based on the stated prices mentioned above, the calculated mean compensation value for large ginkgo trees is 820.86 yuan/tree in our analysis (coefficient of variation, CV = 1.06).

Regarding the price for medium size ginkgo trees, we found that 27 respondents were willing to sell their medium ginkgo trees at market price, whereas the others (148, 84.57%) argued that they should be paid higher than the market price. The mean value of medium ginkgo tree conservation compensation is 249.03 yuan/tree (CV = 1.08), which is much lower than that for large size trees.

Regarding the price for small size trees, only one respondent was willing to be paid at a below market price and four were willing to so at market price. The remaining respondents stated that they should be paid higher than the market price. The calculated mean value of small ginkgo tree conservation compensation is lowest (71.29 yuan/tree, CV = 0.88).

The details of the conservation compensation value of large, medium, and small size of ginkgo trees are as shown in Figure 3. It is found that the dispersion in relation to the medium ginkgo conservation is the greatest, with the comparison of CVs being $CV_m > CV_b > CV_s$.

Generally speaking, the overall conservation compensation value of one ginkgo tree is 388.17 yuan according to Equation (3). The amount for the three sizes of ginkgo trees per household is 6.55, 8.54, and 13.01 yuan, respectively. According to Equation (4), the conservation compensation values per household for large, medium, and small trees are 5376.63, 2126.72, and 927.48 yuan respectively, and the overall conservation compensation value per household is 8430.83 yuan without classification.

TABLE 2 Variable definition and descriptive statistics.

Variables	Options	Descriptive statistics		Mean (SD)
		Frequency	Rate (%)	
Age	1. 30–45 years	18	8.65	61.72 (10.99)
	2. 46–55 years	39	18.75	
	3. 56–65 years	72	34.62	
	4. 66 or more years	79	37.98	
Gender	1. Female (value = 0)	111	53.37	0.47 (0.50)
	2. Male (value = 1)	97	46.63	
Education	1. No schooling (value = 1)	36	17.31	2.30 (0.86)
	2. Primary(value = 2)	91	43.75	
	3. Secondary(value = 3)	63	30.29	
	4. High school (value = 4)	18	8.65	
Job	1. Farming (value = 1)	134	64.42	0.64 (0.48)
	2. Other (value = 0)	74	35.58	
ginkgo	Ginkgo (total)	5,845	100	28.10 (50.54)
	1. $ginkgo_b$ (large, $D \geq 26$ cm)	1,362	23.30	6.55 (7.51)
	2. $ginkgo_m$ (medium, 18 cm–26 cm)	1,776	30.39	8.54 (9.01)
	3. $ginkgo_s$ (small, $D < 18$ cm; $H \geq 2$ m).	2,707	46.31	13.01 (46.51)
Knowledge of ginkgoes	1. Ginkgo is in the ancient forest category	142	68.27	–
	2. Economic forest, providing most forestry products	208	100	–
	3. Dioecious, blooming during April and May, maturing between October and November	207	99.52	–
	4. Forest products: fruits, leaves, pollen, plants, timber, etc.	183	87.98	–
	5. Can be processed for foods, medicine, health-care products, cosmetics, artware, etc.	163	78.37	–
	6. Purifies the air, retains water and soil	96	46.15	–
	7. For science: extracting substances from its seeds and leaves	55	26.44	–
	8. Used for greening and regeneration	115	55.29	–
	9. Aliases: "descendants' tree" or "white fruit tree"	149	71.63	–
Willingness	Willingness to protect ginkgoes:	158	75.96	0.76 (0.43)
	1. Yes (value = 1)	50	24.04	
	2. No (value = 0)			
WTA bids	WTA for $ginkgo_b$ (n_b = 166)	166	79.81	9,025 (8278.43)
	WTA for $ginkgo_m$ (n_m = 175)	175	84.13	2638.92 (2092.49)
	WTA for $ginkgo_s$ (n_s = 144)	144	69.23	347.48 (247.72)
Obs.	208			

Null replaced by "–"; SD, standard deviation; D, diameter; H, height.

5.2 Factors influencing conservation values for different sizes of ginkgo trees

Estimation results for factors determining the different size of ginkgo conservation values are shown in Table 3. It can be found that the influencing factors are different among three sizes of trees. Regarding the influencing factors for large size ginkgo trees, it is found that variables including age, gender, job, family income, the numbers of large ginkgo trees and farmland area have significant impacts. Specifically, family income is positively related to the conservation compensation value. Both the age and the number of large ginkgo trees have significantly negative impacts. These results demonstrated that the value of conservation compensation varies between individuals with different characteristics. For instance, the impact of age indicates that conservation compensation value decreases by 21.21 yuan when 1 year is added to the respondent's age. Similarly, the impact of the number of large size ginkgo trees show that the conservation compensation value of the large ginkgo tree increases

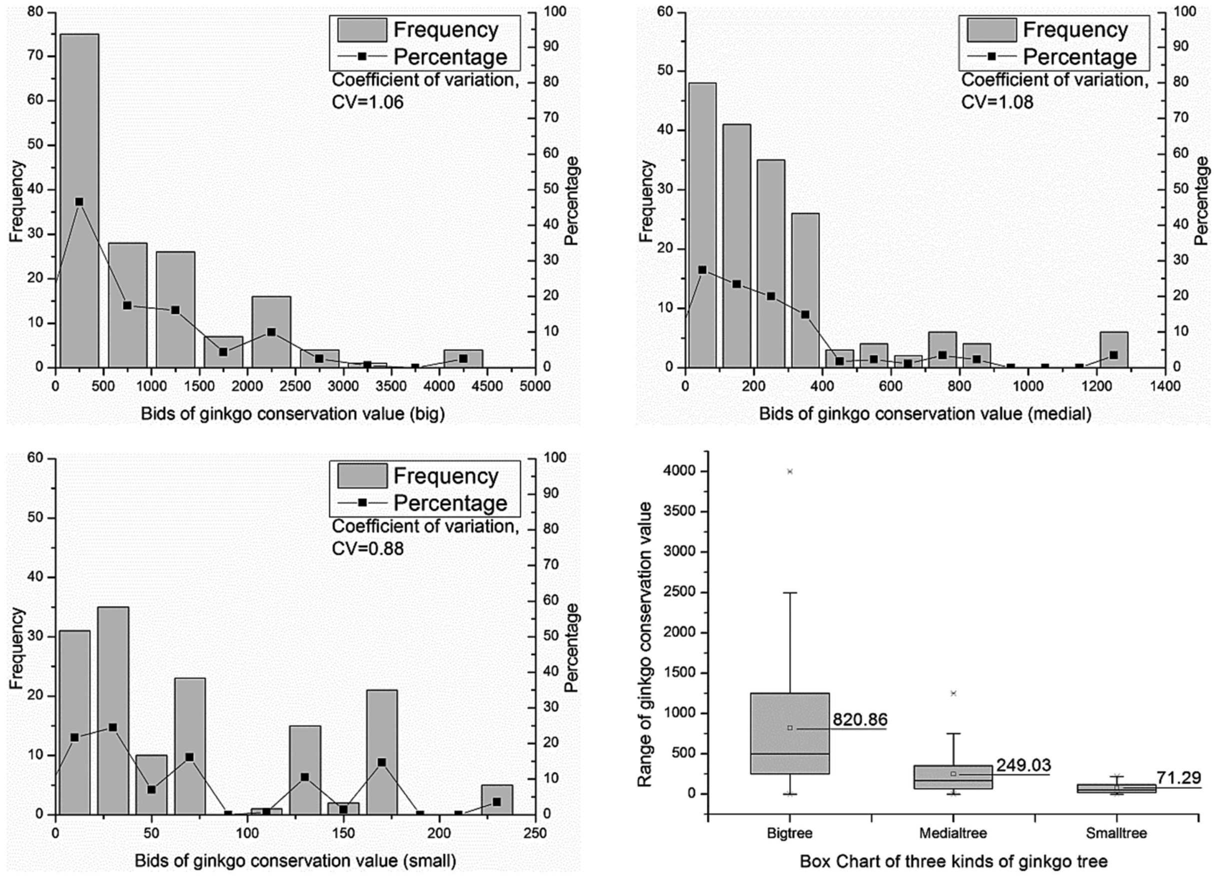

FIGURE 3
Distribution and mean values of the three ginkgo conservation compensation values.

20.85 yuan when an additional large ginkgo tree is added. In addition, the significance of gender shows that male respondents have a 351.1 yuan higher value compared to female respondents. Results also demonstrated that the average compensation value between those who engage in agricultural production is 333.2 yuan higher than migrant workers. Furthermore, the conservation compensation value decreases 132.6 yuan when 1 mu of farmland area is added.

The main significant factors influencing the conservation compensation value for a medium size ginkgo tree are farmland area and respondents' willingness to engage in tree protection. The significance shows that the conservation compensation value decreases 34.92 yuan when 1 mu of farmland area is added. In addition, the value is 135.7 yuan lower for households who are willing to protect the ginkgo trees than those who lack the willingness to protect the tree.

The main significant factors influencing the conservation compensation value for small size ginkgo trees are: the respondent's job; farmland area; and farmers' perception of the importance of the ginkgo's biodiversity. These results show that: (1) the conservation compensation value increases by 6.69 yuan when 1 mu farmland area is added; (2) the value is 22.77 yuan higher on average for respondents engaged in agricultural production compared to those engaged in migrant work; (3) those respondents who believe that ginkgo biodiversity is important reflected a 19.09 yuan lower value than those who do not.

5.3 Robustness check

Given that the reliability of CVM is still questioned by many researchers in the literature, it is necessary to conduct a reliability check in relation to this approach. Reliability refers to the robustness and the replicability of certain technique (Venkatachalam, 2004), which means that the results using the application of different techniques should be consistent and reliable.

Two approaches to reliability check measures are usually applied, namely test–retest and the convergent validity test. The test–retest technique can be categorized as using repeat respondents and a repeated sample population. The latter is more commonly used because of its potential for producing more robust results over time. The convergent validity test is based primarily on the comparison of varied assessment results on the same environmental commodity and services. For instance, the convergent validity test used in the CVM technique is generally to compare the results of WTA and WTP, based on which the degree of convergence (or not) can be identified (List and Shogren, 2002; Horowitz and McConnell, 2003; Miyake, 2010).

In this analysis, given that we failed to applied the WTP valuation because the sample was selected from the same range of respondents at the same point in time, neither the test–retest nor convergent validity test methods can be used. Alternatively, we applied the method proposed by List and Shogren (2002). In

TABLE 3 Estimation results for factors determining ginkgo conservation value.

Explanatory variables	Model (7): V_b	Model (8): V_m	Model (9): V_s
	Coefficient & Robust Std. Err.	Coefficient & Robust Std. Err.	Coefficient & Robust Std. Err.
Constant	2375.4*** (744.7)	113.6 (227.0)	59.56 (42.00)
age	−21.21** (9.157)	2.119 (2.535)	−0.589 (0.555)
gender	351.1* (206.2)	89.46 (63.26)	–
job	333.2* (199.6)	–	22.77* (12.01)
edu	−118.0 (108.8)	−9.829 (29.85)	–
inc	0.00204*** (0.000681)	−0.0000839 (0.000395)	–
ginkgo	–	0.431 (0.293)	–
$ginkgo_b$	20.85** (10.42)	–	–
$ginkgo_s$	–	–	–
farmland	−132.6* (72.98)	−34.92** (17.46)	6.689** (3.381)
familiar	−12.81 (54.87)	26.72* (14.77)	3.283 (3.210)
willingness	−166.5 (200.6)	−135.7** (61.71)	–
bioloss	14.88 (147.0)	–	–
importance	−176.9 (169.4)	42.49 (54.77)	−19.09* (11.40)
R^2	0.147	0.097	0.077
n	166	175	144

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

their study, they state that the ideal calibration coefficient for WTA based on the hypothetical market divided by the real market should range between 0.75 and 1.66, while their calculated mean calibration coefficient is 1.43. In our analysis, we calculated the average WTA values for large, medium, and small ginkgo trees are 9,025, 2,638.92, and 347.48 yuan per tree respectively, which are greater when compared to the Taixing 2012 real market technical compensation value standards (5,200, 1,500 and 425 yuan per tree, respectively, for trees with a diameter of over 50 cm, 20 cm, and 5 cm). Our results show that the WTA values are 1.74 and 1.76 for large and medium-sized trees, and 0.82 for small trees (which are lower in height). The reason for the slightly larger WTA values for both the large and medium-sized trees may be that many of the diameters of the trees examined in our analysis are greater than the Taixing standard. These results demonstrated that our estimation produced above is reliable to a large extent.

6 Conclusion and policy implication

Although numerous analyses of CVM have focused on the overall value of environmental goods and services, very little attention has been paid to the intangible value. This analysis was conducted based on employing the CVM approach for the assessment of conservation compensation value for different sizes of ginkgo trees. In addition, we also investigated the determinants of the WTA value of the ginkgo trees owners. The data set used was based on 208 households in rural Taixing,[1] China.

An intuitive finding in our analysis is that the conservation compensation value of trees for different sizes differs from each other. More specifically, larger sized trees correlate with higher conservation compensation values. The potential reason may be that the larger size means higher economic value. From the rational economist perspective, farmers would accept higher conservation compensation value if they perceive a higher value for ginkgo trees.

Regarding the determinants, demographic characteristics (such as age, gender, and job) are found to be significant. Interestingly, both age and gender are found to have mixed effects on WTA value. Namely, farmers who are older and/or are in households with a male household head are more likely to display a higher WTA value. This result is consistent with the findings by Nape et al. (2003) and Casiwan-Launio et al. (2011). In addition, we also found negative impacts for these two variables. This finding is consistent with the results generated by Tao and Wang (2020). The reason for the mixed result relating to gender may be that the ginkgo trees in our research site are mainly managed by men, hence these males display a higher WTA value than females. It may also be explained by the fact that the men are more educated than women, thus it is easier to access information on ginkgo tree conservation. By categorizing respondents' jobs into two types (farm and off-farm), we further found that farmers with farm jobs display a higher WTA value for large and small trees than those with off-farm jobs. This can be explained by the fact that those with farm jobs invest more than off-farm operators. More importantly, they may invest more emotion in trees than off-farm operators. Regarding the impact of income, despite evidence showing that it is not related to WTA, our findings demonstrated that it has a fractional positive effect on WTA for large trees.

Regarding resource endowment, our findings show that the number of large ginkgo trees is positively related to WTA. A similar finding was also obtained by Danne and Musshoff (2022). The area of farmland is negatively related to the WTA for both large and medium-sized trees. This finding is reasonable according to our fieldwork observations. We found that farmers in our research area are prone to approving the removal of existing ginkgo trees even at a lower WTA in order to set aside more farmland for economic crop cultivation. The findings by

1 We acknowledge that the data set used for developing our estimations is relatively old and this is a shortcoming of this paper. However, according to our follow-up interview documents, it seems that this does not significantly influence our current findings given that the WTA values obtained in two survey rounds are close. This reflects that our conclusions in this analysis are convincing to a large extent. Future analysis in this field is suggested to use a recent data set while further exploring the specific influencing mechanisms for the identified determining factors in our estimation analysis.

Lindhjem and Mitani (2012) are consistent with our result. In contrast, for the WTA of small size trees, farmland area is found to be positively related. The reason may due to the different objectives of raising small trees in contrast to large and medium-sized trees. Selling young trees is also a way of making a living for local farmers. Hence, to compensate for the loss of removing their small ginkgo trees, they require a higher WTA.

Among the perception factors, the extent of familiarity with ginkgo trees' overall value show a significantly positive effect, meaning that farmers with more knowledge of ginkgo trees' value display a higher WTA. However, the effect of this factor is found to be counter-intuitive in the case of small ginkgo trees. One possible reason might be that we did not control sufficiently for some unobserved effects in terms of the differences between different sizes of ginkgo trees.

Given that ginkgo trees provide not only use but also intangible value in terms of maintaining and inheriting valuable species, it is unfair for the public or society to put the sole responsibility for conservation on farmers. From this perspective, the policy implication is that to induce farmers' enthusiasm for ginkgo resource conservation, a payment (subsidy) for compensation is necessary and essential. The standard should not be lower than the WTA value.

Based on the findings of the factors affecting the three kinds of conservation compensation values for different sizes of ginkgo trees (large, medium, and small), we demonstrate that the influencing factors are different between households holding different sizes of ginkgo trees. Thus, from the policy implication perspective, the implementation of policies relevant to ginkgo conservation should be situation specific. For instance, the policy propaganda generated should be different according to the ginkgo tree endowment and the characteristics of farmers in a given region.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

XD: Conceptualization, Data curation, Formal analysis, Resources, Software, Writing – original draft, Writing – review & editing. LP: Conceptualization, Data curation, Funding acquisition, Project administration, Resources, Supervision, Visualization, Writing – original draft. DJ: Investigation, Validation, Visualization, Writing – review & editing. YZ: Investigation, Validation, Visualization, Writing – review & editing. FR: Conceptualization, Investigation, Software, Writing – review & editing.

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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.

Publisher's note

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