Forest Policy and Economics 118 (2020) 102216

Contents lists available at ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

Assessing the economic value of an iconic urban heritage tree

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ARTICLE INFO

Keywords:
Urban heritage trees
Contingent valuation method
Economic value
Multinomial logistic regression

JEL classification:
Q23
Q57
R11

ABSTRACT

This study adopted the contingent valuation method (CVM) to estimate the annual economic value of Qiedong-Wang-Gong (*Bischofia javanica*), the only urban heritage tree that was over a thousand years old in Taiwan, having the largest population in Central Taiwan. In this study, 307 samples were collected and classifying and excluding the protest responses, which took up about 26.7% of the whole sample, resulted in a 36.4% increase in the mean overall WTP. Results indicated that the respondents who ascribed low importance to the existence values of urban heritage trees and those who had never heard of Qiedong-Wang-Gong (or showed little concern about regular payment for protecting urban heritage trees) were more likely not to pay for conserving Qiedong-Wang-Gong. The results also showed that the respondents whose ages ranged from 31 to 50 were likely to pay more than others for Qiedong-Wang-Gong conservation. Using multinomial logistic regression for further analysis, we found that older respondents were more familiar with Qiedong-Wang-Gong than younger ones. To bring more economic benefits of urban heritage trees management, our results suggested that local policymakers should improve young citizens' familiarities with local old trees by linking these green resources with the local culture.

1. Introduction

Heritage trees are precious cultural heritage for local residents, and have close relationships with them from beliefs and culture as well as allusions and legends to traditional customs, which are “dependencies among human, trees, and environments”. However, it is costly to protect heritage trees. Maintenance of heritage trees involves various costs, including smaller cost on plant disease and pest control, and greater cost on slope treatment (Luo, 2008). This study focuses on heritage trees growing in urban areas (a.k.a., urban heritage trees), whose existence may be in conflict with urban development. For instance, some cultural assets in Taiwan have been dismantled or removed since they did not withstand the pressure of urban development from stakeholders. Many other cities in the world have also faced the difficulties between urban development and preservation of green space (Jim and Shan, 2013). Because urban heritage trees serve as symbols of both cultural assets and green space, assessing the economic value of urban heritage trees has been one of the most important issues in planning urban space.

In addition to the use value, urban heritage trees include the nonuse value[1] such as the existence value and the bequest value, which are hard to be completely assessed by trading in markets. Nonmarket valuation is used in economic studies to appraise environmental goods and services that cannot be traded directly in markets. Specifically, nonmarket valuation involves ascribing monetary value to nonmarket goods, such as natural landscapes and public spaces, and plays a critical role in decision-making regarding environmental planning and management (Börger, 2013; Jim and Chen, 2009; Vandermeulen et al., 2011). The contingent valuation method (CVM) is the most widely used approach for assessing the nonuse value (NUV) of goods (Botzen and van den Bergh, 2012), and in particular for determining the existence value people attribute to public goods in urban areas, including urban trees and green spaces (Tyrväinen and Väänänen, 1998; Jim and Chen, 2006; Vesely, 2007; Bernath and Roschewitz, 2008; Lo and Jim, 2010; Brander and Koetse, 2011; Majumdar et al., 2011).

The CVM is a stated preference technique. In this method, questionnaires are used to assess the public's value preferences regarding environmental goods and services. The purpose of CVM questionnaires is to investigate the economic preference of respondents, and the results may be used to represent the preference of a given population. The

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[1] In economics, the nonuse value generally includes the following values. (1) Existence value: It is the value of satisfaction for knowing intact existence of a nonmarket good. No matter whether the individual does or will use the goods, the individual's satisfaction is not affected. (2) Bequest value: It is the value of satisfaction for a good that this generation do not use but preserve to the next generation to use (Becker and Freeman, 2009).

https://doi.org/10.1016/j.forpol.2020.102216
Received 23 February 2020; Received in revised form 17 May 2020; Accepted 17 May 2020
Available online 20 June 2020

institutional context of a questionnaire is based on a trade-off between personal income and environmental quality under hypothetical environmental changes. Individuals are asked to specify the maximum amount of money they are willing pay to prevent a certain negative environmental change. The maximum price that people are willing to pay, or their willingness to pay (WTP), is then aggregated and taken as the underlying value of the specified environmental goods or services.

Heritage trees are valuable parts of local heritage, and people often experience close connections with heritage trees in the areas where they live. Such trees could be part of someone's childhood memory, a connection to older generations and relatives, or carry bequest value for the subsequent generations. Evident in various beliefs, cultures, legends, and customs, the interdependency of human beings, trees, and the greater environment (Fu et al., 2010) demonstrates the high emotional and existence value of heritage trees. In recent years, many sources of Taiwanese cultural heritage have been demolished for urbanization under the influence of interested parties. This trend has incited enhanced efforts to preserve Taiwan's sources of cultural heritage (Yang, 2014). Luo (2008) reported possible measures for the protection of heritage trees, including taking a census of all heritage trees in Taiwan, establishing scientific methods for heritage tree protection, increasing relevant legislation, and deepening people's identification with local culture. Protection measures could cost anywhere from a few thousand New Taiwan Dollars (NTD) for pest prevention to hundreds of thousands of NTD for slope treatment (Luo, 2008). Urbanization has become the greatest challenge to the preservation of green spaces (Jim and Chen, 2006). Thus the assignment of monetary value to the intangible value of heritage trees is critical in urban planning. Monetary valuation emphasizes the heritage trees' NUV, in particular their existence and bequest values.

This study targeted at Qiedong-Wang-Gong (*Bischofia javanica*) in Taichung City (which is the only urban heritage tree over a thousand years old in Taiwan), adopted the CVM and a questionnaire survey to assess the economic value of Qiedong-Wang-Gong, and employed the binary logistic regression and the ordered probit model to investigate the factors that had remarkable influence on whether the residents were willing to pay and their WTP.

2. Methods

2.1. Contingent valuation method

Among various monetary valuation methods, contingent valuation is often referred to as a stated preference (SP) method. Under revealed preference methods, namely travel cost method and hedonic price method, price fluctuations and transaction cost in markets or quasi markets are used as the bases for determining monetary values. By contrast, in the CVM, an economic entity's preference-based statements in hypothetical scenarios are used as the basis for the determination of nonmarket monetary value. Price fluctuation of the NUV of a nonmarket good cannot be observed. Thus, CVM, among other SP methods, may be used as a systematic approach to determine NUVs. In economic research, NUV comprises the following two values: (1) existence value, which refers to conditions where an individual is satisfied with the integrity of nonmarket goods, and the level of satisfaction is not affected by whether the goods can be used on-site, either in the present or future, and (2) bequest value, which refers to the value of preserving goods for future generations (Becker and Freeman, 2009).

2.2. Payment card approach and methods

The CVM is the only recognized method for determining the NUV of goods (Botzen and van den Bergh, 2012), and particularly the NUV of nonmarket goods, including public environmental goods. Four main techniques may be used in the CVM: open-ended approach, bidding game approach, payment card approach, and dichotomous choice approach (Huang, 2013). Open-ended approach lacks a standard basis and often results in a low response rate regarding WTP when respondents are unfamiliar with the hypothetical market. Bidding game approach offers greater flexibility for respondents but requires skilled interviewers to ensure reasonable bids. Furthermore, this technique is time consuming and is restricted to face-to-face interviews. Dichotomous choice approach requires complex statistical models and may produce strategically biased results because model accuracy is susceptible to the influence of model functions. In the present study, payment card approach was used. Respondents were asked to choose their highest WTP from a set of listed amounts. In payment card approach, a respondent's WTP is assumed to be between the chosen amount and the next highest value on the questionnaire. Cameron and Huppert (1989) proposed a statistical model for use in regression analysis of variables with interval structures. This model was later applied to CVM research based on payment card approach (Majumdar et al., 2011; Chen and Qi, 2018). Payment card approach was used in this study to prevent a low response rate regarding WTP, which is often observed in studies using the open-ended approach; respondents were presented with a list of values to choose from. The WTP equation in maximum likelihood estimation (Cameron and Huppert, 1989) is as follows:

$$\log(WTP_i) = X_i'\beta + \varepsilon_i \tag{1}$$

where i represents the sample size from 1 to N; X_i is the vector of explanatory variables; ε_i is the residual, which is assumed to follow a normal distribution whose standard deviation (σ) is between 0 and 1; and WTP_i represents the actual WTP of respondents, which is between WTP_i (lower bound) and WTP_{i+1} (upper bound). Incorporated into the probability function, the choice function for respondents in the intervals is as follows:

$$\Pr(t_i) = \Phi\left(\frac{\log t_i - X_i'\beta}{\sigma}\right) - \Phi\left(\frac{\log t_{i+1} - X_i'\beta}{\sigma}\right) \tag{2}$$

where Φ represents the cumulative density function of standard normal distribution. We first calculate the sum of N independent variables and then take the log of the likelihood function as follows:

$$\log L = \sum_{i=1}^{n} \log\left[\Phi\left(\frac{\log t_i - X_i'\beta}{\sigma}\right) - \Phi\left(\frac{\log t_{i+1} - X_i'\beta}{\sigma}\right)\right] \tag{3}$$

By calculating the lognormal distribution of respondents' WTP, we can calculate respondents' maximum WTP by taking the anti-log of the function.

If unequal-distance WTP levels are considered in the design of the payment card format, or only the factors affecting the WTP scale of respondents are discussed (i.e., the marginal effects are not discussed), then the ordered probit model can be used as the empirical model. Supposing the design of the payment card format, the WTP is divided into K levels. Then, the regression model is expressed as follows:

$$Z_i^* = X_i'\beta + \varepsilon_i \tag{4}$$

$$Z_i = 1, \text{ if } Z_i^* \le \mu_1;$$

$$Z_i = 2, \text{ if } \mu_1 < Z_i^* \le \mu_2;$$

$$Z_i = K, \text{ if } \mu_{K-1} < Z_i^* \tag{5}$$

Let $\mu_0 = -\infty$ and $\mu_K = \infty$ for $k = 1, \ldots, K$. Then, the above equation can be expressed as follows:

$$Z_i = k \text{ if } \mu_{k-1} < Z_i^* \le \mu_k \tag{6}$$

where Z_i is the WTP level of respondent i, and has the ordered property, in which a large Z_i value implies a higher WTP level; and Z_i^* represents a latent variable that is not directly observable, in which the real WTP of the respondent cannot be estimated by the questionnaire survey, or the respondent cannot express his/her own impression and willingness to form a tendency or intention that affects the real WTP. Based on N –

1 cut points $\mu_1, \ldots, \mu_{N-1}$, the range of Z_i is sliced into N intervals. If ε_i follows a standard normal distribution whose accumulative distribution function is $\Phi(.)$, then the conditional probability of Z is expressed as follows:

$$\begin{aligned} P(Z_i = k \mid X) &= P(\mu_{k-1} < Z_i^* \le \mu_1 \mid X) \\ &= P(\mu_{k-1} < X_i'\beta + \varepsilon_i \le \mu_1 \mid X) \\ &= \Phi(\mu_1 - X_i'\beta) - \Phi(\mu_{k-1} - X_i'\beta) \end{aligned} \tag{7}$$

Consider the following index variable d_{ik}:

$$d_{ik} = \begin{cases} 1, & \text{if } Z_i = \mu_k; \\ 0, & \text{if } Z_i \neq \mu_k. \end{cases} \tag{8}$$

Then, the log likelihood function of the ordered probit regression model is expressed as follows:

$$\log L = \sum_{i=1}^{I} \sum_{k=1}^{K} d_{ik} \log[\Phi(\mu_1 - X_i'\beta) - \Phi(\mu_{k-1} - X_i'\beta)] \tag{9}$$

2.3. Empirical model

Under the CVM for determining respondents' WTP in hypothetical markets, respondents first decided whether they were willing to pay. The willing participants then evaluated their WTP and chose a value stated on a card. This procedure involved two decision-making stages. Following previous studies, samples were separated into two main groups for two-stage analysis (Bernath and Roschewitz, 2008; Lo and Jim, 2015; Chen, 2015). In the first stage, respondents were classified into two groups: one with positive WTP and the other with zero WTP. Binary logistic regression was then used to analyze factors. The second stage was only applicable to respondents with positive WTP. Herein, the WTP value was considered to be a dependent variable and was analyzed.

$$\text{First stage: } T_i = \begin{cases} 1, \text{ if } bX_i' + u_i > 0; \\ 0, \text{ if } bX_i' + u_i \le 0. \end{cases} \tag{10}$$

$$\text{Second stage: } Z_i^* = X_i'\beta + \varepsilon_i \tag{11}$$

$$Z_i = k, \text{ if } \mu_{k-1} < Z_i^* \le \mu_k \tag{12}$$

where T_i is adopted to investigate the binary variable of the WTP of respondent i; X_i is the explanatory variable in the regression model; b represents vectors of parameters of the binary logistic regression model at the first stage. The equations in (11) and (12) at the second stage are the ordered probit regression model, which has been mentioned above.

3. Research method

3.1. Study region

According to the Taichung City Self-government Laws and Regulations Regarding the Protection of Urban Heritage Trees (Draft), a tree that meets one of the following conditions may be listed as a heritage tree: (1) age over 100 years, (2) circumference at breast height over 4.7 m, and (3) over 1.5 m diameter at breast height (United Daily News, 2011). Heritage tree number 6, Qiedong-Wang-Gong, located in the West District of Taichung, is over 1000 years old and is honored as a "treasure of Taichung" (Figs. 1–3). Stretching 30 m above the ground, and with a canopy coverage spanning over 1500 m^2, Qiedong-Wang-Gong is the oldest specimen of *Bischofia javanica* in Taichung (excluding those in forest compartments). It is also the only 1000-year-old tree in the city center (Information Bureau of Taichung City Government, 2015). Qiedong-Wang-Gong is robust and massive. Approximately 15 m from the tree trunk, second and third generation trees are sprouting from the roots. The surrounding township was originally called Qiedong-Jiao. Qiedong-Wang-Gong became respected by the locals and served as a religious site. A temple is located beside the tree. In the temple, Lü-Mian-Shu-Shen ("green-faced tree god") is worshipped, and a stone tablet stands beside the temple. Qiedong-Wang-Gong's birthday is celebrated every year during the Mid-Autumn Festival, which falls on the 15th of August in the lunar calendar. On that day, many believers who are qi-zi ("godchildren") of Qiedong-Wang-Gong return to pay respect to Qiedong-Wang-Gong and to change their xianghuo-dai (incense bags worn as amulets; Shen, 2016)

At the end of 2012, a 28-story building with a market value of over

Fig. 1. Side view of Qiedong-Wang-Gong.

Fig. 2. Full view of Qiedong-Wang-Gong.

Fig. 3. Sign indicating Qiedong-Wang-Gong as a protected tree.

Fig. 4. Overlap of residential construction site (yellow frame) and root zone of Qiedong-Wang-Gong (green circle) in 2013 in West Dist., Taichung City; photo from United Daily News, 2013. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

three billion NTD was planned for construction next to Qiedong-Wang-Gong. Locals quickly reacted to the plan, demonstrating concerns that the building would block sunshine for Qiedong-Wang-Gong and affect the tree's access to underground water (Fig. 4). Locals and non-governmental organizations cofounded the Qiedong-Wang-Gong Protection Union to protect Qiedong-Wang-Gong (Lin, 2015). The then Mayor of Taichung, Chih-Chiang Hu, and the then Minister of the Interior, Hong-Yuan Lee, exhibited deep concern for the matter and requested that the building location be changed. For the relocation, a reward for urban building capacity transfer was offered (Shen, 2016). In September of 2013, the construction company announced suspension of construction and returned deposits totaling over three hundred million NTD for more than 300 presold apartments (Hong and Chen, 2013). The company later donated the land to the government, accepted the reward for urban building capacity transfer, and sought another construction site (Shen, 2016). Thus, this conflict between urban development and environmental protection in Taichung City was resolved. This case was the first in Taiwan where presale construction was suspended for environment protection causes (Hong and Chen, 2013; Shen, 2016).

After his inauguration as Taichung City Mayor in December 2014, Chia-Lung Lin converted the donated land into a park with a playground for children. A concrete pavilion and asphalt pavements nearby were demolished, and the underlying areas were covered with gravel and grass to improve pavement permeability. Plans were established to plant additional *Bischofia javanica* in the Qiedong-Wang-Gong Ecological Park (Shen, 2016). In the coming few years, the Taichung City Government will further enhance the ecological park by integrating a playground, i-Bike, and other public transportation options, and by recruiting a tree doctor team and beginning a palaeoecological study, improving pavement permeability, and planting more trees. The purpose of these measures is to enhance local ecological development and environmental sustainability and to establish the ecological park as the new natural landmark of Taichung as well as an urban space for leisure activities (Information Bureau of Taichung City Government, 2015).

Land development in the area is extremely lucrative, and related regulations are lacking at the central-government level; the heritage trees are only protected by city self-government ordinances (Zhang, 2011). Heritage trees are closely connected to early settlements, developments, daily life, and religion. They have weathered environmental changes, and they possess significant value in culture and local consciousness. Thus, the protection of heritage trees facilitates the preservation of this critical environmental resource (Huang, 2013).

The CVM may be used to determine the intangible values, specifically the existence and bequest values of nonmarket goods and of urban heritage trees (UHT) according to the perceptions of locals. The majority of locals believe that the preservation of public goods with cultural and ecological value is a responsibility of the government. Therefore, a high proportion of protest responses are often collected in related surveys. Nevertheless, these survey results can serve as a reference for the applicability of the CVM theory in this context (Lo and Jim, 2015).

3.2. Questionnaire design

The questionnaire comprised five parts. Part 1 listed statements regarding the value of heritage trees, including the cultural and bequest values of UHT and the ecological and recreational values of ordinary urban trees. Respondents' valuation of heritage trees was measured using a five-point Likert scale. Part 2 addressed the familiarity of respondents with UHT. Questions included frequency of visits to UHT in recent years, level of support for current UHT protection measures, level of importance of heritage tree protection to respondents, and level of satisfaction with the state of UHT protection. Under level of importance of heritage tree protection to respondents, the nine items regarding current heritage tree protection measures included central-government-level regulation, city-government-level ordinance, pest prevention, and physical tree supports (Qiu, 2011; Li et al., 2012; Table 1). The purpose of this question was to clarify the relationship between respondents' level of support for various tree protection measures and their WTP. The question was designed to ensure that respondents were informed of the major current heritage tree protection measures, and thus to prevent information bias and enhance the reliability of the WTP results (Mitchell and Carson, 1989; Arrow et al., 1993; Blomquist and Whitehead, 1998; Noonan, 2003; Venkatachalam, 2004; Day et al., 2012). In the final section of this part of the questionnaire, respondents were required to indicate their level of satisfaction with the state of heritage tree protection. The citizens' (respondents') perceived the local government as a provider of public goods. From their perspective, the local government should be responsible for the protection of heritage trees as per city-government-level ordinance. Therefore, the WTP of respondents to protect heritage trees was highly affected by their attitudes toward the role of the government in such protection measures.

In the third part of the survey, the WTP of respondents was determined to enable calculation of the monetary value of Qiedong-Wang-Gong. Before this part of questionnaire was administered, articles about Qiedong-Wang-Gong and four photos shot on-site were presented. Respondents were required to first indicate whether they had heard of Qiedong-Wang-Gong, followed by their yearly WTP for protection of this 1000-year-old urban tree. A payment card approach with ten WTP levels (0–1000 NTD) was used for this question.

A high monetary value for the stonewall trees in Hong Kong was reported by Lo and Jim (2015). The per month per person WTP was 60.9 HKD, which translated to 730.8 HKD (approximately 2800 NTD / year / person). Lo and Jim (2010) analyzed urban green spaces in Hong Kong and assessed their monetary values. They noted that over 70% of respondents visited urban green spaces for recreational purposes at least once a week, and per month per person WTP to maintain green spaces was 77.43 HKD (approximately 3600 NTD per year per person). These results indicated that Hong Kong residents exhibited a high regard for urban green spaces, and accordingly the WTP to protect stonewall trees higher than that the WTPs for other regions. In addition, the WTPs calculated by Bernath and Roschewitz (2008) and Vesely (2007) for the protection of Zurich and New Zealand urban forests were 2700–3700 NTD per year per person.

With respect to all factors affecting respondents' payment decisions,

Table 1
Design of the questionnaire in this study.
Source: Rearranged from questionnaire of this research.

Category	Question	Options	Reference
Socioeconomic background	Gender	Male = 0; female = 1	Lo and Jim (2015)
	Age	Continuous variable (years old)	
	Education	College and above = 1; high school and below = 0	
	Annual income	Continuous variable (NTD / year)	
	Length of residence in central Taiwan. (Taichung, Changhua and Nantou)	Continuous variable (years)	
Recognition of heritage tree values	Cultural value (4 items)[1]	Strongly disagree = 1; disagree = 2; neutral = 3; agree = 4; strongly agree = 5	Huang (2013); Chen (2015)
	Environmental value (6 items)[2]		
	Existence value (2 items)[3]		
	Bequest value (2 items)[4]		
	Recreational value (3 items)[5]		
Familiarity with UHT	Frequency of visits to heritage trees in recent years	Continuous variable (times/year)	Chen and Hua (2015)
	Level of support for current heritage tree protection measures (9 items)[6]	Highly unsupportive = 1; unsupportive = 2; neutral = 3; supportive = 4; highly supportive = 5	Chen (2015)
Recognition of the importance of heritage tree protection (7 items)[7]		Strongly disagree = 1; disagree = 2; neutral = 3; agree = 4; strongly agree = 5	Huang (2013)
Level of satisfaction with the state of heritage tree protection		Highly dissatisfied = 1; dissatisfied = 2; neutral = 3; satisfied = 4; highly Satisfied = 5	Chen (2015)
Have you heard of the 1000-year-heritage tree, Qiedong-Wang-Gong?		Yes = 1; no = 0	Lo and Jim (2015)
WTP to protect Qiedong-Wang-Gong		Payment card approach (0 / 10 / 25 / 50 / 75 / 100 / 250 / 500 / 750 / 1000 NTD per year)	
Reasons affecting payment decision	Protest responses (6 items)[8]	Strongly disagree = 1; disagree = 2; neutral = 3; agree = 4; strongly agree = 5	Grammatikopoulou and Olsen (2013)

[1] Cultural value: (1) Heritage trees are significant local cultural assets, (2) religious sites, and (3) venues for local celebrations and festivals. (4) Heritage tree legends serve as critical local features.

[2] Environmental value: (1) Heritage trees provide shade, (2) purify air, (3) regulate temperature, (4) beautify the township, (5) contribute to environmental education, and (6) provide habitation for animals.

[3] Existence value: (1) Heritage trees possess existence value and should be protected; (2) the existence of heritage trees pleases me.

[4] Bequest value: (1) Greater age of a tree corresponds with higher value for the tree; (2) the values of heritage trees that are preserved for the future generations increase with time.

[5] Recreational value: (1) Heritage trees are critical landmarks that (2) enhance recreational spaces, and (3) enable future recreational development.

[6] UHT protection measures: (1) Law enactment at central-government level, (2) ordinance enactment at local government level, (3) periodic government-sponsored evaluation of heritage tree health condition, (4) periodic watering and fertilization, (5) pest prevention, (6) physical tree supports, (7) fences set up around heritage trees, (8) periodic pruning of tree crowns, (9) periodic public forums regarding UHT protection projects.

[7] Recognition of the importance of heritage tree protection: (1) Respondents expect that the heritage trees will survive. (2) Respondents anticipate raising awareness regarding heritage trees. (3) Respondents are emotionally attached to local heritage trees. (4) The protection of heritage trees must be ensured through law or ordinance enactment. (5) The transplantation of heritage trees due to building construction should be avoided. (6) The importance of UHT preservation surpasses the importance of the construction of buildings and infrastructure. (7) The importance of UHT preservation surpasses that of land revitalization.

[8] Protest responses: (1) Current UHT protection measures are not effective enough. (2) UHT should not be considered in terms of monetary value. (3) Local government should allocate funds for UHT protection. (4) Minimal protection is required when heritage trees are healthy. (5) Relying on only a few donors for UHT protection is unfair. (6) Fund raising is only necessary in emergency situations (such as conflicts with land developments, plant disease, or pest damage).

Part 4 addressed the dimension of protest responses. A five-point Likert scale was employed to measure the respondents' levels of agreement with various items. Contrasting with most CVM-related studies, the present study measured the protest responses of all respondents to confirm whether noneconomic factors, including the respondents' protest responses, affected the respondents' WTP (Jorgensen and Syme, 2000; Meyerhoff and Liebe, 2006; Lo and Jim, 2015). Six of the items most frequently discussed in the dimension of protest responses in CVM-related studies (Lo and Jim, 2015; Grammatikopoulou and Olsen, 2013)—fairness, necessity, efficacy, level of acceptance to elicitation method, and government responsibility—were presented in the protest response section to determine the relationship between protest responses and payment decision for the protection of heritage trees. Part 5 addressed the respondents' socioeconomic background. To suit the requirements for analysis of monetary value ascribed to heritage trees, variables were selected according to respondent gender, age, annual income, education, and length of residence (Becker and Freeman, 2009; Chen, 2015; Lo and Jim, 2015), to evaluate whether they affect whether respondents were willing to pay and their WTP for protesting urban heritage trees.

Regarding the dimension of recognition of the value of heritage trees, Chen (2015) indicated that the use value of UHTs exhibited a greater effect on CVP than NUVs. Studies have also revealed that respondents with higher levels of agreement regarding heritage trees' cultural and recreational values corresponded with higher CVP rates. Thus, we deduced that respondents' approval toward NUV reflected only the individuals' moral considerations but exhibited little effect on CVP-related decision (García-Llorente et al., 2011). However, Becker and Freeman (2009) indicated that in Israel, local residents tended to exhibit higher WTP in terms of heritage trees' NUVs than use values, because heritage trees were sparse, and local residents rarely visited them. Moreover, some heritage trees were located in deserted areas or in rugged terrain, which resulted in low use value. However, the heritage trees possessed NUVs (existence and bequest values). Thus, residents' CVP was based mainly on the recognition of heritage trees' NUVs.

Regarding the familiarity dimension, Becker and Freeman (2009) and Majumdar et al. (2011) identified a positive correlation between WTP and frequency of visits to heritage trees or urban forests. Chen (2015) indicated a positive correlation between CVP and level of satisfaction with the current state of heritage tree protection. In terms of protest responses (noneconomic factors), Bernath and Roschewitz (2008) indicated a negative correlation between level of agreement with "the government should be responsible for protecting heritage trees," and both CVP and WTP results. Lo and Jim (2015) revealed that respondents who agreed more with the statements "relying on a few

donors is unfair" and "current heritage tree protection measures are not effective enough" exhibited lower CVP and WTP.

Under the dimension of familiarity with heritage trees, Becker and Freeman (2009) and Majumdar et al. (2011) indicated that frequency of visits to heritage trees and urban forests was positively correlated with WTP. Chen (2015) proposed that respondents with relatively high approval of current protection measures corresponded with a higher rate of CVP; additionally, the familiarity with the protection measures was positively correlated with CVP and WTP. The aforementioned findings reflect assessments of urban and heritage trees in general.

4. Empirical results and discussion

4.1. Survey statistics

The questionnaire respondents were residents with full legal responsibility in Taichung City. This heritage tree is precious cultural heritage for Taichung residents, and has close relationships with them from beliefs and culture as well as allusions and legends to traditional customs, which may not be meaningful to residents from other areas. In order to know the value of the tree in Taichung, questionnaire respondents are samples from the residents in Taichung City. The survey was administered from August to September 2017. Convenience sampling and snowball sampling were conducted at parks, schools, and urban green paces near Qiedong-Wang-Gong, where numerous people gather. A total of 341 questionnaires were distributed; 307 valid questionnaires were retrieved; and the completion rate was 89.94%.

4.2. Reliability analysis

The research questionnaire was designed based on the CVM, and all retrieved samples were numbered and analyzed using SPSS 22.0. Various statistical analysis techniques were chosen according to data types and hypotheses.

Cronbach's alpha was used to assess the reliability of the questionnaire. In addition to socioeconomic background, the questionnaire covered three dimensions. Dimension one was based on recognition of UHT values, including use values (ecological, cultural, and recreational value) and NUVs (existence and bequest value). Dimension two was based on familiarity with UHT. Questions included frequency of visits to UHT, level of support for current heritage tree protection measures, level of importance of heritage tree protection to respondents, level of satisfaction with the state of UHT protection, and level of satisfaction with state of heritage tree protection. Dimension three addressed the reasons for payment decisions based on presentation of the protest response items. These three dimensions were analyzed individually and together for reliability to assess internal consistency.

Results revealed that the value of Cronbach's alpha was 0.926 for recognition of UHT values, 0.890 for familiarity with UHT, 0.560 for reasons for payment decision, and 0.926 for these three dimensions together. Higher values of Cronbach's alpha indicated higher consistency in question content. As indicated in Table 2, Cronbach's alpha values for the recognition of UHT values and familiarity with UHT were higher than 0.8.Thus, these two dimensions exhibited high reliability. However, reasons for payment decision had a Cronbach's alpha value of 0.7, indicating low reliability. Lo and Jim (2015) reported a reliability value lower than 0.7 for protest responses; the researchers attributed this result to the design of the questionnaire used in the study. In most related studies, protest response has only been measured for respondents with zero WTP. However, in this study, all respondents were required to answer questions regarding their protest responses. This approach led to inconsistency in protest responses and nonprotest responses. However, the overall Cronbach's alpha was greater than 0.8, indicating satisfactory reliability.

Table 2
Reliability analysis results on various dimensions.
Source: Questionnaire used in this study.

Dimensions	Number of items	Cronbach's alpha
Recognition of UHT value	17	0.926
Familiarity with UHT	18	0.890
Reasons for payment decision	6	0.560
Overall	43	0.926

4.3. Descriptive analysis

Table 3 presents the socioeconomic data of respondents. Of the respondents, 45.61% of the sample population was male; ages were 18 to 80, average age was 34; average annual income was 209,120 NTD; 81.4% of the respondents were college graduates; 83.4% of respondents were residing in central Taiwan (Taichung, Changhua and Nantou); and average length of residence was 16.8 years.

With the exception of "religious center" and "venue for local celebrations and festivals," all items corresponding with the variable of recognition of heritage tree values received average scores over 4, reflecting respondent agreement or high agreement with the value-related characterizations (Table 4). The results for "religious center" and "venue for local celebrations and festivals," were between neutral and agreement. "Provide shade," "provide habitation for animals," and "purify the air" scored the highest among all items.

Results for the dimension of familiarity with UHT revealed that respondents visited UHT an average of 2.1 times per year. Overall support levels for UHT protection were between supportive and very supportive. Among the items, "regular public forum," "enactment of law to protect heritage trees at central-government level," and "fences set up for protection" received the lowest scores, with responses between neutral and agree. However, a higher proportion of agreement was evident for "expect the survival of heritage trees" and "raise awareness regarding heritage trees." An average score of 3.03 was observed for the item "level of satisfaction with state of UHT protection," and an exceptionally low proportion of respondents agreed with the statement, at 21.81%. Most of the respondents were unfamiliar with the state of UHT protection, reflected in the 58.3% of neutral responses for this item. Only 106 respondents (35.53% of the sample) had heard of Qiedong-Wang-Gong before the survey.

The average scores for items under protest responses varied more than those among items in other dimensions. As indicated in Table 5, respondents indicated relatively high agreement for the items "current heritage tree protection measures are not effective," and "Heritage trees should not be considered in terms of monetary value," with responses between agree and highly agree. The items "Relying on only a few donors is unfair," and "Fund raising is only necessary in emergency situations," scored the lowest in this dimension, at between neutral and agree.

4.4. Regression analysis and monetary value assessment of Qiedong-Wang-Gong

Fig. 5 depicts the number of respondents associated with each level of WTP. For the respondents with positive WTP, most chose the WTP level of 100 NTD, (n = 92, 29.97%), followed by 500 NTD (n = 51, 16.61%). Additionally, 84 respondents selected zero WTP, representing 27.36% of the sample.

Zero WTP was further divided into true zero and protest zero. Respondents associated with true zero indicated that they perceived no value in heritage trees. Respondents categorized as protest zero respondents did not truly consider the target of evaluation had no benefits to them, but held a negative attitude toward value survey and were reluctant to report their true WTP (Huang, 2013). This study identified 82 protest responses. In most related studies, protest responses have

Table 3
Frequency data of respondents' socioeconomic backgrounds.
Source: Rearranged from the questionnaire used in this study.

Variable		Respondent	Percentage	Average	Standard deviation
Gender	Male	140	45.61	0.46	0.50
	Female	167	54.39		
Age (years old)	18–30	172	56.03	33.76	13.86
	31–40	49	15.96		
	41–50	37	12.05		
	51–60	30	9.77		
	> 60	19	6.19		
Annual income	< 100,000 below	164	53.42	209,120.52	273,947.56
	100,000–300,000	44	14.33		
	300,000–500,000	64	20.85		
	500,000–700,000	20	6.52		
	700,000–1000,000	9	2.93		
	> 1000,000	6	1.95		
Education	College and above	250	81.43	0.81	0.39
	High school and below	57	18.57		
Length of residence in central Taiwan	Nonresident	51	16.61	16.85	16.18
	< 5 years	68	22.15		
	6–10 years	21	6.84		
	> 11 years	167	54.40		

Note: 1. Male = 1; Female = 0.
2. College and above = 1; High school and below = 0.

been excluded from final analyses to prevent under−/overestimation (Huang, 2013; Jorgensen and Syme, 2000; Jorgensen and Syme, 2000; Kotchen and Reiling, 2000). However, in cases where a sample comprised a considerably high percentage of protest responses, exclusion of protest responses may result in sampling bias, because the final sample size may be too small. Table 6 lists the average WTP for the whole sample as well as that for the non-protest responses. The difference between the two WTPs was calculated.

Average WTP per year per person was 180.88 NTD for the whole sample. When the protest zero responses were excluded, the WTP was 200.47 NTD, reflecting a difference of 19.59 in average WTP. Average WTP for the nonprotest responses was 246.80 NTD, 65.92 NTD higher than that of whole sample. Regardless of sample range, median WTP was 100.00 NTD, which was lower than the mean. The per year per person WTP for Qiedong-Wang-Gong protection exhibited a positive skew distribution, with a skewness of 1.841.

Subsequently, the per year per person WTP obtained after excluding protest zero responses from the sample was adopted as the base to evaluate any over−/underestimation of and WTPs of “whole sample” and “nonprotest responses.” The equation for WTP bias is as follows:

$$Bias_{\mathrm{WTP}}\ (\%) = [(WTP_{\mathrm{Est.}} - WTP_{\mathrm{Base}})/WTP_{\mathrm{Base}}] \times 100\% \quad (13)$$

$WTP_{\mathrm{Est.}}$ stands for WTP estimates, which were the per year per person WTPs of the whole sample and of the nonprotest responses. WTP_{Base} stands for WTP base, which, in this study, was the per year per person WTP of sample in which protest zero responses had been excluded. WTP percentage deviation of the whole sample was lower than that of the sample in which protest zero responses had been excluded by 9.77%, whereas the WTP of the nonprotest responses was higher than that of protest zero responses by 23.11% (Table 6). Comparison of the WTP obtained from nonprotest responses with that of the whole sample revealed a difference of 65.92 NTD and a percentage deviation of 36.44%. These results aligned with the proposal by Wu et al. (2014) that the under-estimation of total WTP should range from 29% to 143%, after protest responses are excluded from the sample population. In the studies of monetary valuation of a New Zealand urban forest by Vesely (2007) and of a Switzerland urban forest by Bernath and Roschewitz (2008), respective deviations of 34.09% and 36.26% were reported for the results when protest responses were excluded. These findings correspond with the results in our study. Therefore, exclusion of numerous protest responses, following the conventional approach, may result in inaccuracies in evaluation and eventually lead to misallocation of resources (Wu et al., 2014). Thus, protest responses should only be excluded in studies where the proportion of protest responses in the sample population is low.

Table 7 depicts the monetary valuation of urban forests worldwide for the last 10 years. The results of this research align with those reported by Huang (2013) based on a double-bounded dichotomous choice approach. Huang's results indicated that despite recognition among residents of Taichung that heritage trees exhibit cultural and ecological value, the per year per person WTP to protect heritage trees was relatively low at 100–600 NTD. Results in the present research, which was conducted using a payment card approach, indicated an average WTP to protect Qiedong-Wang-Gong of approximately 200 NTD per year per person, which falls within the range reported by Huang. Additionally, results from Chen's (2015) research on heritage trees in Guangzhou, China; Becker and Freeman's (2009) study on heritage trees in Israel; and the study by Majumdar et al. (2011) on an urban forest in Savannah, Georgia in the United States revealed monetary values that fit within 100–600 NTD.

Compared with the values reported in the aforementioned studies, there were higher monetary values in Hong Kong (Lo and Jim, 2015), in Zurich (Bernath and Roschewitz, 2008) and in New Zealand (Vesely, 2007). In the study of Lo and Jim, the per month per person WTP was 60.9 HKD, which translated to 730.8 HKD (approximately 2800 NTD / year / person). The WTPs calculated by Bernath and Roschewitz (2008) and Vesely (2007) for the protection of Zurich and New Zealand urban forests were 2700–3700 NTD per year per person, which is relatively high compared with the other WTPs listed in Table 7. The difference could due to an array of factors, including the price levels of different countries, size of urban forest and number of heritage trees, and importance of green space to local residents. Based on the results in these studies, the estimated monetary value of Qiedong-Wang-Gong was within a reasonable range.

Table 8 shows the results estimated through the binary logistic regression and the ordered probit model, in which whether the respondents were willing to pay and their WTP are dependent variables.

The three regressions conducted on the samples are given as follows. (1) The samples are classified into two groups depending on WTP = 0 or WTP > 0, and then they are used as dependent variables of the binary logistic model to analyze the factors significantly affecting respondents' WTP for protesting Qiedong-Wang-Gong. (2) Only the

Table 4
Descriptive analysis of recognition of heritage tree values and familiarity with UHT.
Source: Rearranged from the questionnaire used in this study.

Variable			Average	Standard deviation	Agree (%)[1]
Recognition of heritage tree values	Environmental values	Provides shade	4.59	0.67	95.11
		Provides habitation for animals	4.55	0.64	95.11
		Beautify the township	4.43	0.75	89.58
		Environmental education	4.43	0.75	89.58
		Regulate temperature	4.44	0.76	90.88
		Purify air	4.45	0.80	90.55
		Overall	4.48	0.58	–
	Cultural values	Significant cultural asset	4.45	0.68	92.50
		Heritage tree legend contains strong local features	4.31	0.78	85.99
		Religious center	3.90	0.90	65.47
		Venue for local celebrations and festivals	3.86	0.94	65.15
		Overall	4.13	0.70	–
	Recreational values	Enhance recreational spaces	4.26	0.74	86.32
		Important landmarks	4.18	0.87	79.15
		Provide space for future recreational development	4.10	0.82	78.18
		Overall	4.18	0.70	–
	Existence values	Heritage trees are valuable purely for their existence.	4.42	0.73	90.55
		The existence of heritage trees makes me happy.	4.07	0.87	71.66
		Overall	4.24	0.73	–
	Bequest values	The older the trees, the higher their value	4.07	0.92	75.90
		The values of heritage trees that are preserved for future generations increase with time.	4.19	0.83	79.80
		Overall	4.13	0.83	–
Familiarity with UHT	Frequency of visits to UHT (times/year)		2.09	2.27	–
	Level of support for current heritage tree protection measures	Pest prevention	4.37	069	93.16
		Periodic government-sponsored evaluation of heritage tree health condition	4.35	0.66	91.53
		Physical tree supports	4.21	0.76	87.62
		Ordinances at local government level	4.15	0.78	82.41
		Periodic pruning of tree crowns by trained personnel	4.18	0.82	85.34
		Periodic watering and fertilization by trained personnel	4.19	0.77	83.06
		Regular public forums	3.85	0.83	65.47
		Central-government-level enactment of laws to protect heritage trees	3.78	0.98	63.19
		Set up fences	3.66	1.07	60.91
		Overall	4.08	0.58	–
	Recognition of the importance of heritage tree protection	Expect the survival of heritage trees	4.39	0.68	91.86
		Raise awareness regarding heritage trees	4.28	0.79	84.69
		Avoid transplantation of heritage trees due to building construction	4.09	0.93	75.90
		Heritage tree preservation is more important than city development	3.89	0.98	67.43
		Enacting laws to protect heritage trees is necessary	3.91	0.95	69.38
		Heritage tree preservation is more important than land revitalization	3.86	0.98	64.50
		Emotionally attached to local heritage trees	3.84	0.94	64.17
		Overall	4.03	0.72	–
	Level of satisfaction with the state of UHT protection		3.03	0.87	21.82
	Have you heard of Qiedong-Wang-Gong?[2]		0.35	0.48	–

[1] Percentage of respondents indicating “agree” or “strongly agree.”
[2] Yes = 1; No = 0.

samples for WTP > 0 are considered in the regression analysis, in which the WTP is the dependent variable, to evaluate the factors significantly affecting respondents' WTP for protesting Qiedong-Wang-Gong. (3) All the samples are considered in the regression analysis, in which the WTP is the dependent variable, i.e., this analysis integrates the above two regressions.

Table 5
Descriptive analysis of economic factors and protest responses.
Source: Rearranged from the questionnaire used in this study.

Variable	Average	Standard deviation	Agree (%)[1]
Protest responses			
Current heritage tree protection measures are not effective enough.	4.23	0.79	82.74
Heritage trees should not be considered in terms of monetary value.	4.05	0.96	76.87
The local government should allocate funds for UHT protection.	3.95	0.94	73.62
Only minimal protection is required when heritage trees are healthy.	3.55	1.17	55.37
Relying on donations of only a few people is unfair.	3.16	1.03	34.85
Fund raising is only necessary in emergencies (no need for regular donations).	3.08	1.15	35.50

[1] Percentage of respondents indicating “agree” or “strongly agree.”

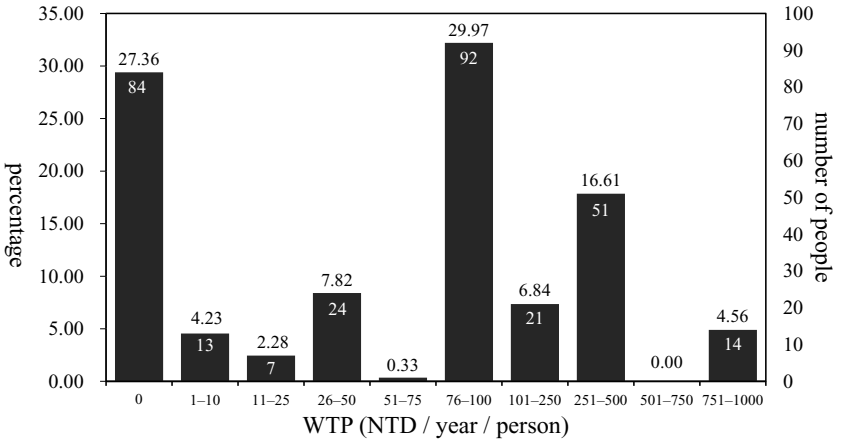

Fig. 5. WTP per year per person for Qiedong-Wang-Gong protection.

Table 6
Descriptive analysis of WTP for Qiedong-Wang-Gong protection.
Source: Rearranged from the questionnaire used in this study.

Sample range	Sample size	Average WTP (NTD)	Percentage deviation(%)	Standard deviation
Whole sample	307	180.88	−9.77	249.24
Whole sample excluding protest zero responses	277	200.47	–	254.82
Nonprotest responses	225	246.80	23.11	261.77

1 The median of all the three sample ranges was 100.00 NTD.
2 WTP of the whole sample excluding protest zero responses served as the basis for calculation.

Table 7
WTP of urban forest and heritage tree protection for residents of various regions.
Source: As in references and the questionnaire used in this study.

Region		Average WTP/year/person (NTD[1])		Approach	Reference
		Whole sample	Excluding protest responses		
Qiedong-Wang-Gong, Taichung		180.88	246.80	Payment card	This research
Heritage trees in Taichung		100–600	–	double-bounded dichotomous choice	Huang (2013)
Guangzhou, China	Heritage trees[2]	–	113.24	Payment card	Chen (2015)
	Rare heritage trees[3]	–	143.49		
Stonewall trees in Hong Kong [4]		2817.50	–	Payment card	Lo and Jim (2015)
Urban forest in Savannah, Georgia, United States [5]		–	337.71	Payment card	Majumdar et al. (2011)
Heritage trees in Israel [6]		–	376.19	Payment card	Becker and Freeman (2009)
Urban forest in Zurich, Switzerland[7]		2751.73	3749.60	Payment card	Bernath and Roschewitz (2008)
Urban forest in New Zealand[8]		2709.08	3632.62	Payment card	Vesely (2007)

[1] Foreign exchange rate from Sept. 4, 2017, Bank of Taiwan.
[2] Chen (2015): Results indicated 24.67 RMB, exchange rate: NTD/RMB = 1/0.214
[3] Chen (2015): Results indicated 31.26 RMB.
[4] Lo and Jim (2015): Result indicated 730.83 HKD, exchange rate: NTD/HKD = 1/0.257.
[5] Majumdar et al. (2011): Results indicated 11.25 USD, exchange rate: NTD/USD = 1/0.0333.
[6] Becker and Freeman (2009): Results indicated 44.66 NIS, exchange rate: NTD/NIS = 1/0.120.
[7] Bernath and Roschewitz (2008): Results indicated 91 CHF (whole sample) and 124 CHF (excluding protest response), exchange rate: NTD/CHF = 1/0.0331.
[8] Vesely (2007): Results indicated 132 NZD (whole sample) and 177 NZD (excluding protest response), exchange rate: NTD/NZD = 1/0.0487.

As indicated in Table 8, Based on comparison of the three regressions, binary logistic regression demonstrated the greatest explanatory power for payment decision (Nagelkerke R^2 = 0.340) followed by ordered probit regression of whole sample (Nagelkerke R^2 = 0.335). Ordered probit regression of only responses with WTP > 0 exhibited the least explanatory power for payment decision (Nagelkerke R^2 = 0.320).[2] The results indicated that the methods used in this research corresponded with greater explanatory power for factors affecting respondents' WTP to protect heritage trees, but less power for predicting respondents' WTP. The findings verified the results for the monetary value of stonewall trees determined using the CVM in the study by Lo and Jim (2015).

Binary logistic regression revealed that respondents with higher levels of agreement with the protest response, "fund raising is only required in emergency situations," corresponded with lower WTP for heritage tree protection. Respondents with higher levels of agreement regarding the existence value of heritage trees, as well as those who have heard of Qiedong-Wang-Gong, corresponded with higher CVP (contingent value participation) rates. We found that ordered regression for responses with WTP > 0 revealed that respondents of

[2] Questionnaires are difficult to explain all the strains especially in the social sciences. Therefore, it is acceptable that the R-squared values are greater than 0.3 (Acock, 2008).

Table 8
Binary/Ordered regression of CVP and WTP for Qiedong-Wang-Gong protection.
Source: Present research.

Variable		Ordered probit regression (whole sample), $N = 307$		Ordered probit regression (WTP > 0), $N = 223$		Binary logistic regression (whole sample), $N = 307$[1]	
		Coefficient	Standard deviation	Coefficient	Standard deviation	Coefficient	Standard deviation
Economic factors							
Recognition of tree value		0.478***	0.065	0.359***	0.088	0.906***	0.168
Financial constraints		0.034	0.069	0.033	0.088	0.156	0.167
Protest resonses							
The government should be responsible for heritage tree protection.		0.114	0.085	0.100	0.107	0.185	0.197
Current heritage tree protection measures are not effective enough.		−0.045	0.094	0.060	0.114	−0.115	0.220
Heritage trees should not be considered in terms of monetary value.		0.185*	0.076	0.217*	0.093	0.250	0.180
Only minimal protection for heritage trees is required.		0.012	0.060	−0.091	0.075	0.154	0.146
Relying on only a few donors for donations is unfair.		0.031	0.070	−0.081	0.087	0.218	0.168
Fund raising is only required in emergency situations.		−0.172**	0.063	−0.116	0.077	−0.369*	0.160
Socioeconomic background							
Gender		−0.160	0.130	0.154	0.154	−0.613	0.321
Age[2]	18–30 years old	0.240	0.239	0.205	0.285	0.088	0.607
	31–50 years old	0.533*	0.213	0.671**	0.249	0.349	0.542
Education		−0.128	0.185	−0.158	0.221	−0.077	0.459
Annual income[3]	< 100,000	−0.758	0.479	−0.571	0.533	−2.215	1.465
	100,001–500,000	−0.710	0.477	−0.441	0.527	−2.294	1.475
	500,001–1000,000	−0.508	0.501	−0.302	0.550	−1.760	1.541
Length of residence in central Taiwan[4]	1–5 years	−0.076	0.216	−0.017	0.252	−0.098	0.541
	6–10 years	−0.515	0.293	−0.337	0.347	−1.027	0.703
	> 11 years	−0.300	0.179	−0.149	0.207	−0.538	0.450
Recognition of UTH values[5]							
Ecological value		−0.016	0.139	0.201	0.184	−0.372	0.329
Cultural value		−0.136	0.133	−0.279	0.169	−0.003	0.308
Recreational value		−0.083	0.143	−0.031	0.179	−0.114	0.336
Existence value		0.131	0.156	−0.278	0.202	0.817*	0.385
Bequest value		−0.103	0.115	−0.216	0.143	−0.190	0.267
Familiarity with UTHs							
Frequency of visits to UTHs		0.008	0.031	−0.005	0.038	−0.018	0.081
Level of support for current UTH protection measures [6]		0.249	0.178	0.292	0.208	0.296	0.453
Recognition of UTH protection importance[7]		0.024	0.164	0.448*	0.195	−0.540	0.411
Level of satisfaction with current state of UTH protection		0.121	0.075	0.060	0.090	0.331	0.200
Have you heard of Qiedong-Wang-Gong?		0.489**	0.145	0.193	0.170	1.209**	0.383
−2 Log likelihood		969.836		648.191		278.030	
Chi-square		120.775		82.111		82.279	
p		0.000***		0.000***		0.000***	
Nagelkerke R^2		0.335		0.320		0.340	

* p value < .05.
** p value < .01.
*** p value < .001.
[1] Dependent variable = 1 for WTP > 0, 0 for WTP = 0.
[2] Based on the age group > 51 years old.
[3] Based on the group with annual income > 1000,000 NTD.
[4] Based on the group of nonresidents of central Taiwan.
[5] Variables under this dimension are the means of all items of the recognized values of UTHs.
[6] This variable is the average value of items under "Level of support for current heritage tree protection measures" in Table 4.
[7] This variable is the average value of items under "Recognition of heritage tree protection importance" in Table 4.

31–50 years old corresponded with higher WTP than respondents in the other two age groups.

Respondents with higher levels of agreement with the items "UHT should not be considered in terms of monetary value" and "Protection of heritage trees is critical" exhibited higher WTP. The ordered probit regression model of the whole sample incorporated all significant items in the other two regression models for the prediction of the respondents' payment decision; however, the variables of "existence value" and "Protection of heritage trees is critical" exhibited nonsignificant effect on WTP in this integrated model.

The results derived for each dimension in analysis are compared with those from related studies on the monetary valuation of urban forests and heritage trees. For the dimension of socioeconomic backgrounds. Regression analysis using the CVM revealed a positive correlation between annual income and WTP (Vesely, 2007; Majumdar et al., 2011; Chen, 2015; Lo and Jim, 2015). A positive correlation was also evident between education level and WTP (Becker and Freeman, 2009; Majumdar et al., 2011).

Regarding the factors of CVP, Chen (2015) reported that older and less educated individuals exhibited less of a tendency toward positive WTP in the Guangzhou heritage tree monetary value assessment. The present study revealed that various age groups corresponded with vastly different degrees of WTP; a significantly high WTP was correlated with the 31–50 age group. Referred to (Vesely, 2007; Majumdar

et al., 2011), the respondents' ages were divided into three categories (i.e., old, middle, young). Bernath and Roschewitz (2008) employed the CVM to analyze the urban forests in Zurich, Switzerland, and their results indicated that retired residents' WTP was remarkably less than the WTP of the residents that have not been retired. It was inferred that the respondents' ages did not have a linear relationship with whether the respondents were willing to pay and their WTP for protesting heritage tress; but after the age achieved a peak, the respondents' WTP changes with the factors such as retirement and income change. Therefore, this study divided the respondents' ages to analyze the respondents' WTP. The analysis results showed that the group at the age of 31–50 years has remarkably higher WTP for protesting Qiedong-Wang-Gong than the other two groups based on age.

In the study by Chen (2015), we deduced that respondents' approval toward NUV reflected only the individuals' moral considerations but exhibited little effect on CVP-related decision (García-Llorente et al., 2011). However, in the study by Becker and Freeman (2009), the heritage trees possessed NUVs (existence and bequest values). Thus, residents' CVP was based mainly on the recognition of heritage trees' NUVs. The present study demonstrated that “existence value” was a significant factor in residents' CVP, echoing the results reported by Becker and Freeman (2009), despite the difference in locations between the city-based Qiedong-Wang-Gong in this study and the heritage trees scattered across deserted lands in Israel, which were the subjects of the aforementioned study. Chen (2015) and Becker and Freeman (2009) assessed the monetary value for heritage trees in general, rather than focusing on a specific urban heritage tree. Taichung residents were relatively unfamiliar with Qiedong-Wang-Gong (only 65% of respondents expressed they had heard of Qiedong-Wang-Gong before completing the questionnaire), reflecting that they had not benefited from the use value of Qiedong-Wang-Gong. Thus, the existence value of Qiedong-Wang-Gong was an influential factor for CVP.

Under the dimension of familiarity with heritage trees, in the studies by Becker and Freeman (2009), Majumdar et al. (2011) and Chen (2015), the familiarity with the protection measures was positively correlated with CVP and WTP. The aforementioned findings reflect assessments of urban and heritage trees in general. In the present study, the value of a specific urban heritage tree was investigated using the CVM and binary logistic regression. The result revealed that “whether respondents had heard of the urban heritage tree” significantly affected the CVP. Furthermore, respondents who had heard of Qiedong-Wang-Gong demonstrated a higher WTP for Qiedong-Wang-Gong.

According to the aforementioned studies, annual income of respondents and frequency of visits to heritage trees were the main factors in payment decisions regarding both UTHs and forests. The present study focused on a single urban heritage tree, and respondents» familiarity with the heritage tree was the main influencing factor of WTP.

As indicated in Table 9, whether respondents had heard of Qiedong-Wang-Gong was adopted as the binary dependent variable and socioeconomic background as the independent variables. Binary logistic regression was used for analysis to determine which groups of respondents exhibited greater familiarity with Qiedong-Wang-Gong. According to the results, a lower proportion of the younger respondents (18–30 years old) had heard of Qiedong-Wang-Gong than the respondents aged 31–50 years old. A relatively high proportion of respondents who reported high frequency of visits to UHTs also reported knowing of Qiedong-Wang-Gong before the questionnaire.

5. Conclusion and suggestions

Qiedong-Wang-Gong was the subject of this study on monetary valuation. This 1000-year-heritage tree located in a city center was the focus of the first and only case in Taiwan where construction of presold apartments was suspended for heritage tree protection. This background distinguishes Qiedong-Wang-Gong among the 225 other heritage trees in West District, Taichung, Taiwan.

In this study, the CVM was adopted, and surveys were administered to citizens of Taichung by convenience sampling and snowball sampling. These means were used to determine the socioeconomic backgrounds of respondents, elicit responses toward various values of UHT, and to identify factors influencing WTP for Qiedong-Wang-Gong protection, such as the level of familiarity with UHTs. Payment card approach was used for WTP data collection. Regarding monetary valuation of public goods rich in cultural and ecological meanings, a high proportion of protest response was observed in the survey results, because most respondents believed that maintenance of public goods was the government's responsibility. Treatment of protest responses in the CVM is controversial. In our research, all respondents were required to indicate their protest responses to verify whether noneconomic factors affected respondents' WTP.

In this study, 26.71% of the 307 retrieved valid questionnaires were protest responses. The WTP per year per person was 246.80 NTD when protest responses were excluded, differing from the result when protest responses were included by 36.41%. Binary/ordered probit/logit regression analysis suggested that (1) WTP of respondents aged 31–50 was significantly higher than that among those > 51 years old. (2) Respondents who knew of Qiedong-Wang-Gong before taking the questionnaire exhibited higher WTP than those who did not. (3) Among discussed values of UHTs, existence value exhibited the greatest effect on CVP. Based on the results of this research, the following suggestions are offered for future research on the CVM and urban heritage tree protection projects.

1. If a sample involves a high proportion of protest responses, a decision model should be used to mitigate under-/overestimation when certain responses are excluded.

In this study of the monetary value of Qiedong-Wang-Gong, 26.63% of the sample was protest responses. The exclusion of protest responses generated results that deviated 36.44% from overall results. According to Lo and Jim (2015), in cases where a sample comprises more than 50% protest responses, error correction model and methods other than the CVM should be used to assess the monetary values of nonmarket goods. Additionally, Heckman (1979) proposed the Heckman two-stage procedure, which may be used to address protest responses. In stage one, the whole sample is analyzed. In stage two, WTP is assessed based on the results from the previous stage. Thus, in this study, the conventional strategy of excluding protest responses was challenged for cases with high proportions of protest response. Future research might explore the statistical correlation between respondents' WTP and noneconomic factors, including protest responses.

2. Environmental education should be enhanced. In particular, raising local residents' awareness of heritage trees' existence value as well as their familiarity with heritage trees could boost CVP for heritage tree protection and increase nonmarket value of UHT.

Results from regression analysis indicated that respondents who had heard of Qiedong-Wang-Gong exhibited higher CVP in the protection of heritage trees. Additionally, those who indicated greater concordance with the trees' existence value also exhibited relatively high CVP. Thus, greater familiarity with heritage trees and recognition of existence value corresponded with greater willingness for involvement in heritage tree protection. Furthermore, regression analysis indicated that residents aged between 18 and 30 were less familiar with Qiedong-Wang-Gong and less satisfied with current urban heritage tree protection measures. We suggest that governments integrate UHT with local features to encourage connection between young residents and heritage trees, and thus promote engagement in heritage tree protection projects.

3. The framework of this study could be implemented in future

Table 9
Binary logistic regression on whether respondents have heard of Qiedong-Wang-Gong before.
Source: The present research.

Variable		Coefficient	Significance	Marginal effect	Standard deviation
Gender		−0.162	0.551	0.850	0.271
Age[1]	18–30 years old	−1.143	0.010*	0.319	0.443
	31–50 years old	−0.737	0.072	0.479	0.410
Education		0.491	0.184	1.633	0.369
Annual income[2]	< 100,000	1.360	0.250	3.896	1.182
	100,001–500,000	2.146	0.067	8.554	1.174
	500,001–1000,000	1.817	0.133	6.155	1.211
Length if residence in middle Taiwan[3]	1–5 years	0.279	0.570	1.322	0.491
	6–10 years	0.895	0.127	2.447	0.587
	> 11 years	0.751	0.058	2.119	0.396
Frequency of visits to urban heritage trees (yearly)[4]	1–5 times	1.204	0.000***	3.333	0.340
	> 6 times	2.224	0.000***	9.244	0.638
−2 Log likelihood		342.645			
Chi-square		53.061			
p		0.000***			
Nagelkerke R^2		0.219			

*p value < .05.
p value < .01.
p value < .001.
[1] Based on age group > 51 years old.
[2] Based on the annual income group > 1000,00 NTD.
[3] Based on the group of nonresidents of central Taiwan.
[4] Based on the group with yearly frequency of visit to heritage trees = 0.

research for further assessment of overall monetary value of heritage trees in Taichung.

Chen (2015) indicated that under the CVM, respondents may face difficulty in distinguishing lump-sum single payment from recurrent payment. In the present study, the concept of lump-sum single payment was implemented in the questionnaire to determine respondents' WTP for the protection of the research subject. However, recurrent payment may have been a more intuitive concept for respondents regarding subjects with high monetary value. This may have caused an underestimation of the research subject's monetary value. Therefore, one iconic heritage tree was selected for valuation. For the valuation of multiple UHTs in Taichung, the monetary value deduced from this research may be applied to other individual trees. Alternatively, questionnaires regarding UHTs in specific districts could be distributed, and results could then be aggregated. In practice, the two aforementioned methods may be more accurate than Becker and Freeman's (2009) and Chen's (2015) for the valuation of multiple heritage trees.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This work has been supported in part by the Ministry of Science and Technology, Taiwan, under Grants 108-2410-H-005-045-MY2 and 107-2410-H-005-043-MY2; and the Ministry of Education, Taiwan, under the Higher Education Sprout Project.

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