

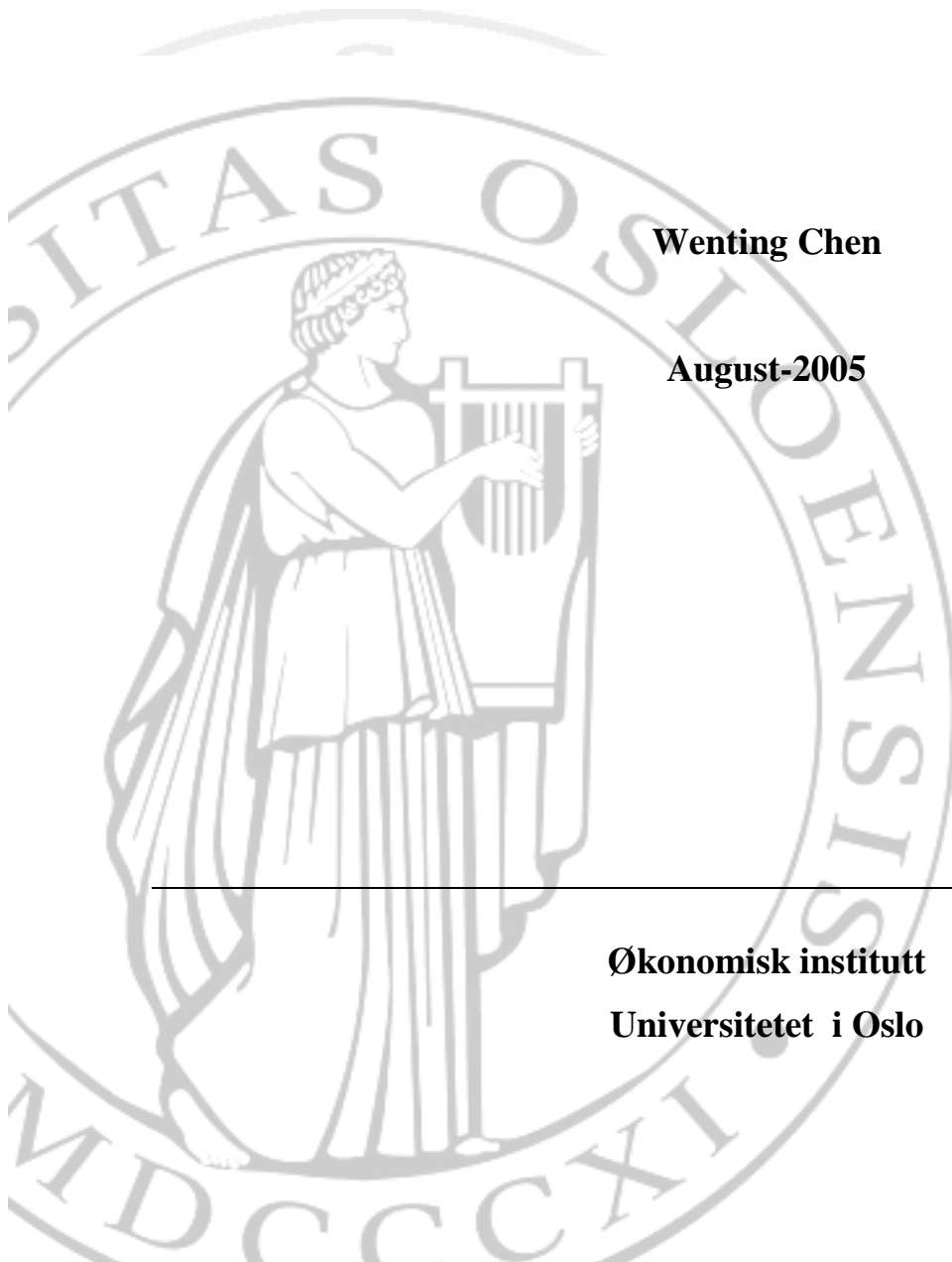
Recreational Value of Lake Wuliangsu Hai Inner Mongolia, China

Application of the Travel Cost and Contingent Valuation Methods

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Acknowledgement

The study is finished with help and support of Inner Mongolia lake restoration project, my supervisors and a lot of friends.

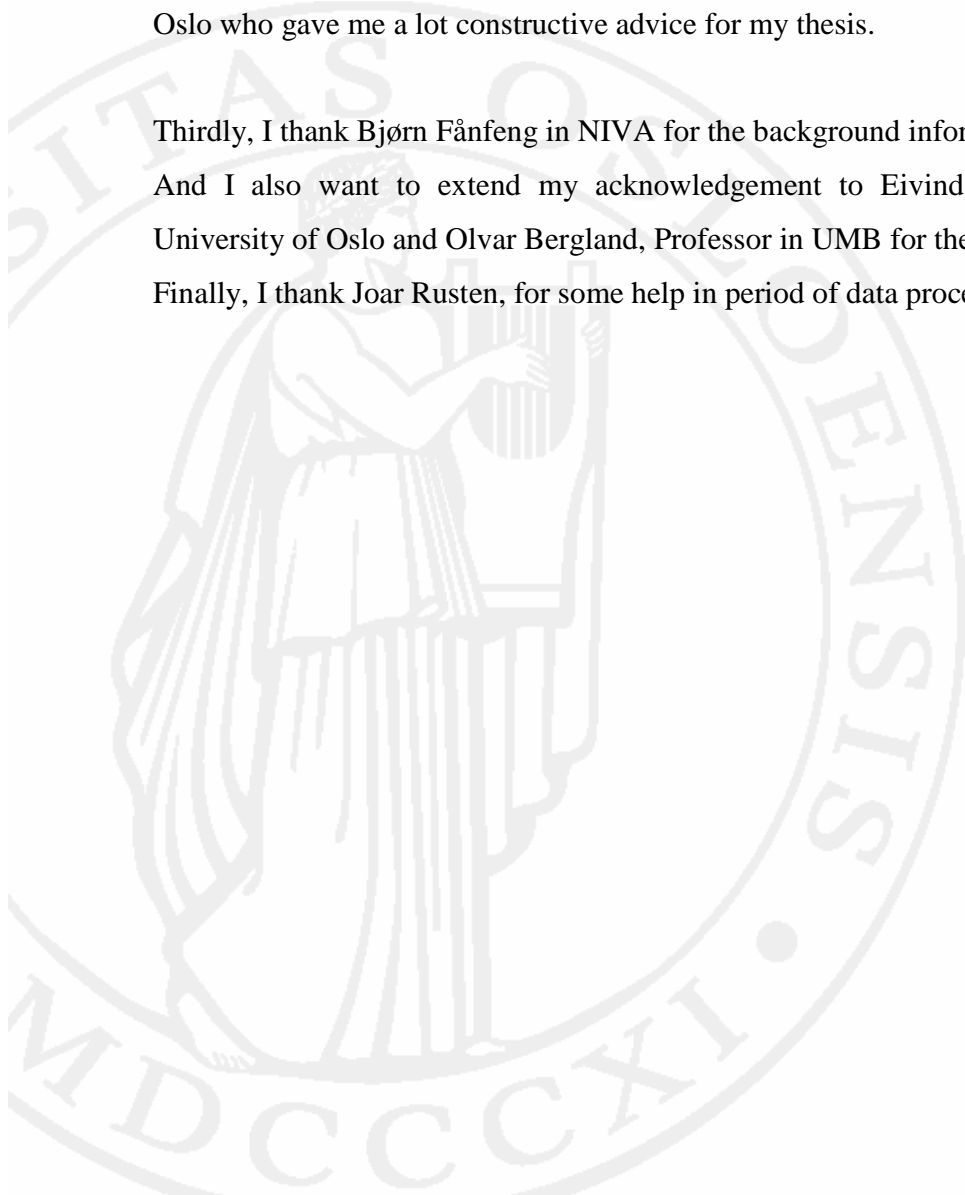
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Executive summary

This study is aimed to estimate the total recreational value of water improvement in Lake Wuliangsu Hai, Inner Mongolia, China. In our study, we combine travel cost method (TCM) and contingent valuation method (CVM) to fill the gap where the use value of the future lake after restoration doesn't exist. In China, both TCM and CVM are quite new and not widely applied like those in USA and European countries. And our study is the first case to apply non-market valuation to the lake restoration program in a wild lake in north China.

The result of the study will be used in the final cost and benefit analysis. Together with fishing, aquaculture and reed cutting, etc, recreational value of the lake is as one part of the benefits of indirect use of the lake. By comparing the benefit of the indirect lake water use and the cost of different lake restoration measurements the most effective and sustainable restoration plan will be given in the end and will be carried out by local government in the near future. The result of this study is based on the on-site sampling from 25th August to 12th September among 525 lake visitors. Questions related to both TCM and CVM were presented to the respondents.

(1) Field work summary

-More than 80% respondents came from Inner Mongolia. At about 50% respondents among lake visitors has bachelor degree and the largest age group among these respondents is among 30 -40 years old.

-About 60% lake visitors agree that water quality is poor and has disagreeable smell while approximately same percentage of visitors still think that the surrounding wild area of the lake is well preserved.

- "Boat sightseeing" and "Walking and enjoying the lake along the lake shore" are the most two popular activities. Although most respondents express that they enjoy bird watching, only less than 10% of total time was spend on Bird Island in the lake to especially watch birds. This may due to the fact that the Bird Island hasn't been fully developed and finishing constructing yet.

Still, most respondents went to the Bird and Fish Museum, the total time spent there is less very little.

-More than half of the lake visitors have been to the lake before. And more times respondents had been to the lake the more WTP they offered for the lake restoration which is consistent with the result of other CV study.

- More than 30% respondents go to the lake as a side trip or one of their package trips. And most respondents stay the lake for only one day.

- The largest proportion of respondents has the monthly household income 2000-3000 yuan.

(2) Results summary

-Total recreational value of Lake Wuliangsu Hai with present condition is from 10.5 million yuan (US\$1.2 million) to 21.7 million yuan (US\$2.6 million)

-WTP for the improved lake is from US\$ 0.17 million (1.4 million yuan) with mean WTP at about 59.52 yuan(US\$7.17). And only 6.29% of the respondents' WTP is zero. The mean WTP is more interesting than the absolute total value of WTP since we can scale up the WTP for the lake improvement by different definition of visitors. The entire amount will be huge if we put the potential visitors to the lake as whole population in China.

-Monthly household income is negatively related with the visit rate which implies that when income increases, respondents will be more likely to visit other lake with better condition rather than Lake Wuliangsu Hai with present condition. While the higher income of respondents the larger amount of WTP for the lake improvement.

- 72.76% of respondents express the environment concerning and their WTP for the lake restoration is higher than those who don't.

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-The maximum price that locals still want to visit Lake Wuliangshuai is 734.6 yuan (US\$88.5) which means they will not visit the lake if the price of the trip is too high.

- The WTP level that maximizes the total annual income is around US\$5.3 (44 yuan) and the maximum total annual income from boating and entrance is about US\$111009 (921377yuan)..

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1 Rationale

The thesis estimates the recreational value of the Lake Wuliangsu Hai located in the north part of the Autonomous Region of Inner Mongolia, the People's Republic of China. As one part of the economic benefits resulting from the restoration plan of the lake, the main purpose of the thesis is to estimate the recreational value of the lake, both use and non-use value, by combining two frequently used methods: the Travel Cost Method and the Contingent Valuation. Concretely speaking, the analysis is done by estimating the consumer surplus for the lake in its present condition, and willingness to pay for the improved water quality and therefore provide a basic guideline to the management and control plan of the whole lake.

My work with this study is divided into two parts. The first part consists of fieldwork to collect the data needed for the empirical analysis. Some of the statistic result of the fieldwork is documented in section 4. The second part of my work, which comprises the major part of this study, consists of data processing and analysis of results.

The main objectives of this thesis are as follows:

- to estimate the recreational value (use value) of users for the Lake Wuliangsu Hai, that is, the consumer surplus of the present water quality of the lake through Travel Cost Method (TCM)
- to evaluate the non-use value of users for the lake with improved water quality through Contingent Valuation (CV).
- to investigate influence of social characteristics on the visitor rate, thus, consumer surplus for the current lake and willingness to pay for the improved water quality. Sensitivity analysis will be used in the measure.
- to give guidelines to the decision maker, tourist industry of Lake Wuliangsu Hai and the local

government in Inner Mongolia who are responsible to the management and control of the Lake Wuliangsu Hai.

The rest of the study is organized as follows.

Section 2 gives introduction to the background of the project and the Lake Wuliangsu Hai.

Section 3 describes the methodology used in the study

Section 4 explains the field work and results from the survey.

Section 5 and 6 present the economic analysis and the result of consumer surplus in TCM and willingness to pay (WTP) in CV.

Section 7 discusses the limitation and the drawback of the study

Section 8 draws conclusion for the thesis.

Section 9 discuss the policy relevance for future management of the Lake Wuliangsu Hai,

2 Background for the project and the Lake Wuliangsu Hai

2.1 Background for the project

The thesis is one part of the large project entitled: '*Inner Mongolia Lake Restoration Project*'. This large project is carried out by Inner Mongolia Environmental Science Institute (IMESI) with cooperation with Norsk Institutt for Vann Forskning (NIVA) and IVL Svenska Miljöinstitutet AB funded by SIDA and NORAD. The main task of the whole project is to prepare a Management and Control Plan for Lake Wuliangsu Hai and its local catchment in Northern-China, with the aim to “keep the lake as a lake.”(Norway, 2004)

2.2 Background of Lake Wuliangsu Hai

2.2.1 Location of Lake Wuliangsu Hai

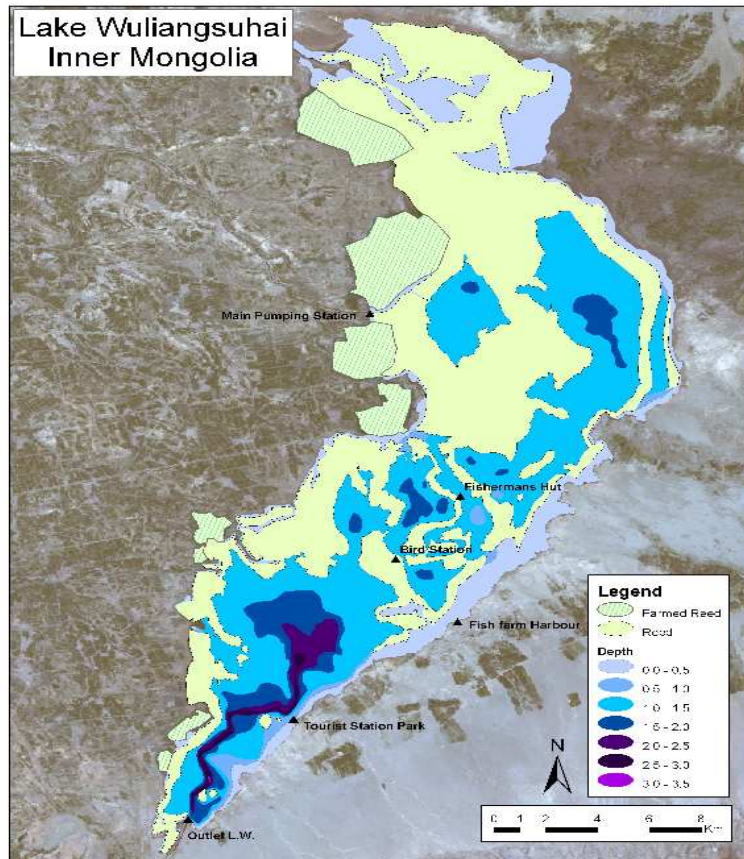
Lake Wuliangsu Hai is located in the mid of Inner Monogolia, People's republic of China .It is the largest inner land lake in Huanghe basin and the seventh largest lake in China. It was a meander of the Yellow River 150 years ago and now become approximately 35 to 40 kilometers long and 5-10 kilometers wide. The average depth is about 1.5 meters and the average surface area is about 300 square kilometers (Lindbolm 2003)(Figur 1).

Although it is a very shallow lake, Lake Wuliangsu Hai plays a very important role in socio-culture, economics, biology and climate. Since it is the only lake in the middle of a large arid grassland area on the edge of the Gobi Dessert in Inner Mongolia, it is honored as “The pearl of the Gobi” by the native people (Faafeng, 2004).

Fishing has been the most important industry in the nearby area during the latest 150 year lake history, and the lake has fed a considerable number of people living along the lake shore. Meanwhile, reed harvesting is another important income source for local people and has

overweighed the fishing in resent decades. The product from reed harvesting is used as raw material for the paper plant in the nearest town, Wulateqianqi.

Figur 1: Lake Wuliangshuai depth map



Source: Barton (2005)

Since the lake is the huge wet land rarely exists in that rigid dry area, it has become an important breeding site and migration “stepping stone” for birds migrating from Europe. More than 200 species of birds have been identified and more and more will be found out in the near future. The lake area also provides the natural habitat for thousands of other wide animals who live on the wetland (Norway, 2004).

In the last 20 years, Fish Farm, the main administration for the lake has introduced eco-tourism around the lake and proved success in the early several years. Generally speaking, both the reed and the tourist industry brought large income for the Fish Farm.

2.2.2 The historical change of the lake

Although the lake played an important historical role, the size of the lake has diminished and the water quality has deteriorated drastically in latest years. On one hand, since the lake came into being just because of the change of course of the Yellow River 150 years ago, whether the the Lake will exist or not depends on the Hetao irrigation scheme. Without the irrigation scheme, the lake would have been very likely dried up already because of the harsh weather (Faafeng, 2004)

On the other hand, as a recipient of the polluted water from agriculture, untreated municipal sewage and industrial discharge in the Hetao Basin, the water quality in the lake has deteriorated drastically over the last 20 years. High sedimentation rate and heavy eutrophication have led to rapid growth of submerged plants which is the main reason for the smaller size of the lake. What's more, the shallower the bed of the lake, the easier the growth of the reeds. Compare to the today's size, the lake was three times larger during the first half of last century, and its depth was at least 1 meter greater. According to interviews with local fishermen and satellite images, about half of the lake surface is currently covered by reed and the other half is open water with heavy density of submerged vegetations (Faafeng, 2004). The reduction of fish and the worse boating condition are both caused by the massive growth of the reed and submerged weed

2.2.3 Competing uses of lake water

Lake Wuliangshuai exists because it is part of the whole Hetao irrigation system, while it is heavily polluted due to the fact that it serves as a recipient of untreated waste water from cities, industries and farmland nearby. Although people who pollute the lake don't have the direct interest of the lake water quality, those who live on the lake apparently prefer a less polluted lake. Actually, there are a lot of stakeholders including both human beings and wild animals who depend on the lake water and environment of lake area. A key point here is the conflict of interest among different stakeholders. The stakeholders can be divided into three groups: wild animals, local people living on the lake shore, and people in the Hetao Basin.

Recreational Valuation of Lake Wuliangshuai

The first group of stakeholders is the wild animals living on the lake, such as fish, birds and other animals. As we know, the shallow lake is a wetland and provides numerous habitats for different species. In the 1950s, the lake used to breed abundant amounts of different species of fishes. At the same time, the lake provides numerous habitats for both emigrating birds and the native wild animals. However, the change taken place in the latest 20 years tells a miserable story for these animals. The number of species of fishes has dropped drastically in these 20 years and there is almost no edible fish existing in the lake now. The rampage of the submerged weed makes the survival of the fish even more difficult. The die out of fish and the shrink of the lake bereave the birds' resting place and may cause several red listed species become extinct. Other wild animals which live on the lake will face the loss of habitat too. Therefore, all birds, fish and other animals benefit a lot from a lake with deep, clean water and dynamic ecosystem.

Another main group of stakeholders is local people who live on the lake. They also benefit from a lake with clean water and diversified species. From an economic point of view, although deterioration of water quality of the lake may not make much difference in economic terms in short run, it does mean a permanent loss in the long run.

In the short run, the income source for local people shifts from fishing to reed harvesting when the lake can no longer support fishery. Both seem to be profitable and enough to support locals. In the 1950s, when there were abundant fish in the lake, the Fish Farm (the administrative company who responsible for the lake) and nearby populations had their living standard substantially improved by living on the fish. But nowadays reed harvesting has become the main industry for the local people who previously lived on the fishing. These former fishermen now cut the reed in the winter on the ice and sell them to three pulp plants in the nearest town. 40-60days work can bring each family more than 3000 yuan income every year which account almost 1/3 annual household income in that under developed area (Faafeng, 2004). The gain from reed cutting seems to be able to cover the loss from fish for these people.

However, the shift of income source is temporary rather than permanent if nothing is done to preserve the lake. The lake will disappear entirely pretty soon if nothing is done to improve the water quality and reduce the sediment rate. All the income including that from tourism will then

disappear permanently together with the drain of the lake.

These scenarios imply that a deterioration of the water quality in the lake may not make much difference for income of local people in short run since their main income is from reed harvesting which is not affected by current deterioration of lake water. But it does mean a potential permanent loss for them in the long run if the lake disappears.

The last group of lake stakeholders is the industries, nearest towns and farmers in the Hetao Basin who treat the lake as a recipient of pollutions and let out the untreated waste water. Reduction in pollutants entering the lake requires installation of new equipment and introduction of new techniques by industries and communities, and adoptions of environmentally sound fertilizer by farmers. All of these actions will increase cost. While the deterioration of the lake water will not influence the interest of these people directly in the short run. Therefore, the restoration of the lake only imposes extra costs on these industries and citizens in the nearest town and farmers in the Hetao Basin, and is a burden rather than benefits for them in the short term.

In one word, there is currently a strong competition in use of lake water. While the eco-system and the native people require a deep and clean lake, the industry, citizens in the upper stream and farmers in the Hetao Basin care little about the water quality and want to treat it as a recipient of waste water because of the lower cost.

2.2.4 The importance of eco-tourism to the lake

Eco-tourism is very important for the lake development and native people who live on the lake. On one hand, the sustainable development will lengthen the life span of Lake Wuliangshuai which will benefit both the native people and the whole ecosystem in the long run. Eco-tourism is the result of the restoration of the lake and makes a good relationship between human being and the nature

On the other hand, developing the eco-tourism can solve some conflicts between different

stakeholders and make the restoration of the lake easier to carry out. The income from eco-tourism can reduce the economic burden in the early period of lake restoration and contribute to covering part of the cost needed. For example, if the income from eco-tourism can be reallocated by government, it can be used to subsidize the industries, cities and farmers who pollute the lake to install new equipment to reduce the pollutant in the waste water. This will release the tension between these stakeholders and those who directly benefit from a lake with good water quality.

In addition, eco-tourism brings a new income source for the local people and will benefit them in the long run. In the short run, one way to "Keep the lake as a lake" is to raise the water level of the lake by either introducing more water from the Yellow River or dredging the bottom sediment. The production of reed which is the main income source of the local residents will be very much likely to decrease if the water level is raised by more than 0.5 meter from present level although the final result also depends on the speed of lake water increase (Faafeng, personal communication). However, there will always be some reeds left even the lake return to the depth that was the level 20 years ago and the loss from reed cutting could be compensated by revenue from ecotourism.

Therefore, the income from eco-tourism which offsets the loss from reed harvesting can not only provide a way of sustainable lake development, but also can subsidy the restoration project and release the tension between different stakeholders.

3 Methodology

3.1 Basic concepts of economic value

The main purpose of the thesis is to estimate the economic value of restoration of Lake Wuliangsu Hai. The economic benefits generated by the lake are non-market benefits due to the lack of the explicit market price. Therefore the definition of economic value here is a monetary measure of wellbeing rather than monetary value which is usually used in finance.

The more specific explanation of economic value is given as (Bateman et al, 2002)

“The economic value is a monetary measure of the wellbeing associated with the change in the provision of some good. It is not to be confused with monetary value unless the latter is explicitly designed to measure the change in wellbeing, nor with financial value which may reflect market value or an accounting convention. This term thus can be used interchangeably with ‘welfare change’ according to Freeman(1993)’s Note.”

Nowadays, economic value is a term widely used to describe the welfare provided by environmental goods where market price is not available or can't correctly reflect the value of environmental goods. We may distinguish between three categories of economic value related to the presence of a resource: use value of users, passive value of users and passive use value of non users (Strand, 2005). *Use value* is “the value arises from the actual and planned use of the service by an individual for recreation” (Perman et al, 2003). *Passive use value* is also often called non use value. It is the value that “refers to the life-support service role of the natural environment which are 'indirectly used ' by individuals (and firms) themselves”. For example, the value corresponds to future generations by protecting the water quality (bequest values) and the value relates to the motivation that other people may enjoy cleaner lake (altruistic values) or that the lake should be preserved to for the sake of a natural habitat for fish, plants and wildlife (existence values) (Day and Mourato, 1998).

In order to estimate the economic value of non-market goods and services, two empirical methods are widely used. One is the travel cost method (TCM), and another is the contingent valuation method (CVM).The former is an example of a so-called indirect approach, and the

latter is a direct approach. And both of them are samples of direct method since TCM and CV are both focus on eliciting value of goods from the individuals or representative samples affected by the environmental goods (Strand, 2005). Although both of them are used in measuring the well-being of non-market good, the rationales of the two methods are different. TCM is based on the principle of revealed preference while the contingent valuation is based on stated preferences.

Economic evaluation of rivers and lakes has traditionally focused on the demand for on-site recreation use. However, non-use value usually plays a very important role in their total economic value, too. Neglecting the non-use value will lead to bias if our aim is to evaluate the total economic value. Thus, in the thesis, we will include both demand for on-site recreational use value and non-use value of the lake as well. Both TCM and CVM will be used in our study. TCM is used to estimate of the use value of the lake in its present condition, and CVM is used for the valuation of improvement in water quality. Total economic value of the lake includes both use value and non-use value.

3.2 General overview of Travel Cost Method (TCM) and Contingent Valuation (CV)

3.2.1 General overview of TCM

As a method used to evaluate non-market resources, travel cost method came into being earlier than contingent valuation. It was first suggested by Harold Hotelling. The first important application was done by Clawson (1959) and Clawson and Knetsch (1966), to estimate the non-market value of major national parks in the USA.

TCM is usually used to evaluate the demand for the services of recreational sites. The basic idea is that visitors must travel to the site in person and incur the cost to overcome the distance (Haab and McConnell, 2002). As Burt and Brewer (1971) state, “The consumer is transported to the commodity for consumption to take place...”. This basic idea makes outdoor recreation easier for statistical estimation of demand function.

The assumptions of general travel cost model are that the existence of observable behavior and

preference is connected with the amenity to be valued in some precisely defined way. The criteria are given as follows, (Bockstael 1995).

1. Individuals are observed to incur costs to consume commodities related to the environmental amenity of interest.
2. The commodities are not purchased in a market setting with prices based on supply and demand.
3. The cost of consuming commodities is the travel cost to the recreational site. Differences in costs cause differences in quantity demand.

TCM has developed considerably since it first came to use. It is now extended to value a wider range of non-market goods rather than environmental goods. At the same time, the early approach in classic zonal models has been developed to more sophisticated statistical models like Poisson model. What is more, a lot of researches have been done in order to find models that are easier to be applied to reality and increase the validity. For example, some TCM applications have been generalized to include substitute bundles (Burt and Brewer, 1971; Cicchetti, Fisher and Smith, 1976). And Smith and Kaoru (1990) carried out a meta-analysis of TCM studies which provides a good appreciation of the properties of the model in a value estimation context. while Bockstael et al (1991) come up with a set of broader issues in recreational demand modeling. (Haab and McConnell, 2002)

Besides the theoretical development, TCM, as an indirect approach which reduce the involved errors concerning the true surplus, has been widely applied to different "Recreational market" to measure the welfare effects of changes of environmental amenities.

One of the environmental amenities is the water quality. There are several famous empirical studies, such as Binkley's survey on the recreation benefits of water quality improvement in an urban setting and Caulkin's development of TCM for lake recreation by comparing the single site model and multi-site model, (Caulkins et al, 1986). Similar evaluation was also done by Smith

and Desvousges (1986) and Bockstael et al (1987).

3.2.1.1 Theoretical background of Travel Cost Model

The underlying decision process of travel cost method is imbedded in the demand function of the household production model of Becker (1965). Households maximize utility subject to two constraints, household income and time available.

If we regard trips to a recreational site as an essential input in consuming the “recreational experience”, the demand function for trips to a site on a constructed cost per trip is then consistent with the household production model. Since household income is correlated with time available, the two constraints mentioned above can then merge into one. In addition we assume that traveling is the only entertainment in the leisure time.

The general construction of TCM model is as follows. Here we use Marshallian demand.¹

Maximize $U(C_i, V_i)$ subject to

$$\sum_{j=1}^n x_{ij}(c_{ij} + w_i t_{ij}) + z_i \leq y_i \quad (3.2.1)$$

Where

V_{ij} = the number of trips to site j, $j=1, \dots, n$.n is the number of sites.

X_{ij} = the number of times to a site during a certain period.

C_{ij} = the round-trip travel cost incurred to site j.

w_i = the wage rate and t_{ij} is the total time consumed every round trip which may either include the on-site time or not.

$w_i * t_i$ = the time cost.

¹ Similar discussion of the model can be found in Haab and McConnell (2002).

Z_i = the other composite commodity bundles consumed at a price normalized to 1.

y_i = the full income.

The constraint: $\sum_{j=1}^n x_{ij}(c_{ij} + w_i t_{ij}) + z_i \leq y_i$ comes from the combination of budget constraints and

the time constraint, $\sum_{j=1}^n x_{ij} c_{ij} + z_i \leq y_i$ (3.2.2) and $\sum_{j=1}^n x_{ij} t_{ij} + h_i = T_i$ (3.2.3). T_i is the total time

available. And the total disposable income is given by $y_i = y_i^0 + w_i h_i$ (3.2.4) where w_i is the after-tax wage rate and y_i^0 is the fixed income for individual i . If we substitute h_i in (3.2.4) with that in (3.2.3), we can get the constraint function (3.2.1). Further deduction is left to the reader who has further interests. The constraint means that the total expenditure of traveling and other commodities for an individual cannot exceed his or her total income. The individual allocates total time available between work and leisure until the marginal utility of work equals that of leisure.

Since travel cost can be regarded as a price P_{ij} of a trip for individual i to the j site, the utility maximization with interior solutions for the quantities which is the number of visit here thus become the standard demand function

$$x_{ij} = f_i(p_{ij}, q, y_i^f) \quad (3.2.5)$$

where

y_i^f is the full income that could be earned if the person work all of his time available which satisfies the equation: $y_i^f = y_i^0 + w_i T_i$.

q is the quality of different sites.

3.2.1.2 Basic assumptions for general TCM

The conditions mentioned below are aimed to keep the calculated surpluses to standard welfare

measures (Haab and McConnell, 2002):

First, the travel cost and opportunity cost for the trip are proxies for the true cost of a recreational trip. Regarding travel cost which takes into account the opportunity cost simply as a cost implies that the travel on the way itself does not provide positive utility to the traveler that is no pleasure associated with the trip;

Second, the quantity consumed V_{ij} in the model is the number of trips to the same site for consumer i .

Two further assumptions commonly made by Haab and McConnell (2002) are that “each household spends an equal length of time at the site” and “all trips are single site (purpose) trips”. We do not make these assumptions here, since the model mentioned above allows for variation in both on site time and number of purpose along the trip.

What is more, how to include multi-purpose trip into travel cost method has been discussed for a long time. Neglecting multi-purpose trips will apparently introduce bias in the estimation. In our model, we will compare the results with and without multi-purpose trips. Haspel and Johnson (1982) and Brown and Plummer (1990) developed two different ways to treat multi-purpose trips. One is based on the average travel cost per purpose while another is based on the marginal travel cost per purpose. More detailed discussion of the two different ways of multi-purpose trip will be given in next section.

This is the basic version of travel cost model. In terms of the site choice, TCMs can also be divided into two categories, single site model and multi-site models. Single site zonal model is the classic travel cost model and is good at evaluating the present value of a recreational site, while random utility models with multi-sites have been widely used in empirical research especially to measure the loss of a specific recreational site when there are several substitute sites.

In my study, I will mainly focus on the single site zonal model instead of Poisson random utility model to estimate the consumer surplus due to the lack of comparable substitutes in our case.

3.2.2 General Overview of Contingent Valuation

The other method we use in this study is contingent valuation (CV). It is a survey-based methodology to elicit value of non-market goods (Parsons, 2000). Although CV can be used to estimate both users' value and non users' value, it has been mostly applied to evaluate the non-user's value while the travel cost method is only available for users' value (Perman et al, 2003).

By directly asking a sample of relevant populations about how much they are willing to pay (WTP) to obtain some environmental good or avoid some environment deterioration or how much compensation they will accept for certain damage, CV provides a way to estimate values when the relevant markets are nonexistent and the revealed preference method does not apply. It is also called direct and stated preference method compare to TCM (Boyle, 2000).

3.2.2.1 Short description of the development of CV

Contingent Valuation is first conducted by Davis (1963) to evaluate the big game hunting in Maine. CV didn't gain recognition as a way to get Hicksian surplus for public goods until the implication by Hammack and Gardner (1974).

With the application of CV, a lot of skepticism and criticism arose and lead to further research on its validity and reliability. Bishop and Heberlein (1979) showed that the CV method met the convergent validity while Carmines and Zeller (1979) showed that it also met criterion validity. The result of contingent valuation is comparable to that of travel cost method for the same target and the result of contingent valuation is less than the cash transaction estimate. In the synthesis of Cummings et al (1986), operating conditions necessary for a credible contingent valuation study was provided. These operating conditions include the respondent familiarity, choice experience with the commodity, certainty in practice of evaluation and the use of willingness to pay instead of willingness to accept. An important landmark was the book of Mitchell and Carson (1989), who gave a comprehensive overview of this method and its implication. In the book, focus was

shifted to the design of specific studies where a major aim was to reduce the sampling bias and increase the efficiency of the method.

After 25-year ebb and flow, the issue of NOAA (the National Oceanic and Atmospheric Administration) panel provides specific recommendations on how contingent valuation studies should be designed and conducted to elicit “reliable” estimates of non-use values (Boyle, 2000). These informative opinions set the trend to investigate the credibility of CVM especially in the field of non-use values. Krström (1999) and Bishop et al (1995) provide more details about the history of CVM.

Until now, CVM has been widely used for different ranges of public-good valuation purposes, including related policy issues, ranging from the early hunting application by Bishop and Heberlein (1979), to several recent health-care applications for non-use values. In addition to the development in application of traditional valuation for non-use value of environmental goods, it has been used extensively to determine the stated WTP of household and resource user for public and quasi-public goods.

3.2.2.2 Theoretic background for contingent valuation

The theoretical CV model to be estimated is based on the difference between the baseline utility with the current environmental condition and the utility with the new environmental condition. The Hicksian surplus for a program to protect one environmental amenity is defined as

$$v(P^0, Q^0, y) = v(P^1, Q^1, y - c) \quad (3.2.6)$$

v = the indirect utility function

P = the price of the environmental good if the real market exists

Q = the quality of that good

0 = current quality (status quo)

1 = improved quality

² Boyle (2000)

y = total income

c = Hicksian compensating variation or the WTP.

Here we assume that $P^0 < P^1$ and $Q^1 > Q^0$ which means the water quality in Period 1 is better than period 0 and accordingly the price will be higher after the improvement of environment quality. At the same time, the respondent is required to attribute to the improvement of the environment. Since c is the willingness to pay of individuals for the improvement of the environment amenity, it is deducted from income y . In equilibrium, individuals are indifferent before and after the change.

Since no change in the environmental amenity really takes place during the time of survey, the survey designer has to be aware that respondents are clear about the hypothetical condition after a change. The specific requirement is given below,

The respondents should be clear about (Boyle, 2000):

- 1) How the policy change affects resource conditions and
- 2) How the change in the resource affects the services they receive.
- 3) The importance of their contribution and the way through which they can contribute to the improvement.

3.2.3 Overview of relevant studies

3.2.3.1 Relevant studies for combined TCM and CV

One of the frontier issues now is to combine contingent valuation data with revealed preference data, for example, travel cost method since the combination allows for the consistency of revealed preference data to be imposed on the contingent valuation data in the estimation and at the same time, the latter can be complementary to the former where revealed estimation do not exist (Boyle, 2000). However, until now most studies have only been applied to the random utility model (Adamowicz et al, 1997; Cameron 1992; Kling 1997; McConnell et al 1999). As

mentioned by Boyle (2000) that the contingent evaluation data can help to estimate the long-term contamination where users' behavior for an improved level of water quality does not exist.

3.2.3.2 Implication of non-market valuation of water quality in wetland/lake in Asia and China

Non market valuation especially contingent valuation and travel cost method have been widely applied to estimate the recreational value of water quality in Asia. Some studies were done to evaluate the value of wetlands by Ramsar³ while others were done to evaluate the value of lakes.

In Table 1, we list the results of several existing studies of recreational value of wetland and lakes in Asia. In general, the annual recreational value of these cases listed in Table 1 is very high compare to the local income, from 1 million to more than 150 million US dollars. We will compare our final result with these cases in the section 7.

To our knowledge, until now there exists only few empirical studies which combine the zonal travel cost method and the contingent valuation to estimate value of improved water quality. As to China, both TCM and CV are quite new and not widely applied like those in USA and European countries. One of the studies known in China is done by Day and Mourato (1998). They apply CV to estimate the willingness to pay for water quality maintenance in the Beijing area. Another is done by Du (2003).She evaluate the recreational value of improved water quality of East Lake in Wuhan, China. Du's study tried to combine zonal TCM and CVM to assess the total value of the lake (both its use value and its non-use value). However, she didn't take into account of the impact of multi-purpose trip and assume that all the visitors only have one aim that

³ Ramsar is a world wide organization. In the Ramsar Convention, wetlands are defined as: "*Areas of marsh, fen, peatland, or water whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, depth of which at low tide does not exceed six meters*" and may include "*riparian and coastal zones adjacent to the wetlands or islands or bodies of marine water deeper than six meters at low tide lying within*", (IUCN, 1971). According to this definition, Lake Wuliangsuhai belongs to the wetlands although it hasn't become the member of RAMSAR yet. Therefore, results of Ramsar case studies are comparable with that of Lake Wuliangsuhai in this study.

is to enjoy the lake. What’s more, neither of the study in China use payment card to elicit WTP. Day and Mourato (1998) recommend using payment card in China in the end of their study, too. Therefore, our study will be a good comparison with these two earlier research. However, even if a similar project has been previously carried out elsewhere, its economic consequence may not be useful as an indicator of the impact of new project in our case.

Table 1: Case study of recreational value of water quality for wetland / lakes in Asia

Case Study	Methodology	Results	Authors
Economic value of Bhoj Wetland, India	CVM (WTP)	Annual total: US\$1.05million	Verma et al(2001)
Non-executive benefit of preserving coastal wetlands around the Youngsan Rive, South Korea	CVM (WTP)	Annual total: US\$176million	IUCN (2005)
Economic value of watershed catchment protection, Ruteng National Park, eastern Indonesia	CVM (WTP)	Annual mean: \$2-3 per household	IUCN (2005)
Value of Improved Water Quality for Recreation in East Lake, Wuhan, China:	TCM and CVM (WTP: open ended question)	Annual total: TCM:US\$5.01million CVM:US\$1.81million (after improvement)	Du (2003)
WTP for water quality maintenance in Chinese Rivers, Beijing, China	CVM (WTP: dichotomous choice question)	Annual total: US\$60 million 22\$ per household (All the rivers in Beijing area)	Day and Mourato (1998)

3.3 Model Specification

In this section, we will provide a framework for both TCM and CV to analyze data and these data will be summarized in the next section.

3.3.1 Single site zonal TCM

The zonal single site model was first proposed by Clawson and Knetsch (1966). As in all other TCM studies, travel cost is regarded as a price of the recreational services on a site, and the target problem is consistent with the demand function. Residential places of visitors are divided into several geographical zones and number of visit of different zones varies with the travel cost. Except all the assumptions mentioned in general overview of TCM, single site zonal TCM has two more assumptions (Haab and McConnell, 2002), that is,

- a) It's possible to divide the geographical region surrounding the site into smaller zones and the distance from each zone to the recreational site is the same for all individuals living inside;
- b) There exists a demand function for each zone and zonal demand functions are the same for all zones.

These two assumptions are essential since they make it possible for zonal TCM to estimate the consumer surplus (CS) for each zone and therefore the aggregate CS.

Given time and income constraints, the object function of single site zonal model is given below,

$$v_i = f_i(C_i(C_{tri} + C_{ti}), z_i) \tag{3.3.1}$$

v_i = constructed variable which is the visit rate to the site from zone i . it follows the formula ⁴

⁴ There are three steps used to get v_i

First, the stating point (residential cities) of the respondents are divided into 43 different zones

Then we sum the visits of all the respondents in each zone and get V_i

In the last, we divide V_i by N_i . and get the visit rate of each zone v_i

$$v_i = \frac{V_i}{N_i} \quad (3.3.2)$$

N_i = Population of each zone in 2002⁵

V_i = Total visits of all the respondents in each zone which is the summary of the visits of all the respondents of each zone

C_i = Total cost to go to the specific recreational site.

C_{tri} = Travel cost for the trip from zone i to the recreational site.

C_{ti} = Time cost for the trip from zone i to the recreational site.

Z_i = Other personal characters e.g. gender, education, age etc.

In the following, we will discuss construction of independent variables, concrete functional form and role of time cost and multi-purpose in our model.

3.3.1.1 Definition of variables

(1) Visit rate (v_i)

As mentioned above, v_i is the visit rate from zone i. There are two ways of sampling, on site sampling and off-site sampling. While off-site sampling get access to census data from different zones directly, on site sampling only sample those who really take the trip (Bateman et al, 2002). In our case, we choose the on-site sampling to improve the responding rate. However, there are two potential problems for the welfare calculation of on-site sampling.

One is that the data obtained from survey is truncated. Only those who actually carry out the trip are observed while those who take zero trips (those who want but haven't taken the trip) are omitted. This will lead to downward bias in welfare analysis (Bateman et al, 2002).

⁵ Here we use the statistic of population in 2002 of each zone together with the data we collected in 2004 rather than the statistic in 2004 for two reasons. First, the census data in 2004 hasn't been available. Second, since the population only increases 4% in whole China (Now specific data available to the different zones respectively) and the influence of the increase in population is even become smaller concerning to the visit rates. Thus we use the statistic in 2002 as approximate estimate for data in 2004..

Another potential problem is that there maybe exist selection problem when assuming that distribution of preferences for a site are the same for all the visitors from different zones. The problem stems from the self -selection of residence place. Usually, zones close to the target site will have larger representations of individuals with higher preferences for the site than those live further away. Thus our model may under value the true social valuation of the lake (Strand, 2004)⁶

(2) Travel cost

$C_i(C_{tri}, C_{ti})$ is the cost variable. C_{tri} is round trip travel cost and C_{ti} is time cost relating to the trip. Total cost for those who travel by cars is calculated by general formula

$$C_{tri} = (\alpha + \beta_i/S)D_i \quad (3.3.3)$$

D_i = round trip travel distance in kilometer. It varies according to the definition of trip and will be discussed later in the study.

α = constant pecuniary travel costs per km for car which is the running cost of a car.

β_i = opportunity cost of travel time per hour for visitors from zone i .

S = constant travel speed for car.

Travel cost for those who came by train or plain are based on the price of the tickets.

In our model, α is set at 2 yuan/km⁸. Since there is no official standard of marginal travel cost for automobiles in China, α is calculated according to the average price for taxi in Inner Mongolia.⁹

⁶ Actually, we may include a variable which correlates with the preference of visitors from different zone to overcome this problem. For example, the variable can be the number of visits during a certain period in history of each visitor. Since usually those who live closer to the lake will visit more frequently than those who live further away. The former, as mentioned in our text, have higher preference to the lake than the latter. But here we skip further statistic test for simplicity.

⁷ Strand (1979)

⁸ yuan is the Chinese currency, where 1 yuan \approx 8.24 US\$

⁹ It is plausible based on the assumption that those who live within 500 km from the lake are assumed to come by car and the taxi fee will definitely cover the running cost. Of course, we may overestimate the running cost for the

S is set at 60km /hour due to the fact that the speed limit on highways in China is 100km/hour; the normal speed is 70-80km/hour on highway and 60-70km/hour in city outskirts, while it is less than 60km/hour inside the city or town. Therefore 60km/hour is a reasonable estimation for average travel speed when stops are included. The standard distance and time one the way is based on the information on webpage Railroad (2004) and Airchina (2004).

The travel cost variable mentioned above is a so-called “calculated travel cost”. Until now, almost all the travel cost in the TCM is constructed by some convention together with information from the survey (Perman et al, 2003). Randall (1994) describes this method as “researcher assigned visitation cost estimates”. He argues that the correct way is to use data that are based on the perceptions of those visitors who doing the traveling and “the best we can expect from the researcher assigned way is ordinary measurable estimates.” However, according to the data we get from the survey, travel times and traffic costs stated by the respondents differ very much from one individual to another even their residential place are the same.¹⁰ One way to explain the inconsistency between responses from visitors and the standard is that time is less valuable to some respondents, say, who are retired or unemployed, than those having regular jobs.¹¹ In section 5, we will compare the result of travel cost from stated traveling time from respondents and standard travel cost from researcher based calculation..

(3) Multi-purpose trips

Multi purpose trips have been a hot topic in the TCM literature for a long time. In zonal TCMs, a *trip* is usually defined as the residential place to the target recreational site. This concept is based on another primary assumption that the trip has only one purpose or that the most important purpose of the trip is to visit the recreational site in study. However multiple destination trips seem to be more common in reality. In our survey, about 67 % of the respondents reported that their trips are single purpose trips, while the rest 33 % reported that visiting the lake is not the only purpose. The latter either came to the lake because they visited relatives or friends in towns

vehicle there if we use the taxi fee which also includes profit. But taking into account the harsh weather and therefore correspondingly higher maintaining fee, it's still practical if there is no other alternatives available.

¹⁰ For example, one respondent came from Baotou to the lake. He claimed only one hour by car while another one stated 2hours .etc. While in the convention calculation which use the standard data from the traffic bureau of China, the time span should be two and half hour.

¹¹In footnote 10, two and half hour trip as to the visitor who only reports 1 hour is as 1 hour to him in terms of utility.

close to the lake; or had a business trip from other Province nearby; or had a package trip to several tourist attractions in North China. Thus the one-purpose assumption in the traditional zonal TCM will lead to either underestimate or overestimate welfare. If we drop respondents who had multi purpose trips, we will underestimate the consumer surplus since those with multi-purpose trips have to incur the cost for the trip to lake and has consumer surplus in terms of the lake too. On the other hand, if we treat all multi-purpose visitors as if single-purpose ones, we will overestimate the aggregate consumer surplus since in the case the cost that ought to be ascribed to the lake visit for these visitors is only part of the overall cost. In principle the proportion to be ascribed to the lake visit could be quite small if the trip has several destinations beside the lake. Therefore, neither of the two ways of tackling the problem of multipurpose trips is proper.

Researchers have developed several different ways to deal with the multipurpose trip. Haspel and Johnson (1982) share total trip costs among the multiple destinations, and then use a fraction $1/n$ of total travel cost as the cost to the target site, where n is the number of destination. While Brown and Plummer (1990) suggest using the marginal prices as a cost to the recreational site. In their model, *trip* is defined as the trip from the latest departure place to the target site for the only purpose to that site. Their assumption is that the option to go to the target site doesn't influence the probability of taking the initial trips to other sites.

Mendelsohn et al (1992) have developed an alternative method which assumes that each site that is visited on the way to the target site has its own demand function in a demand equations system. Although this model captures the substitution between packages trip and individual site, it entails demanding requirements upon the survey design which are not practical in our survey.

In section 5, I will compare the “marginal price” approach and the “fraction “approach in our model. In the “marginal approach”, we treat the travel cost as the cost from the latest departure place to Lake Wuliangshuai. For example, consider one visitor who takes a package trip travels from home to place A, and then from A to the lake. The travel cost of visiting the lake is then defined as the cost of traveling from place A to the lake. Both the travel cost en route and the time cost are calculated according to this definition. In “fraction approach “, consumer surplus of

each zone is divided by the average number of package trip for each zone.

(4) Time cost

Aside from the tangible traffic fee for the trip, another important cost variable is the opportunity cost of time. It usually represents a sizable portion of the total cost for the trip and thus needs careful approach. Here we will discuss on-site time and how to measure the time cost.

The first issue is on-site time. Time spent for the trip includes two parts: time spent on the way and on site. If on-site time is the same across agents, the difference in time cost among different visitors is only the time spent on the way. Smith, Desvousges and McGivney (1983) developed a model to treat exogenous on-site time. However, on-site time is endogenous rather than exogenous in real life; neglecting endogenous on-site time will lead to bias in the final welfare. McConnell (1992) tried to include endogenous on-site time by putting on-site time in both utility function and cost function. In our study, on-site time is endogenous and varies across visitors. We will include both time spent on the way and on-site time in our model.

Another issue is how to estimate the opportunity cost of time. Since people's leisure time typically has an alternative allocation in the form of work time, the opportunity cost of time is reasonably related to a person's wage to some extent. In Becker's household model, individuals can substitute working time for leisure time at the margin. That is, working time is fully flexible and individuals can adjust their working time to the point that the marginal utility of work equals that of leisure. According to this approach, the marginal cost of time spent on recreation equals the wage.

Nevertheless, in the real world, quite a few people work fixed forty hours a week and have a fixed salary. Thus they cannot in practice trade off work and leisure freely against each other. Trade-offs between work and leisure are not applicable to those who don't work either. In order to solve such problems, a lot research has been done to quantify the opportunity cost of time. One of the most widely used approaches is to base the opportunity cost on the wage rate. For those who have fixed working schedules, common fraction of the wage used to value time cost is typically from one third of the wage to the full wage (Parsons, 2000; Haab and McConnell,

2002).¹² Another approach is put forward by Smith, Desvousges and McGivney (1983). They impute the individual wage rate by regressing the wage on income and a vector of personal characteristics. The advantage of this model is that it includes non-wage earners too. Although this model is both theoretically and intuitively sound, it requires more information about whether the working time is flexible or not. And more information usually means a long questionnaire which makes it less practical in empirical research.

If we are to use a particular fraction of the wage rate to represent time cost, what percentage of the wage rate should be used in our specific case? There are two facts that we should pay attention to. One is that working hours are usually fixed at 40 hours a week in China and most individuals cannot adjust between working time and leisure time freely by themselves. Another fact is that a lot of visitors to Lake Wuliangshuai are participating in group trips arranged by their employers. As to companies, they can adjust working time and leisure time close to margin during workdays so as to maximize their utility¹³. Therefore, working time is flexible to some extent in our case, and fraction of wage for time cost is less than 100% but will not be very small. We will compare the welfare by using full wage rate as time cost and that by using 60% of the full wage as time cost in our analysis.

(5) Substitute site

Ignoring the presence of substitute sites will also lead to improper valuation of the target site. If we assume that the cost of visiting different sites is identical, and preferences for visiting these sites are the same at marginal. The greater the number of substitute sites, the smaller the social loss of removing the target site, therefore the lower social value of it. Omitting substitute sites may then correspondingly overestimate the social value of the target site (Strand, 2004).

However, there is no comparable natural lake near round within 500km around Lake Wuliangshuai in our study. There are a few *man-made* lakes near by. One is a small and newly created man-made lake in Wulateqianqi which was finished just this year. Another is in Yinchuan, a city more than 450 km away from the lake. The third man-made lake is in a park in

¹² Here we use hourly wage. Hourly wage is annual income divided by the number of working hours a year which is usually from 2000 to 2080 (Parson 2000).

¹³ Here we assume that companies and their employees have the same interest in both leisure and working,

Hohhot, the capital city of Inner Mongolia which is about 300 km away from the lake. But none of them can be treated as a comparable substitute for Lake Wuliangsu Hai when it comes to the natural lake. All of the three lakes are man made and have very limited wildlife watching and boat sightseeing.

(6) Other specifications

1) One day trips

All the trips in our model are one-day trips. Although some visitors claimed multi-days trips, all of them are actually multi-purpose trips since they never go back to the lake after one day's trip. Therefore all these claimed multi-days trips are regarded as one-day trip in terms of visiting the lake in our models.

2) It is only the quantity and the quality of the visit to Lake Wuliangsu Hai that provides utility to visitors. The travel en route, the travel time and inputs used to produce the trip itself do not yield utility.

3.3.1.2 Functional forms in the zonal travel cost model

There are three alternative functional forms that represent realistic alternatives in our case, namely the linear, semi-log and log-log functions. The functional form difference mentioned here is mainly for the relation between visitation rate and travel cost variable. Linear function has been proved poor by related implications, both in terms of the fit to data and predicting the real demand function (Strand 1979). A problem with the linear form stems from the assumption that the marginal utility of lake visits across individuals is constant. The assumption is usually inconsistent with data on demand in empirical context. Generally speaking, exponential (semi-log) regression which assumes that marginal utility of lake visits is decreasing when visit rate increases has been proven superior to other alternatives in several applications (Strand, 1979). In our model, we will compare the regression result from both semi-log and log-log function. But we will only use the result from semi-log function in the welfare calculation in view of conservative because the absolute value of coefficient of travel cost in semi-log function is bigger than that in log-log function (Strand, 1979). The consumer surplus from semi-log function will be

smaller than that got from Log-log function. We use the semi-log function to calculate consumer surplus in view conservative when the warfare estimation will be put into the cost and benefit analysis in the final manage and control plan for government

The regression formula are given as follows,

1) Semi-log function

$$\ln v_i = \beta_0 + \beta_1 TC_i + (\beta_2 Income_i + \beta_3 Age_i + \beta_4 Gender_i + \beta_5 Edu_i) \quad (3.3.4)$$

2) Log-log function

$$\ln v_i = \beta_0 + \beta_1 \ln TC_i + (\beta_2 Income_i + \beta_3 Age_i + \beta_4 Gender_i + \beta_5 Edu_i) \quad (3.3.5)$$

TC_i = mean of total travel cost of zone i

$Income_i$ = mean of monthly household income of zone i

Age_i = average age of zone i

$Gender_i$ = mean of gender of zone i

Edu_i = average year of education of zone i

$\ln TC_i$ = $\log TC_i$

In TCM model, we only include four social demographic variables. Other behavioral and attitudinal variables are not included here even some of them may be significant at acceptable level. The reason is that the behavioral variables such as the *Nov5y* (number of visits 5 years before) are correlated with the distance, that is, those who live near the lake will visit the lake more frequently. Therefore, including these variables may cause multi co-linearity problem. While all the attitudinal variables are stated preference and are more or less correlated with willingness to pay in CV. Including the stated preference into TCM with revealed behavior will lead to bias although we still don't know to what extent the bias would be.

Since the visitation rate of each zone is between 0 and 1, $\ln v_i$ will be negative. Although it doesn't seem to have the real meaning at first glance, it does show the correlation between the

dependent variable and the independent variable.

In our model, gender is a dummy variable which set man equals 1 and woman equals 0. Mean of gender for each zone equals the fraction of male visitors from the zone, and must lie between 0 and 1. The interpretation of the coefficient associated with gender is that, if the coefficient is negative, the visit rate of men is less than that of women by the absolute value of $\beta_4\%$. This explanation of dummy variable in terms of zonal average can be applied to all the other dummy variables in our regression.

Perceptions of the lake of the respondents are not included in our formal regression of TCM. The results of log-log models is given in Appendix 3.

3.3.1.3 Formula for calculating Consumer Surplus

(1) Aggregate consumer surplus

According to basic demand theory, the higher travel cost, the lower visit rate from each zone. When price goes too high, demand will drop to zero. The price at which the visit rate becomes zero is defined as “choke price”. Choke price (P_c) is the intercept of the demand curve and the x axis in the graph. All the shadow area under the demand curve between choke price and the travel cost is the net consumer surplus for each zone.

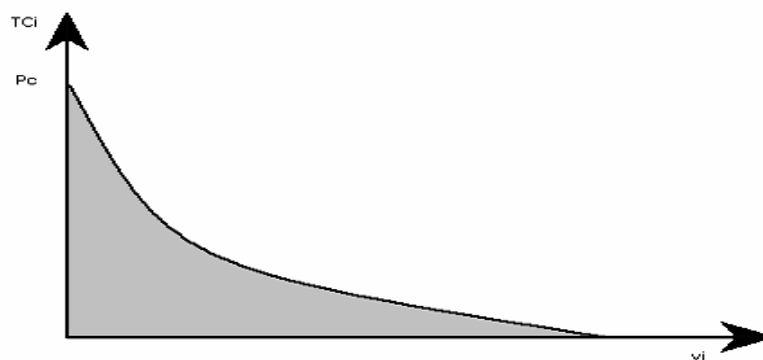


Figure 2¹⁴ Choke price and consumer surplus

¹⁴ P_c in the graph is the choke price where the visit rate equals zero

In our model, v_i is the observed visit rate of each zone. If we multiply v_i by the population of each zone, we get exactly the observed number of visits of each zone. However, we will get another result of consumer surplus if we use the estimated visit rate \hat{v}_i rather than the real visit rate v_i directly from survey. The estimated visit rate \hat{v}_i is the point located exactly on the curve of the regression function. The standard assumption of unbiased regression implies that the estimated point and the real visit rate will overlap if and only if random error ε_{ij} equals 0. However, both ways of calculating consumer surplus are principally correct. The only difference is influenced by interpretation of error term ε_{ij} . If the error term represents a systematic and relatively stable difference in preferences between zones and such estimated functional form can be expected to hold for each zone, using the estimated visitation rate will be more proper. On the other hand, if the error terms mainly contain observation errors in \hat{v}_i or random fluctuations in the visit rates from one year to another, the calculation of consumer surplus should rather base on the observed visitation rate. (Strand, 1979) However, we don't know which situation could better count for error term in our case or may be possible that some part of the error stems from the systematic ones while others stem from the observation error or random fluctuation. Therefore, we will use both ways to calculate the consumer surplus and the "true" consumer surplus will lie between the two results. Figure 3 gives a visual explanation to the difference between observed visitation rate and estimated visitation rate.

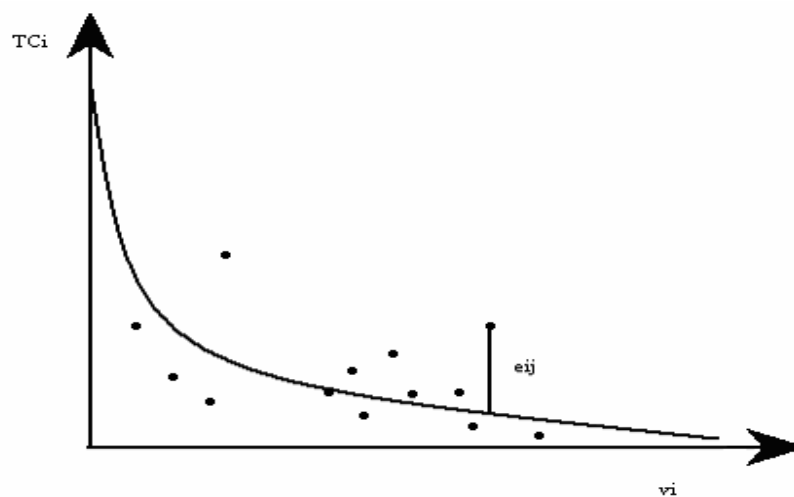


Figure 3: Estimated demand curve and real visit rate

The formula used to calculate consumer surplus based on semi-log regression is given below.¹⁵

$$CS_i = N_i \left(\int_{TC_i}^{\infty} f_i(C_i(C_{tri}, C_{ii}), Income_i, z_i) dC_i \right) \quad (3.3.6)$$

or

$$CS_i = N_i \left(\int_{TC_i}^{\infty} e^{\beta_0 + \beta_1 TC + \beta_2 Income_i + \beta_3 Gender_i + \beta_4 Age_i + \beta_5 Education_i} dTC \right) \quad (3.3.7)$$

Simplified version is

$$\begin{aligned} CS_i &= N_i \left(\int_{TC_i}^{\infty} e^{\beta_0 + \beta_1 TC + \beta_2 Income_i + \beta_3 Gender_i + \beta_4 Age_i + \beta_5 Education_i} dTC \right) \\ &= \frac{N_i}{\beta_1} e^{\beta_0 + \beta_1 TC + \beta_2 Income_i + \beta_3 Gender_i + \beta_4 Age_i + \beta_5 Education_i} \Bigg|_{TC_i}^{\infty} \\ &= -\frac{N_i}{\beta_1} V_i \\ &= -\frac{V_i}{\beta_1} \end{aligned} \quad (3.3.8)$$

The aggregate consumer surplus in this case is

$$CS_{total} = \sum_{i=1}^n CS_i \quad (3.3.9)$$

The estimated consumer surplus is then

$$CS_i^{\hat{}} = -\frac{\hat{V}_i}{\beta_1} \quad (3.3.10)$$

$$CS_{total}^{\hat{}} = \sum_{i=1}^n CS_i^{\hat{}} \quad (3.3.11)$$

¹⁵ Similar discussion for the formula here can be found in Strand (1979).

(2) Separate consumer surpluses

Due to the structure of the semi-log function, the calculated choke price for each zone is very high. This may be reasonable for visitors who come from regions far away from the lake, as many of these are likely to have high incomes and will in normal case bear high travel cost to the site. If we treat locals in the same way as non locals, total welfare will be then very likely to be overestimated. However, decision makers need more reliable and conservative estimation of CS. Therefore, we arbitrarily divide the entire sample of visitors into two groups, non-locals and locals. Local visitors are defined as those who live within 500 km from the lake; while non-locals are those whose home is more than 500km away from the lake.

One point here is that although we divide visitors into two groups, we still assume that all the zones, local and non-local, face the same estimated demand curves. Only when it comes to calculating the consumer surplus of locals, demand curve of locals is assumed to be equal to linear function (3.3.12) since the demand curve of locals is truncated and is only one part of original one.¹⁶

$$v_i = \beta_0 + \beta_1 TC_i \quad (3.3.12)$$

The linear specification for the local CS is for convenience, but is likely to be a good approximation when the choke price for locals is relatively low.

Formulas used to calculate the two separate sets of consumer surpluses are given below.

- 1) Formula for **non locals** is the same (3.3.6) - (3.3.11).
- 2) Formula for **locals** of each zone is

¹⁶ In equation (3.3.12), we chose not to include other social demographic variables as in equation (3.36)-(3.38) since the explanatory power of the linear regression including social demographic variables was unacceptably low.

$$\begin{aligned}
 CS_i &= N_i \int_{TC_i}^{\frac{\beta_0}{\beta_1}} (\beta_0 + \beta_1 TC) dTC \\
 &= -N_i \frac{v_i^2}{2\beta_1}
 \end{aligned}
 \tag{3.3.13}$$

Total consumer surplus then is

$$CS_{total} = \sum_{i=1}^n CS_i
 \tag{3.3.14}$$

For the estimated consumer surplus, the formulas are as follows

$$\hat{CS}_i = -N_i \frac{\hat{v}_i^2}{2\beta_1}
 \tag{3.3.15}$$

and

$$\hat{CS}_{total} = \sum_{i=1}^n \hat{CS}_i
 \tag{3.3.16}$$

The choke price for the locals now becomes

$$P_{choke} = -\frac{\beta_0}{\beta_1}
 \tag{3.3.17}$$

where the visit rate of locals drops to zero.

As for the log-log specification, the formulas used are in appendix 2.

3.3.2 Log likelihood models in Contingent Valuation Modelling

We will now go to the framework of contingent valuation model. In this part, we will choose a probability distribution model that fits our data best to analyze how social demographic, behavioral and attitudinal parameters influence respondents' willingness to pay for the improved

water quality in Lake Wuliangsu Hai. Similar model is discussed in Bateman et al (2002). And Day and Mourato (1998) has done a very good implication of the model.

First, we will find a log likelihood model which fits our data best to estimate the distribution of WTP if the respondents are willing to pay more than zero for the stated policy and analyze how the influence of social demographic variables on WTP is.

Second, a function to calculate the average WTP will be discussed.

3.3.2.1 General overview of the probability model

According to whether or not respondents will to pay for the stated policy, we can divide them into three categories, respondents with positive WTP, “protests” who refuse to pay for the stated policy due to characteristics of the CV exercise, and “consistent zero” who do not want to pay for the stated policy because it provides no welfare to them. Since a random individual can only belong to one of the groups, the total probably is equal to 1. The aim of our modeling for WTP is to find out the distribution of the positive WTP.

We define true willingness to pay of individual i as following from this equation:

$$f(z_i) = y_i + \varepsilon_i \quad (3.3.18)$$

where $f(z_i)$ is a function designed to express *true* WTP, while y_i is the WTP in the sample. We define

$$y_i = y_i(x_i) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_n x_n. \quad (3.3.19)$$

x_i is parameter that affects willingness to pay including social demographic, attitudinal and behavioral variables. Equation (3.3.19) implies that WTP is affected by different background variables of individuals.

ε_i is the random component of the model representing unexplained characteristics of utility. It is assumed to obey the normal distribution with mean zero and standard deviation σ .

In our model, we specify equation (3.3.19) as follows¹⁷

$$y_i = \beta_0 + \beta_1 \ln income_i + \beta_2 nov5 yf_i + \beta_3 noigroup_i + \beta_4 gender_i + \beta_5 age_i + \beta_6 edu_i + \beta_7 enconcern_i + \beta_8 Per1 + \beta_9 Per2 + \beta_{10} Per3 + \beta_{11} Per4 + \beta_{12} Per5 + \beta_{13} Per6$$

(3.3.20)

Where

$\ln income_i$ = log monthly household income of individual i .

$nov5 yf_i$ = Number of visits to the Lake Wuliangshuai in last five years.

$noigroup_i$ = Number of people traveling in the same group as individual i .

$enconcern_i$ =Environment concern indicating variable (dummy)¹⁸

$Per1$ =Perception of lake water quality. (Dummy: clean=1; not clean=0)

$Per2$ =Perception of lake water smell. (Dummy: disagreeable smell=1; not=0)

$Per3$ =Perception of lake surrounding area. (Dummy: clean and well maintained=1; not=0)

$Per4$ =Enjoy boat sightseeing (Dummy, enjoy=1; not=0)

$Per5$ =Enjoy bird watching (Dummy, enjoy=1; not=0)

$Per6$ =Will visit the lake more often if the water quality improves (Dummy, Will =1; not=0)

$gender_i, age_i$ and edu_i are gender, age, and years of education of individual i

Here we include all the behavioral and attitudinal variables in addition to income ($Income$) and $noigroup$. Attitudinal variables are adopted in order to test the correlation between the stated preference and the WTP while the behavioral variables are used to test whether there is any correlation between revealed preference and the WTP. In addition, the variable $noigroup$ is used

¹⁷ Here we use $\ln income$ rather than $income$ due to the decreasing marginal utility of income in economic theory.

¹⁸ Definition detail of $enconcern$ has been discussed earlier.

to test whether there is any free rider problem exists. However, we will not include the last six attitudinal variables, *Per1* to *Per6* when we calculate median positive WTP in the later section.

In a dichotomous choice question, given a value b_i , the answer of respondent i will be

$$\begin{aligned} \text{Yes} & \quad \text{if } f(z_i) \geq b_i \\ \text{No} & \quad \text{if } f(z_i) < b_i \end{aligned} \tag{3.3.21}$$

That is

$$\begin{aligned} \text{Yes} & \quad \text{if } \varepsilon_i \geq b_i - y_i \\ \text{No} & \quad \text{if } \varepsilon_i < b_i - y_i \end{aligned} \tag{3.3.22}$$

When ε_i is assumed to follow a normal distribution with mean of μ and standard deviation σ , we get the probabilities of “yes” and “no” answers equal to

$$\begin{aligned} \Pr(\text{Yes}) &= \Pr(\varepsilon_i \geq b_i - y_i) = 1 - \Phi\left(\frac{b_i - y_i(x_i)}{\sigma}\right) \\ \Pr(\text{No}) &= \Pr(\varepsilon_i < b_i - y_i) = \Phi\left(\frac{b_i - y_i(x_i)}{\sigma}\right) \end{aligned} \tag{3.3.23}$$

Where (3.3.23) is the cumulative normal distribution.

We can then derive the cumulative density function of the probability distribution:

$$F(z; a, \sigma^2, \rho) = \Phi\left(\frac{f(z_i) - y_i(x_i)}{\sigma}\right) \tag{3.3.24}$$

As to the distribution of true WTP $f(z_i)$, the normal distribution, is one of the most commonly used distributions in statistics studies. However, lack of any restriction, thus in particular allowing for negative values of independent variables, the normal distribution is not suitable for

our case where the willingness to pay is always greater than or equal to zero. On the country, the log-normal distribution excludes negative values by definition and is a better distribution than standard normal distribution. However, since $f(z_i)$ is the true WTP and is actually unknown. We have to use Box-Cox transformation in order to find the better fit distribution. The Box-Cox transformation is given by

$$\frac{z_i^\lambda - 1}{\lambda} = f(y_i(x_i)) + \varepsilon_i \quad (3.3.25)$$

where λ is a parameter estimated in the Box-Cox transformation.

If λ equals 1, the distribution of true WTP values follows a normal distribution, while if λ equals 0, a log linear function with log-normal distribution is better in interpreting the true WTP.

However, although log normal distribution manages to deal with positive WTP, it does neglect the zero WTP. Therefore, a model with a spike representing the probability of a value of zero will be used in our study together with the log likelihood model of positive WTP. However, the probability of zero WTP is assumed not to be influenced by other variables in our model.

The specific mixed model is given below¹⁹.

$$F(z; a, \sigma^2, \rho) = \begin{cases} \rho & \text{if } WTP = 0 \\ \rho + (1 - \rho)\Phi\left(\frac{f(z_i) - y_i(x_i)}{\sigma}\right) & \text{if } WTP > 0 \end{cases} \quad (3.3.26)$$

$F(\cdot)$ = Cumulative density function which indicates the probability of household willingness to pay that is equal to z or less.

¹⁹ The mixed model mentioned here doesn't exclude the WTP exceeding household income (or the certain percentage of household income). Therefore, a truncated model with adjustment which scales up probability of observing a positive WTP less than income limit to one is a improved version for the model mentioned here. But since the proportion of outliers whose WTP exceed the income limit is very low and only accounts 1.52% of the total population if we set the income limits at 5% of yearly income. So in later analysis, we simply discard these 8 observations in this regression model and choose a probability model that best fits the rest of the sample. Admittedly, trimming the tails of distribution by deleting outliers will lead to dropping people who have high values and disenfranchise those who have the most to lose, but the bias here is relatively small concerning the low percentage of outliers.

Figure 4 gives the probability density function of WTP with log normal distribution and spike.

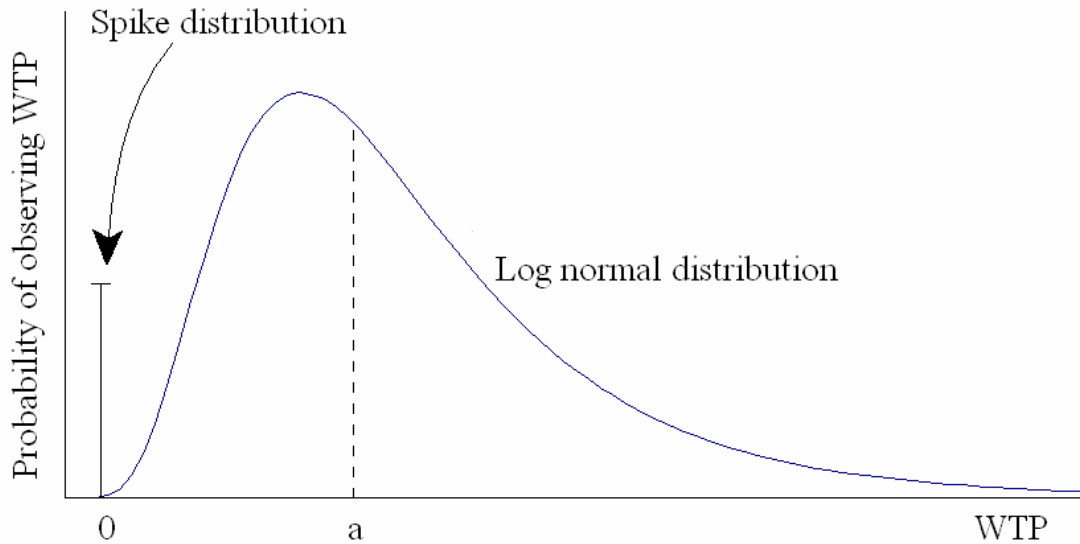


Figure 4: The probability density of WTP with log normal distribution and spike

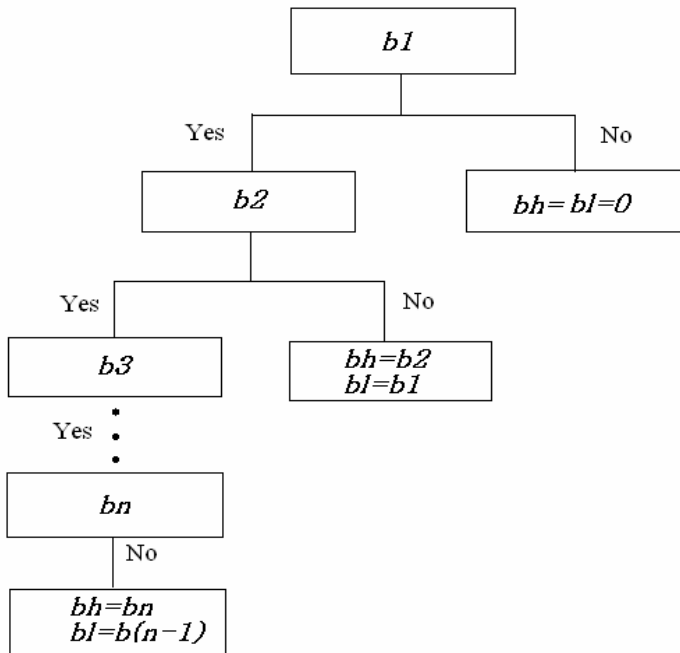
3.3.2.2 Log likelihood model with double-bounded data

The aim of our analysis of CV model is to estimate how background characteristics of respondents affect their WTP and to calculate the average WTP. The height of the spike in Figure 4 is the probability of WTP consistent zero. We will neglect effects of social demographic variables on the spike at zero and simply assume that the probability of zero WTP doesn't vary across population and is the same in all population. Our focus is to choose a best fit distribution for positive WTP and to analyze how it is influenced by different parameters. The mean WTP is related to specific distribution function of average positive WTP and the height of spike.

In the field work, respondents were presented with a payment card with a list of suggested possible values rather than just one dichotomous question for WTP. The up bidding game is among those who willing to pay for the stated policy is shown in Figure 5. Those who will to pay

for the stated policy means that they reply “yes” to the question that whether they are willing to pay for the lake improvement or not.

Figure 5: Procedure of up-bidding in survey



b_1 is the initial bid which equals the present price to visit the lake given that the respondent will pay for the stated policy.

$b_h = b_l = 0$, that is his WTP will be regarded as consistent at level zero if he rejects the initial bid, where b_l is the lower bound of bid level and b_h is the higher bound of bid level.

$b_h = b_2$ and $b_l = b_1$ if respondents say “yes” to b_1 and “no” to b_2 .

$b_h = b_n$ and $b_l = b_{n-1}$ if respondents say “yes” to all bids that are smaller or equal to b_{n-1} but “no” to b_n

Where $b_1 < b_2 < \dots < b_{n-1} < b_n$.

According to the bidding process given above, each respondent ends up with a value b_h to which the answer is “no”. While the value that he gives the last “yes” is b_l . This implies that the true WTP of the respondent is between a lower bound b_l and an upper bound b_h .

Thus the probability function of WTP, between the upper and lower bound, is given as

$$\Pr(b_l < y_i \leq b_h) = F(b_h; a, \sigma^2, \rho) - F(b_l; a, \sigma^2, \rho) = \Phi\left(\frac{f(b_h) - y(x_i)}{\sigma}\right) - \Phi\left(\frac{f(b_l) - y(x_i)}{\sigma}\right) \quad (3.3.27)$$

According to the probability function, we build up log likelihood function with Box-Cox transformation

$$\log L = \log\left(\Phi\left(\frac{b_h^\lambda - 1}{\lambda} - y_i(x_i)\right) / \sigma\right) - \Phi\left(\frac{b_l^\lambda - 1}{\lambda} - y_i(x_i)\right) / \sigma \quad (3.3.28)$$

If $\lambda=1$, the log likelihood model becomes

$$\log L = \log\left(\Phi\left((b_h - y_i(x_i)) / \sigma\right) - \Phi\left((b_l - y_i(x_i)) / \sigma\right)\right) \quad (3.3.29)$$

If $\lambda=0$, the log likelihood model follows the log normal distribution

$$\log L = \log\left(\Phi\left((\ln(b_h) - y_i(x_i)) / \sigma\right) - \Phi\left((\ln(b_l) - y_i(x_i)) / \sigma\right)\right) \quad (3.3.30)$$

The final estimation of λ , σ and coefficients of different social demographic variables will be discussed in detail in section 5.

3.3.2.3 Average willingness to pay

The function used to calculate the total average WTP is given below

$$\text{Average WTP} = \text{Probability of positive WTP} * \text{Average positive WTP} \quad (3.3.31)$$

Where

$$\text{Probability of positive WTP} = 1 - \rho$$

$$\text{Average positive WTP} = \text{media WTP}^{20}$$

The total willingness to pay for the stated policy is found by multiplying the average WTP in the sample by the annual visitation to the lake. Here we assume that the sample in the period of field work is representative of all annual visitors to the lake.

²⁰ The function of media WTP is highly sensitive to the distribution. Therefore, we will specify the function for media WTP after the distribution is determined.

4 Description of fieldwork, survey design and survey results

4.1 Description of fieldwork

The field work was conducted during the period 19th August to 12th September, 2004 in Lake Wuliangsu Hai. During the first four days of this period, from 19th August to 22nd August, a pilot survey was carried out based on an initial questionnaire for the purpose of making it more efficient and easier to understand. And several changes were made in the survey mechanism according to the problems in pilot survey. The main change was in the payment vehicle. Individual taxes are still rather unfamiliar to most people in China who do not have their own businesses. The price of visiting the lake in the form of a boating and/or entry fee is more direct and easier for respondents to grasp. The payment vehicle is thus changed from additional income tax to the summary of boating fee and entry fee. In addition, we found that there was no comparable lake scenery in the vicinity of the Lake Wuliangsu Hai. Therefore single-site TCM model is used in final analysis.

The final survey started on 25th August and ended on 12th September 2004. On-site personal interviews were used to ensure a sufficiently high respondent rate and to avoid misunderstandings and unclear features of the survey mechanism. The respondents were chosen among those who visited the lake during the period of survey time. A total number of 525 respondents were interviewed during the final survey. They were intercepted either after finishing their trips to the lake and in the process of leaving, or in the middle of their visit. All questions were presented to respondents orally, rather than to give them the questionnaire and let themselves fill it out. Further explanations were given by interviewers to clarify the purpose of the question which is both time saving and misunderstanding minimizing. A card showing alternatives was used for registering household income. Up-bid payment card was adopted to elicit WTP of the respondents for the lake after restoration. With the help of boat drivers and officers near the dock, most of the visitors cooperated quite well.

The statistical program for handling the data is STATA 8. Microsoft Word, Excel and Openoffice6.0 were also used in the data processing stage.

4.2 Survey design

4.2.1 General overview

Since we will combine two valuation methods, TCM and CV, the questionnaire used in the survey includes questions concerning both revealed preference and stated preference. The questionnaire is given in Appendix 1..

The questionnaire is divided into four parts. The first part elicits information concerning TCM. Questions in this part is mainly to elicit the parameters need in the single site TCM model, such as the residential place of respondents, time spent both on the way and on site, and stated expense etc. The second and the third part are CV questions which include attitudinal questions and WTP questions. The last part of the questionnaire consists of social demographic questions which are shared by both TCM and CV.

We will focus on more about the rationale for the CV in our survey design since stated preference is more sensitive to design of questionnaire than the revealed preference. Therefore, survey design is very important in CV to elicit real WTP of the respondents for the target policy.

4.2.2 Survey design for Contingent Valuation

Questions concerning CV in our questionnaire mainly include three parts

- WTP questions
- Attitudinal questions
- Social demographic questions

The main purpose of attitudinal questions is to collect information on respondents' attitude towards the water quality and lake activities while social demographic questions are to gather information about social – economic characteristics of respondents.

WTP questions are the core of CV since it is used to elicit the willingness to pay for the improved water quality in the lake after restoration. In the scenario before the WTP questions, the present condition of the lake and the previous state of the lake in twenty years ago were presented to the respondents. Then, three main source of pollution was given as the main reason for deterioration of water quality. Specific description of future condition of the improved lake was given afterwards. Great care was taken to create a realistic future scenario to respondents. Each respondent was then presented a future blueprint of the lake in which they could swim, go fishing and have better boat sightseeing, bird watching and tourist facilities. Respondents were also informed of the result if no action was done to the lake. Three different actions were presented in Table 2.

Table 2: Optional actions to be taken, indicated in the survey

<i>No.</i>	<i>Actions</i>
1	Industry and cities invest in wastewater treatment to avoid bad smelling water, allow swimming and fishing in 10 years
2	Fish Farm company buy water from the Yellow River Commission to maintain lake level
3	Fish Farm company dredge channels and cutting back reeds around lake to ensure continued boating

After respondents were clear about difference between current and future conditions of the lake, they were told which role they should play in the lake restoration together with the payment from industry and local government.

Up-ward bidding payment card was used to elicit WTP. The sum of entrance fee and boating fee was used as payment vehicle. The upward payment card was carried out by bidding up by interviewer while the respondents themselves could not see the payment card to minimize the

strategic behavior. The respondent will answer “yes” if their WTP was higher than the amount presented and “no” if it was lower. The benchmark price was set at the sum of the current entry and boating fee to reduce the anchor bias.

In order to distinguish those who simply refuse to pay for the restoration of the lake and those whose WTP is zero, respondents were asked whether they were willing to pay a higher price than their current price 28 yuan, the sum of present entry fee and boating fee, for the improvement of local amenities before the bidding game was started. Those who refused to pay the present price were regarded as “protests”. The reason is that every one who came to the lake has to pay 28 yuan for the lake with current condition and this question make respondents clear whether they were willing to pay for the improvement or not. Therefore those whose WTP for the improvement is 0, will reply “yes” to this question. At the same time, reasons for not willing to pay for the improvement is required to make sure that those who answer “no” are real “protests”. We thus feel that we are able to distinguish between those with “true” zero WTP and those who refuse to pay, from the answer to this specially designed question with high degree of certainty,.

If the respondents agree to pay for the improvement of the lake, they will be guided to an upward bidding game and the bidding game uses payment card shown in Table 3. As mentioned earlier, those who say “yes” to this entry but “no” to the next upper price will be considered to have zero WTP. And those whose WTP were greater than zero will end in the price where they refused to pay. Thus, we get a range of their willingness to pay. $(P_{lower} \ P_{upper}) \cdot P_{upper}$ is the upper interval which was censored at the maximum bid on the bidding game. And P_{lower} is the lower interval which corresponds to the last “yes” answer. Since the true WTP lies somewhere in between, the data is treated as interval data.

Table 3: Upward bidding payment card used in the survey

Would you still visit the lake if the fee was..? (CHECK AMOUNTS STARTING FROM LOWEST)

___8+20=28 RMB
 ___11+25=36 RMB
 ___14+30=44 RMB
 ___17+35=52 RMB
 ___20+40=60 RMB
 ___25+50=75 RMB
 ___30+70=100 RMB
 ___50+100=150RMB
 ___more.(Please specify)_____

4.3 Results for survey parameters

In this section, we will provide the result summary of main survey parameters.

4.3.1 Social demographic characteristic

The following tables and figures present a summary of selected social demographic characteristic. They illustrate the distribution of age, gender, household monthly income and education respectively. Figure 6 shows that average age of the sample is round 40 years old and Figure 7 illustrates that 72.38% of them are men among the 525 respondents. What’s more, Figure 8 tells that the mean of monthly household income is 4242 yuan while the media is 2500 yuan. And Figure 9 shows that more than half respondents have education as bachelor.

Figure 6: Distribution of age

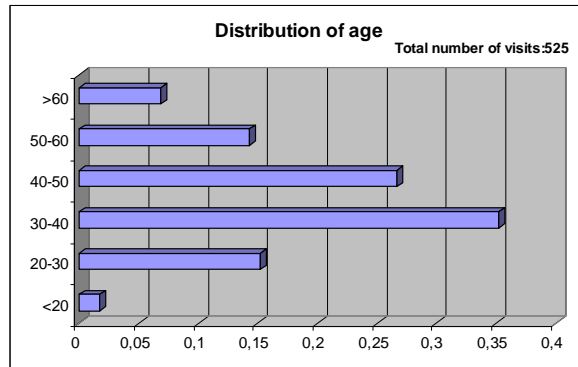


Figure 7: Distribution of gender

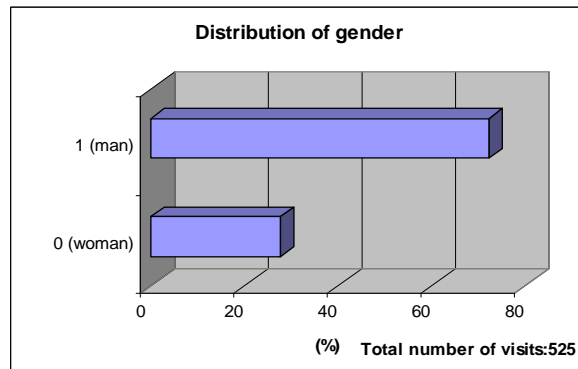


Figure 8: Distribution of household monthly income

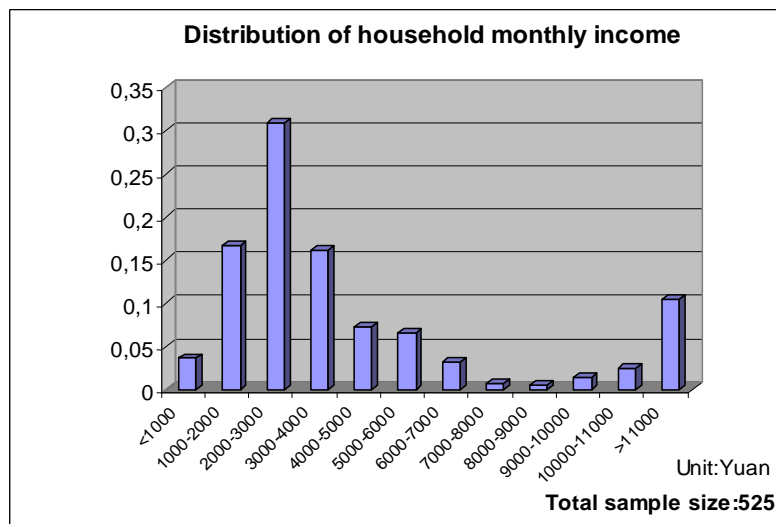
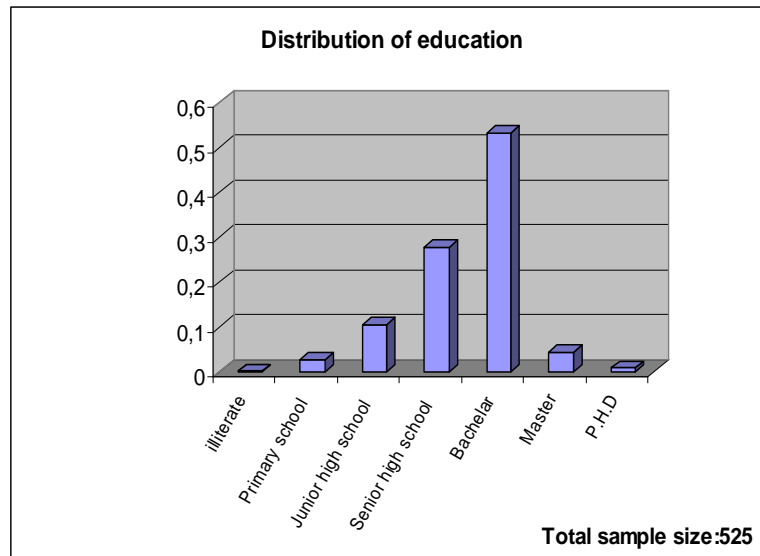


Figure 9: Distribution of education



4.3.2 Attitudinal perception towards the lake quality

Table 4 illustrates a list of distribution of different attitudinal variables. Only 38.67% of the respondents agree that the water in the lake is very clear, while 40.95% of all the respondents think that the lake has a disagreeable smell. This implies that although most of the respondents agree that lake water is quite poor, they don't think it is "too bad" such that water would have a disagreeable smell. At the same time, 61.33% of the visitors are satisfied with the environment in the surrounding area of the lake.

Most visitors state that they enjoy the boat sightseeing and the bird watching on the lake and agrees that they will visit lake more frequently if the water quality becomes better.

Table 4: Attitudinal distribution

	(%)
Lake water is clean	
Agree	38.67
Disagree	61.33
Water has disagreeable smell	
Agree	40.95
Disagree	59.05
Surrounding area is clean	
Agree	61.33
Disagree	38.67
Enjoy boat sightseeing	
Agree	95.05
Disagree	4.95
Enjoy bird watching	
Agree	98.10
Disagree	1.90
Willing to visit the lake more frequently if the water quality is improved	
Will	96.38
Will not	3.62

4.3.3 Behavioral characteristics

One variable specially designed in our case is environmental concerning variable (*enconcern*). It is a dummy variable which equals 1 if respondents choose C or D and 0 if they choose A or B to the following multiple choice in Table 5.

Table 5: Question for *Enconcern*

If you go to a tourist attraction that is extremely dirty, what will you do then?

A Complain and decide never to come back

B Throw rubbish every where

C Keep the nature tidy and keep it as nature

D Become a member of environmental organization and advocates others to protect nature

The definition of environmental concern in our context is that one feels personally responsible for the environment where he goes. Thus, those who chose A or B are assumed to be not much concerned for the environment, while those who chose C or D are regarded to be more concerned about the environment. Figure 10 is the distribution of *enconcern* variable.

Figure 11 and Figure 12 describe the familiarity of the visitors to Lake Wuliangshuai. Figure 11 shows that almost 40% visitors never had been to the Lake Wuliangshuai before. While Figure 12 illustrates the distribution of the number of visits to the Lake in the last five years among those who had been to the lake.

Figure 13, Figure 14, and Figure 15 describe the distribution of residential place for all the respondents, multi-destination trip against only destination trip and distribution of lake activities respectively. While most respondents only spend one day in Lake Wuliangshuai, more than 32% have multiple purposes with the trip to the lake.

Until now, “Boating” and “Enjoy the lake by lake shore” are the two most important activities for visitors while the “Bird watching on Bird Island” and “Bird and fish museum” occupies less time of the visitors for the trip to the lake. The latter may be due to the fact that the bird island hasn’t been finished yet, and the museum has not been renovated for a long time.

Recreational Valuation of Lake Wuliangshuai

Figure 10: Distribution of *enconcern*

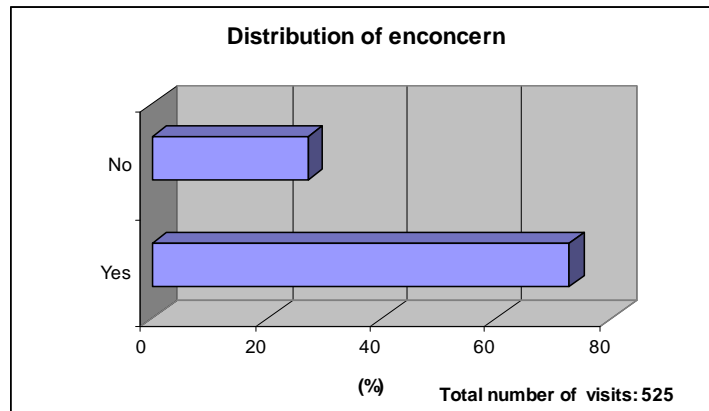


Figure 11: Distribution of whether visit the lake or not

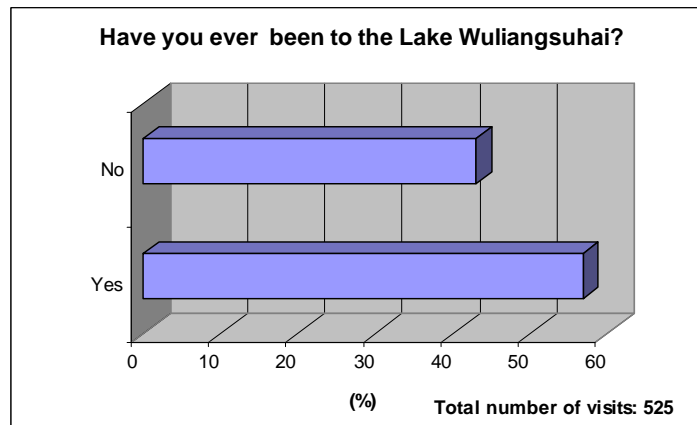


Figure 12: Distribution of number of visits to the Lake in last five years

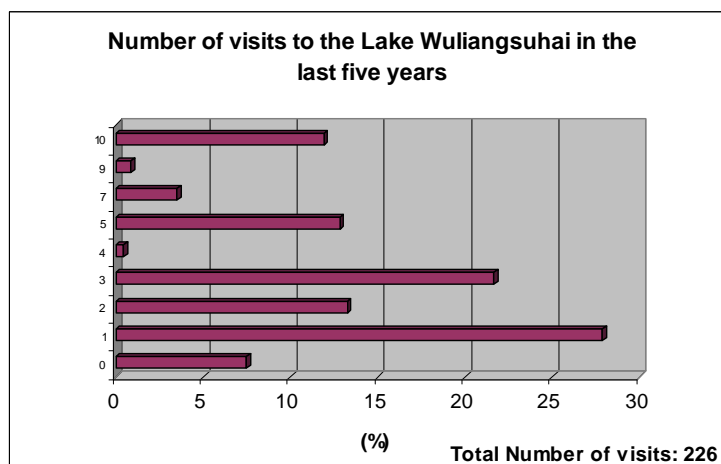


Figure 13: Distribution of residential place

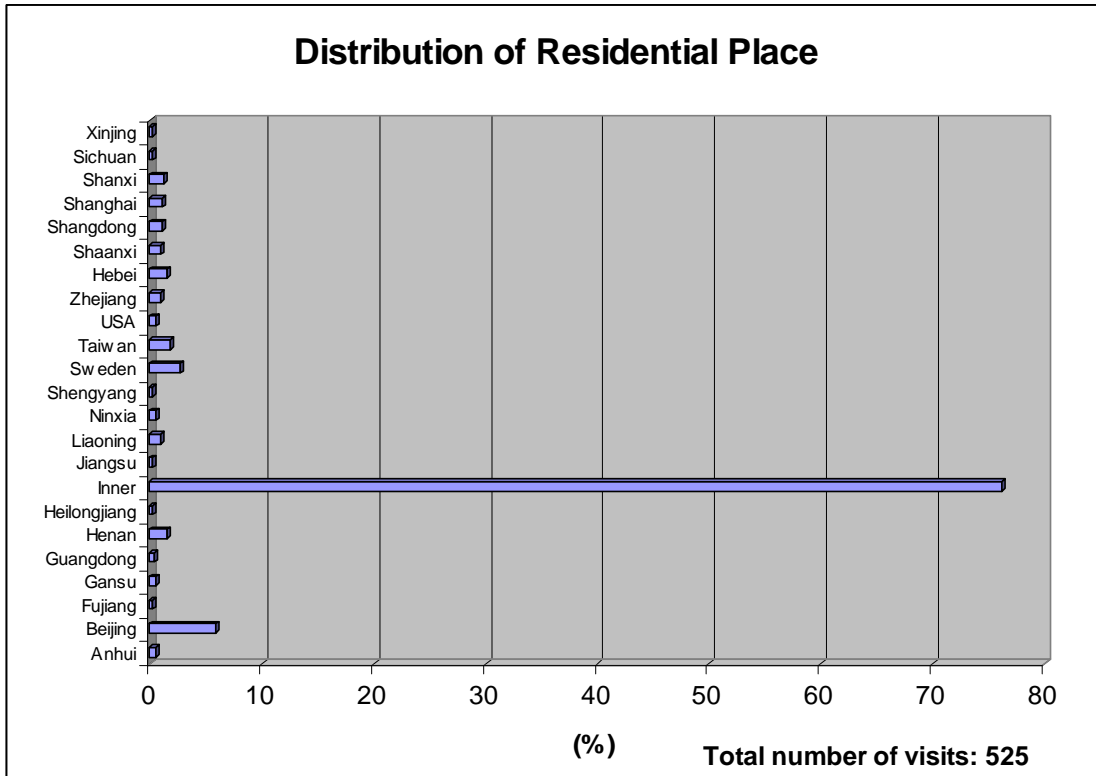


Figure 14: Distribution of multi-purpose trip or single purpose trip

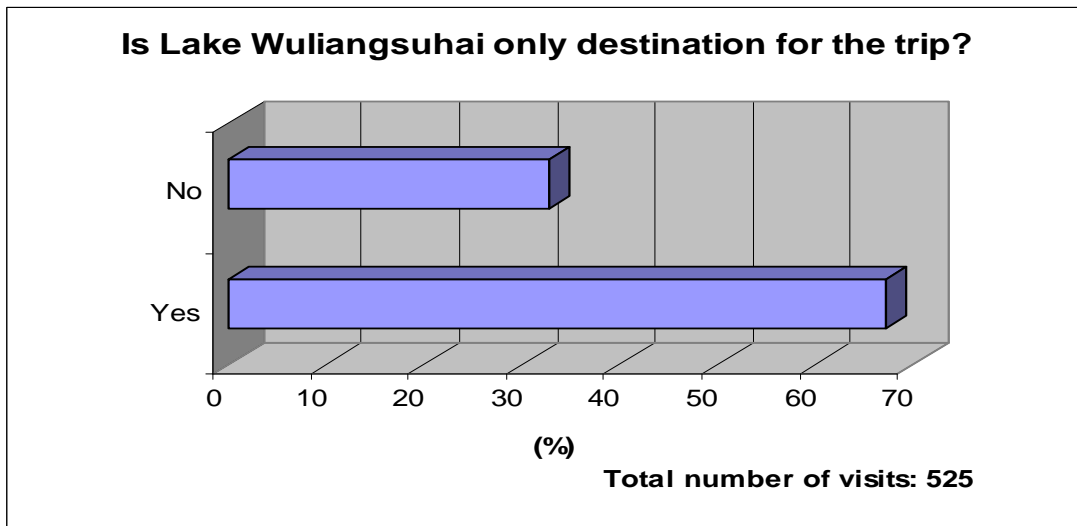
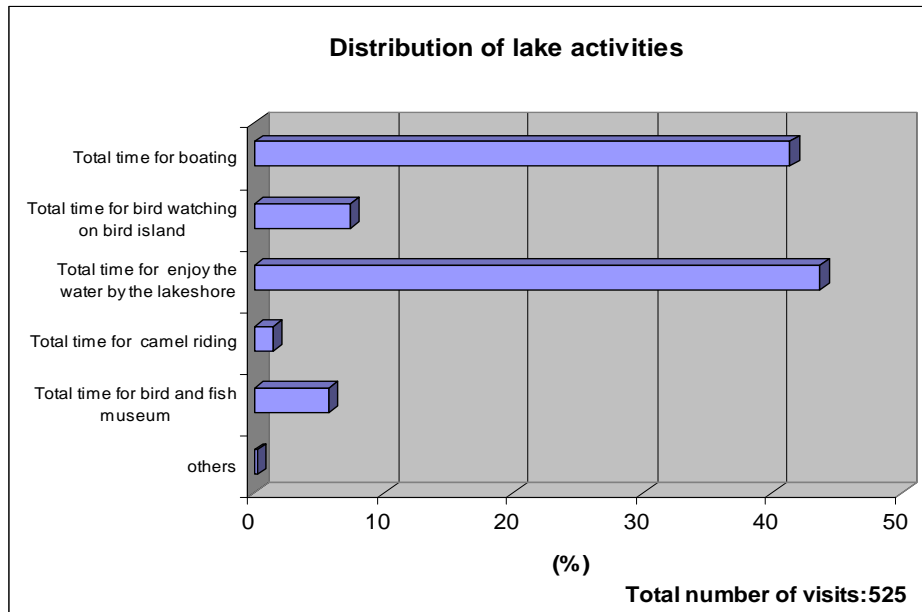


Figure 15: Distribution of lake activities



4.3.4 Willingness to pay

Table 6 is the summary of willingness to pay in our sample. The valid sample size in total is 525 and the response rate is 100% due to the on-site sampling. Among all valid interviews, only 1.14% of them stated that they refused to pay for the improvement of the lake; these are treated as protest bidders in the table. Low protest rate here can be viewed as a strength of the survey although we cannot rule out one possibility that some respondents might give incorrect responses. This is a bias imbedded in the on-site sampling procedure and we will not comment more on this in the following discussion. The percentage of respondents with consistent zero WTP counts for 6.29%, while 92.57% of the respondents who reported positive WTP. Compare to many other relevant studies, the percentage of zero WTP in our case is very low. However, it seems clear that not all those who stated a positive WTP expressed their true valuation. In particular, some may state an amount of WTP that exceeds their ability to pay concerning their income. We treat the respondents who stated WTP in excess of 5% of their personal yearly income as “outliers”. “Outliers” are those whose WTP is overstated²¹. Therefore we divided those with positive WTP

²¹ Here we assume that the family size is three which is most common case in China. Thus personal yearly income equals the yearly household income divided by three.

into two categories. One is outliers and another is truth tellers .In our regression and sensitivity analyses we exclude the outliers and consistent zeros.

Table 6: Summary of WTP

	Number	Percentage
WTP protests	6	1,14%
WTP consistent outliers	8	1,52%
WTP consistent zeros	33	6,29%
WTP coding error/missing	0	0
Total sample size	525	
Sample reponse rates	100,00%	
WTP >0	486	92,57%
WTP =0	33	6,29%
WTP protests	6	1,14%

5 Model Estimation and regression results

5.1 Expected relation between the dependent and independent variables in TCM

Table 7 illustrates the expected sign of social parameters used in single site zonal TCM.

Table 7: Expected sign of the coefficients in the model

visit rate	
household income	+
Gender	+
Age	-/+
Education	+

This table is based on principles from economic theory and shows that higher income leads to higher demand for a normal good. However, the marginal demand decreases as income rises. Gender and education are expected to be positively correlated with the visit rate. That is, the higher the education of respondents, the greater preference for nature, and the older the person, the less tendency there will be to travel.²² However, the sign of gender can be either negative or positive.

In the following table, we present the estimated signs of different parameters.

5.2 Results for single site zonal TCM model

5.2.1 General review of result

In Table 8, there are 4 different models according to the different definition of time cost and the trip. There are 43 different zones and 5 explanatory variables in each model and all the four models here are based on semi-log function and their results will be used in calculating consumer surplus²³. Different models are located in different column and the coefficients of variables are in

²² The expected sign of age and education are more or less based on common sense.

²³ We only focus on the semi-log model even log-log model has better adj- R^2 . There are two reasons concerning this: 1) coefficients of travel cost in the semi-log models are generally larger than those in the log-log models which means a smaller consumer surplus derived from the former. Thus it's better to use the consumer surplus based on the

corresponding lines with the variable name list on the left column. Further reason and discussion for log-log function are given in Appendix 3.

Table 8: Results of TCM: semi-log regressions

Ln (visitrate)		Model 1	Model 2	Model 3	Model 4
Totalcost	Coefficient	-			
	t-value	0.0004161***			
Totalcost2	Coefficient		-		
	t-value		0.0004595***		
totalcost(claimed)	Coefficient			-0.0004443* ¹	
	t-value			-2,05	
totalcost(oneaim)	Coefficient				-0,0003493
	t-value				-0,46
Householdmonthlyincome	Coefficient	-0.0000836**	-0.0000817**	-0,0000306	-0.0000883*
	t-value	-2,15	-2,10	-0,59	-1,94
Gender	Coefficient	-0,7847271	-0,7980202	-1,5264250	-2.00128*
	t-value	-0,77	-0,78	-1,38	-1,75
Age	Coefficient	0.05189905*	0,0530175	-0,0135118	0,0042581
	t-value	1,65	1,68	-0,41	0,13
Education	Coefficient	0,0083529	0,0308323	-0,0411775	-0,1044487
	t-value	0,10	0,36	-0,45	-1,13
Constent	Coefficient	-12.92549***	-13.26425***	-9.721133***	-9.137181***
	t-value	-6,52	-6,54	-5,01	-4,45
Adj-R2		0,3240	0,3244	0,1610	0,0708
F		F(5,37)=5,03	F(5,37)=5,03	F(5,37)=2,61	F(5,37)=1,64
Sample size		43	43	43	43

*** Significant level:1% ** Significant level:5% *Significant level:10%

In the first three models, the definition of trip is from respondents' residential place to Lake Wuliangsohai which means we neglect multipurpose trips and assume that all the visitors in our sample only have one aim that is to enjoy the lake. While the starting point of the trip in Model 4 is defined as the latest departure place to the lake.

Another main difference among these four models is the way to calculate the time cost. Model 2 uses 60% of the hourly wage as the opportunity cost of time while the other three use 100 % of hourly wage as time cost. In Model 1, 3 and 4, we assume that all trips are arranged by the

former in views of conservative when it comes to the decision making. 2) There is some at odds in the results of consumer surplus in log-log models .Two of them become negative which is not reasonable. This may be due to the functional problem of log-log models.

company or those who have the 100% flexible working time. While in model 2, we assume that working time may not fully flexible and only adjustable to a certain extent²⁴.

5.2.2 Detail discussion of coefficient of different parameters

1. The coefficient of travel cost

1) In Table 8, the coefficients of travel cost in all the four models are negative which means that the higher the cost is for the trip, the lower is the visit rate. This is consistent with expectations, and is a necessary condition for the TCM model to be valid. However price of the trip here is not very sensitive to the demand, visit rate, compare to that in the log-log models in Appendix 3. For example, in Model 1, the coefficient of travel cost is only -0.0004161 which indicates that one unit increase in the total travel cost of the trip is associated with only 0.04161% decrease in the visit rate.

Our assumption in Model 4 is that previous trips in the package trip don't influence the trip to Wuliangsuhai. However, the explanatory power of the coefficient of travel cost which treats each trip as it is from the latest departure place is very low. In Model 3 which is with claimed travel cost, the travel cost variable is negatively correlated with the visit rate at significant level 0.1. It indicates that visitors aware of the cost of trip and the revealed behavior are therefore consistent with their awareness at least to some extent, while the insignificant result in Model 4 shows that the multi-purpose cannot be neglected.

Figure 16 and Figure 17²⁵ illustrate the relationship between the visit rates and the travel cost based on 100% wage rate time cost and 60% wage rate time cost respectively. The scattered dots

²⁴ Even the trip organized by the company who can have enough possibility to make the utility of leisure and working equal at margin, they can only make this change freely during weekdays which means trips taken at weekends will have less opportunity cost than 100%.

²⁵ In all the three graphs here, log visit rate is on the x-axis and travel cost with different time cost is on y-axis. Since the visit rate for each zone is very small and between 0 and 1. Therefore the log visit rate is negative and most of them between -16 and -8. However, even the absolute value of the visit rate becomes negative, the correlation between the visit rate and the travel cost will not be changed by logarithm. Thus, even the number on the x-axis doesn't seem to consist with common sense, it does give the visual correlation between these two variables.

in each graph are the points from the data while the smooth curve in two graphs is based on the predicted visit rate from the semi-log function.

Figure 16: Relationship between visit rates and travel cost with 100% wage rate time cost

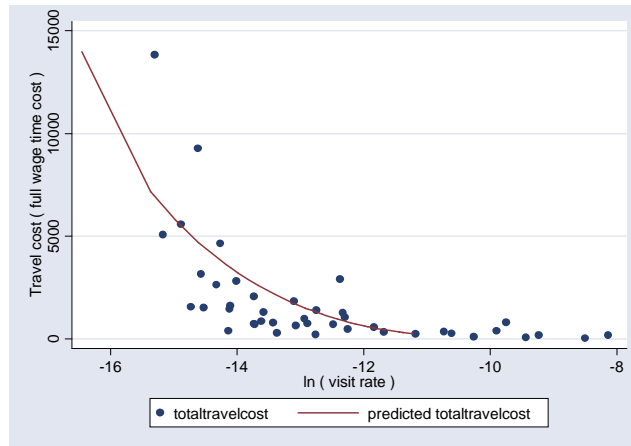
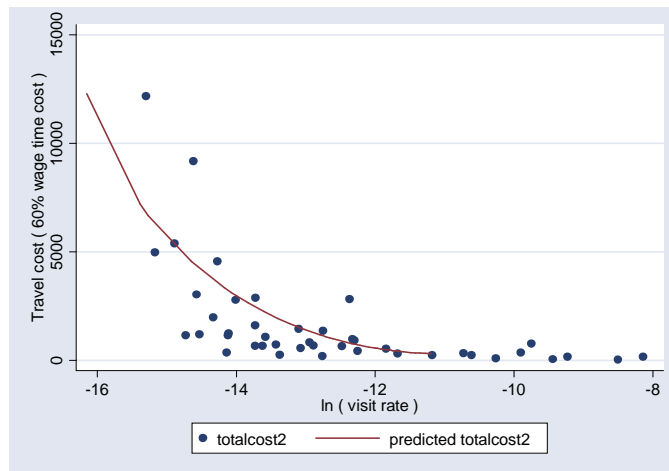


Figure 17: Relationship between visit rates and travel cost with 60% wage rate time cost

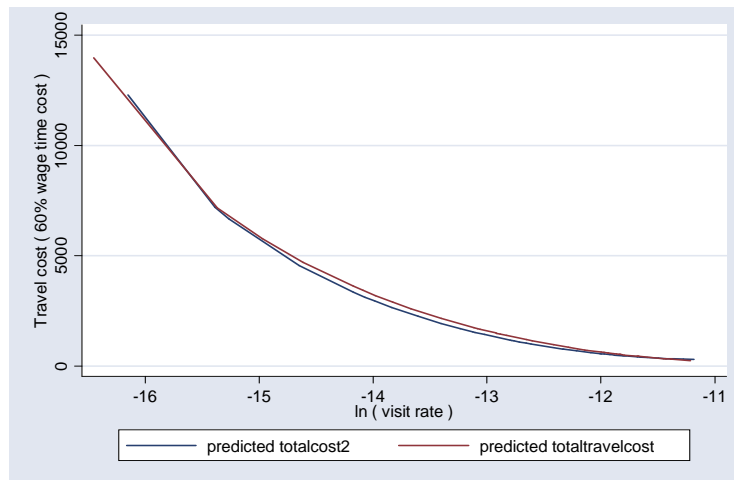


2) The coefficient of the travel cost at full wage rate time cost is smaller than that at 60% wage rate time cost in absolute value, which imply that the visit rate is less sensitive if we use the full time cost than the 60% wage as time cost.²⁶

²⁶ This may also be the result of using the same visitation rate from sample in the two regressions which is a reason mentioned later.

In Figure 18, we put the regression curve of two different travel costs together.

Figure 18: Comparison between the curves with full and 60% wage rate time cost



We find out that the curves with two different opportunity costs differ little when the travel cost was very low and the visit rate become higher if we use the full wage rate as time cost. The difference is due to the definition of the time cost.

Increasing by one unit the travel cost with the full wage time cost is associated with less reduction in the visit rate, than that in the case of 60% time cost. Thus in the graph, the consumer surplus for the full wage time cost is larger than that for 60% wage time cost. As a result we may over estimate the total consumer surplus if we use the full wage rate as opportunity cost, when the correct opportunity cost is 60% of the wage rate. As most employees in China cannot adjust their working time much at the margin, and even the company who organized the trip to Lake Wuliangshuai in our survey cannot adjust their time for trip on weekends, 60% wage rate would appear to be an appropriate approximation of true time opportunity cost, and will be used for our final welfare calculations.

2. The coefficient of monthly household income

The coefficients of the monthly household income in all the four models are negative although

the effect of income on the demand is quite small. The negative relation between household income and the visit rate indicates that the more income of visitors the less visits they incur in our model. Given that there is no multi correlation between income and travel cost, one explanation for the negative relation is that the visit to the lake is an inferior good which means that, among visitors to Lake Wuliangshuai, visitors with relatively low incomes dominate. This may be because of the poor quality of lake water and tourist facilities. Therefore, the current lake does not cater to high-income households. Those who have higher income would choose to visit other recreational sites which have better quality of environment and amenities.

Another reason is given below if we still regard the lake as a normal good. The household income has two effects, substitution effect and a “complementary effect”. On one hand, the complementary effect which is the direct influence of income on the visit rate means that higher income of the family more visits they will take to the lake. On the other hand, the substitution effect stems from the impact of income on travel cost. The total cost of the trip contains two factors, round trip travel cost and time cost. The latter is correlated with income. The more income one has the higher opportunity cost of traveling which lead to the lower visit rate. Thus, the final sign of the coefficient of household income depends on the weight of the two effects. If the substitution effect outweighs the “complementary effect”, the sign of the coefficient will become negative.

3. Age

The coefficients with respect to age in all models are positive, which is opposite to our expectation that older people go traveling less. Our explanation for this phenomenon is that elder people would like to go to more peaceful place to enjoy the nature like Lake Wuliangshuai. However, the explanatory power of most models is very low and we can't reject zero hypothesis except Model 1.

4. Other discussion

Coefficient of gender variable is significant only if we regard the trip as a one-purpose trip in Model 4. Since gender is a dummy variable in our estimation where 0 stands for women and 1 for men, the negative coefficient implies that men go to the lake less frequently than women. But

the explaining power is low in most models, too.

Coefficient of education is not significant in all the models thus we can't reject the zero hypothesis at any acceptable level. Thus we can assume that education doesn't affect the visit rate very much at least from our sample.

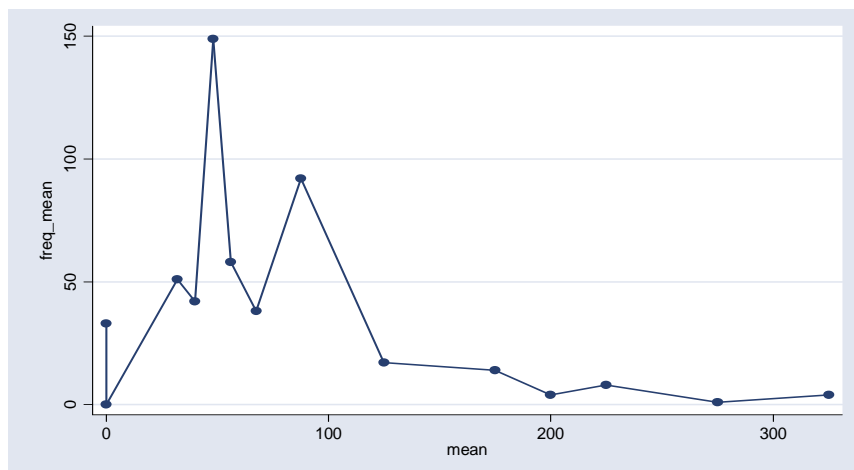
5.3 Results for the CV model

5.3.1 Distribution of population of WTP

5.3.1.1 Distribution of mean WTP

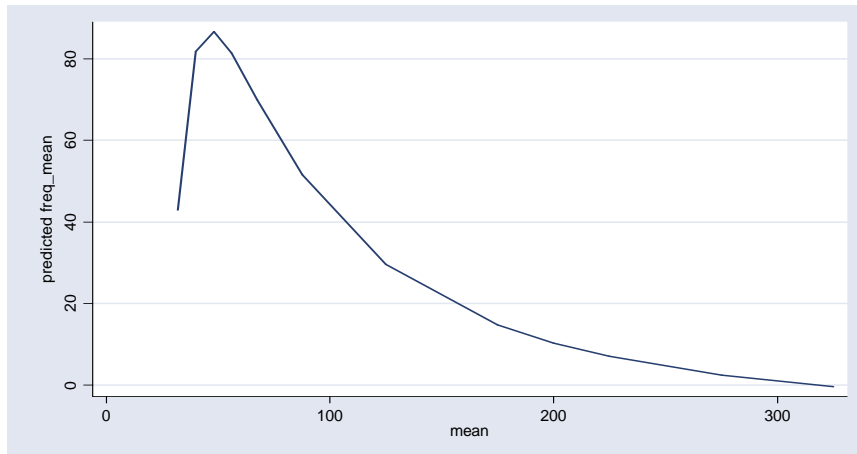
Figure 19 and Figure 20 present the distribution of mean positive WTP²⁷ of the double bounded data with spike and without spike respectively. Both of them skew to the right. Therefore, log normal may be a better fit distribution in our case. However, the final decision of which distribution should be used in the regression model is left to Box-Cox transformation.

Figure 19: Distribution of mean of WTP with spike



²⁷ Mean positive WTP = $\frac{b_h + b_l}{2}$

Figure 20: Distribution of mean of WTP without spike



5.3.1.2 Estimation of distribution of positive WTP

As shown earlier, the true distribution of positive WTP can follow a number of different distributions. The most common ones are the normal and lognormal. Since we don't know the true distribution until now, we will use a more general function which can nest both of the two distributions, that is the Box-Cox transformation (Equation 3.3.28). Box-Cox transformation is usually used to convert data to a normal distribution when estimated functional form has poor fits. When λ equals 1, the Box-Cox model in (3.3.28) collapses into the linear specification in (3.3.29) while the original model becomes log linear equation (3.3.30) if λ equals 0. Therefore, from the result of Box-Cox transformation, we can choose a distribution that is closer to the true distribution.

5.3.1.3 Expected signs of parameters

Table 9 gives the expected sign of coefficients for different social-demographic and attitudinal parameters in the log likelihood model.

Table 9: Expected sign of independent variables in CV

	Expected sign of coefficient
<i>Lnincome</i>	+
<i>Nov5yf</i>	+
<i>Noigroup</i>	+/-
<i>gender</i>	+/-
<i>age</i>	+/-
<i>edu</i>	+
<i>enconcern</i>	+
<i>Per1</i>	-
<i>Per2</i>	+
<i>Per3</i>	-
<i>Per4</i>	+
<i>Per5</i>	+
<i>Per6</i>	+

lnincome: Since the Lake Wuliangsu Hai in the future with improved water quality can be regarded as a normal good even though the present lake appear to be an inferior good, higher income would imply higher willingness to pay for lake restoration. However, the increase in the income will lead to less increase in the WTP. That is , the marginal WTP is decreasing. Therefore *log income* is used here.

Nov5yf: The number of visits to the lake in the last five years indicates the familiarity of the respondents to the lake. Therefore, we expected that the more familiar to the lake the more willingness to pay for the restoration and improvement since those who went to the lake more frequently will be more aware of the environment problem than those who didn't.

Noigroup: The sign of the coefficient is uncertain. If *noigroup* is positively correlated with the WTP, there may exist “free rider”, the more people travel in the same group the less individual wants to pay for the improvement.

Gender and age: The expected sign of coefficients of these two variables can be either positive or negative.

Edu: Education is another important social demographic variable in our model. We expect respondents with more education will concern more about the long run interest like environment, therefore will to pay more for the lake improvement.

Enconcern: This dummy variable is a variable to show the relationship between attitudes toward environment and WTP. We expect that those who are more aware of environment will to pay more than those who are not.

Per1, Per2 and Per3: These three variables all concerns about the attitude to the water quality. Generally, we expect that those who are not aware of the pollution problem in the lake are likely to pay less than those who are aware of this.

Per4 and Per5: These two variables concerns the attitude to the lake activities, boating and bird watching. Those who like boating and bird watching are expected to pay more than those who are not interested in these activities.

Per 6: This variable reports the possible visits of respondents in the future. Those who express the possibility to visit the lake again after restoration are expected to pay more for the improvement.

5.3.1.4 Results of the log-likelihood models

First, we regress the full equation (3.3.28) with specification of y_i in (3.3.20). The result is shown in Table 10.

Table 10: The Box-Cox transformation

Number of obs = 478 *Wald chi2(13)* = 5.32
Log likelihood = -960.3474 *Prob > chi2* = 0.9674

	<i>Coefficient</i>	<i>Standard Error</i>	<i>z-statistic</i>
<i>lnincome</i>	.0035955	.0016591	2.17**
<i>nov5yf</i>	.000343	.0002465	1.39
<i>noigroup</i>	-.000087	.000062	-1.40
<i>gender</i>	.0020526	.0014052	1.46
<i>age</i>	-.0000583	.0000505	-1.15
<i>edu</i>	.0000679	.0001713	0.40
<i>enconcern</i>	.0031772	.0017055	1.86*
<i>per1</i>	-.0005127	.0011221	-0.46
<i>per2</i>	.0004913	.0007968	0.62
<i>per3</i>	-.0002109	.0010909	-0.19
<i>per4</i>	-.0009009	.0022712	-0.40
<i>per5</i>	-.0017351	.0040304	-0.43
<i>per6</i>	-.002194	.0030375	-0.72
<i>_cons</i>	1.079536	.1035139	10.43***
σ	.0106163	.0044198	2.40**
λ	-.8775003	.1010461	-8.68***

***: Significant at 1%. ** Significant at 5%. * Significant at 10%.

However, the explanatory power of the whole model is very low since the p-value of *chi2* is not significant at any acceptable level. Therefore, we cannot reasonably use the Box-Cox transformation for predicting the distribution of positive WTP in our case

Fortunately, since the normal and log-normal distributions are the most commonly applied distributions in estimating WTP, we will use these two distributions respectively to estimate the

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double bounded log likelihood model. The results of equation (3.3.29) and (3.3.30) are given in Table 11 and Table 12.

Both of the two models are significant at 1% level. Generally speaking, in log likelihood models, the larger the probability of the output, the better fitness is the model. As reported below, the log likelihood given in the log normal distribution is larger than that in the normal distribution. Thus, we can conclude that the log normal distribution is a distribution that fits better for the positive WTP in our data

Table 11: Results of the normal distribution

<i>Number of obs</i> = 478	<i>Wald chi2(13)</i> = 38.04
<i>Log likelihood</i> = -1138.0181	<i>Prob > chi2</i> = 0.0003

	Coefficient	Standard Error	z-statistic
lnincome	9.496429	2.155486	4.41***
nov5yf	.9901443	.5918737	1.67*
noigroup	-.1992419	.1493718	-1.33
gender	5.16658	3.305631	1.56
age	-.1739642	.1294782	-1.34
edu	.022439	.4977346	0.05
enconcern	6.956521	3.297067	2.11**
per1	-1.499075	3.235599	-0.46
per2	-.0864319	2.296779	-0.04
per3	-.7412802	3.192974	-0.23
per4	-1.812127	6.608954	-0.27
per5	-9.642889	11.67483	-0.83
per6	-4.637929	8.600581	-0.54
_cons	3.514885	25.24054	0.14
σ	31.25808	1.0935	28.59***

- The more familiar respondents are with the lake, the higher is their WTP for the improvement, and the effect is significant at level 10%.
- The dummy variable for gender is positive in the WTP function. It implies that men are willing to pay more than women, although the difference is small.
- Those who expressed more awareness of environment will pay more than those with less awareness although the absolute value of the difference is small in this case as well.
- *Age, edu, noigroup* and all the attitudinal and perceptual variables are not significant at any acceptable level. In addition the sign of coefficients of *Per4* and *Per5* are opposite to the expected ones without good reason.

5.3.3 Median WTP

Finally, we will use median WTP to calculate the final average WTP due to the possibility of “fat tail” distribution of positive WTP. The function of media positive WTP with log normal distribution is given below,

$$Median = \exp(\bar{y}) \tag{5.3.1}$$

where the conditional mean \bar{y} is found by inserting the mean of each variable used in equation (3.3.20) into the same equation together with the estimated coefficients from log likelihood function without attitudinal perception from *Per1* to *Per 6*. The result of log likelihood function without *Per1* to *Per6* is given in the Appendix 4.

6 Welfare calculation

6.1 Consumer surplus of TCM

6.1.1 Assumption

Before we start to calculate the average consumer surplus per zone and total consumer surplus for the whole year, we will discuss our assumption first. Basically, our welfare calculation based on the following assumptions:

- The sample took in the period of field work represent the entire group of visitors for the whole year. Since the tourist season every year in Lake Wuliangsu Hai is usually from 1st of May to 7th of October which includes both spring and autumn. Our assumption means that autumn visitors also represent the group of visitors in spring.
- Our sample is representative for all types of visitors visiting the lake since the period of survey covered almost all the autumn tourist season.
- Monthly distribution of the number of visitors doesn't change from year to year. And the monthly distribution of visitors this year obeys the distribution table in Appendix 5.

6.1.2 Average consumer surplus per zone

Table 13 and Table 14 give the results of the consumer surplus for non-locals and locals respectively. Here the consumer surplus is based on the semi-log regression for non locals and linear for locals. While Table 15 shows the average consumer surplus for all the zones by using the same semi-log function without separation.

In all the three tables, consumer surplus are calculated according to full wage rate time cost, 60% wage rate time cost (bolded) and claimed travel cost respectively. In addition, for each type of cost, consumer surplus with and without considering multipurpose trip and that with estimated

visit rate are also listed. As to the trip without taking into account multi purpose, we assume that all the respondents come directly from their residential place to Lake Wuliangshuai. When it comes to the consumer surplus with multi purpose trip, we base on the “fraction theory” mentioned in the methodology section and simply divide the consumer surplus without multi purpose by the average number of purpose each trip for each zone.

Table 13 illustrates that for non-locals, the average consumer surplus per zone given 60% wage rate time cost is from 3812 yuan to 10627 yuan. While for locals (Table 14), the average consumer surplus per zone given 60% wage rate time cost is from 6756 yuan to 6796 yuan. However, if we don’t distinguish the locals and non-locals, the aggregate average consumer surplus per zone is from 9229 yuan to 18174 yuan which is illustrated in Table 15.

Table 13: CS for non-locals

Number of zones: 31

			Average Consumer Surplus per Zone(Yuan)
Full wage rate time cost	With observed visit rate	Without multi purpose	8527.727
		With multi purpose	4210.073
	With estimated visit rate	Without multi purpose	18739.09
		With multi purpose	11532.24
60% wage rate time cost	With observed visit rate	Without multi purpose	7722.279
		With multi purpose	3812.43
	With estimated visit rate	Without multi purpose	17032.71
		With multi purpose	10627.06
Stated time cost	With observed visit rate	Without multi purpose	7986.466
		With multi purpose	3942.857
	With estimated visit rate	Without multi purpose	18210.88
		With multi purpose	9912.357

Table 14: CS for the locals

Number of zones: 12

			Average Consumer Surplus Per Zone(Yuan)
Full wage rate time cost	With observed visit rate	Without multi purpose	13893.79
		With multi purpose	10978
	With estimated visit rate	Without multi purpose	8414.848
		With multi purpose	6796.243
60% wage rate time cost	With observed visit rate	Without multi purpose	13893.79
		With multi purpose	6796.243
	With estimated visit rate	Without multi purpose	8367.262
		With multi purpose	6756.205
	Choke price		734.6

Table 15: CS for all

Number of zones: 43

			Average Consumer Surplus Per Zone(Yuan)
Full wage rate time cost	With observed visit rate	Without multi purpose	27553.75
		With multi purpose	20069.85
	With estimated visit rate	Without multi purpose	15656.51
		With multi purpose	10030.05
60% wage rate time cost	With observed visit rate	Without multi purpose	24951.29
		With multi purpose	18174.24
	With estimated visit rate	Without multi purpose	14237.22
		With multi purpose	9229.15
Stated time cost	With observed visit rate	Without multi purpose	25804.9
		With multi purpose	18796.01

Summary of comparison among Table 13, Table 14 and Table 15

- Full wage rate time cost versus 60% wage rate time cost:
Consumer surplus for full wage time cost is bigger than that for 60% wage time cost. This may be due to the fact that different time cost times associate with same visit rate from sample in our estimation. Cost associated with the lower total travel cost shifts the whole demand curve downwards.
- Estimated visit rate from regression function versus observed visit rate:
Consumer surplus with observed visitation rate and with estimated one from regression function are generally different from each other under the same time cost category. The only difference between the two ways of calculating consumer surpluses is explanation of error term. If the error term stems from the systematic preferences between zones, estimated visitation rate will be used while the observed visitation rate is used when the error term represents the observation error and random fluctuation. Since both ways of calculation are principally correct, we can say that the “true” consumer surplus is located between the two ranges. What’s more, the result that consumer surplus with stated travel cost given full wage rate time cost is between that with observed visit rate and estimated visit rate proves our assertion here.
- Single purpose versus multi purpose trip:
The average consumer surplus from the three tables differs a lot between that with multi-purpose and that without. The reason is that average purpose per trip is 1.29702 for locals and 2.377394 for non-locals which indicate that non-locals will be more likely to go to the lake as a side trip. And the average purpose for both locals and non-locals are larger than 1, neglecting multi-purpose will lead to the final consumer surplus overestimated.
- The calculated choke price for locals given a 60% wage rate time cost is about 734.5 yuan which implies that no locals whose place of residence is within 500km of the lake will visit the lake if their consumer surplus given 60% wage rate time cost exceeds 734.5 yuan. And there is no general choke price for non-locals under our assumptions.

6.1.3 Total annual consumer surplus for the tourist season

Our survey is carried out from 25th August to 12th September and total number of respondents is 525. However, due to the unspecific report for residential place, only 493 responses were used in final TCM and consumer surplus estimation. Since the total tourist season is from 1st May to 7th October every year, we simply scale up to the whole tourist season for the total consumer surplus per year based on the assumptions mentioned in (1). The scaling is based on the monthly distribution for tourist provided by Fishfarm in Appendix 5. Therefore, we got 26000 visits for Year 2004

Total annual estimate of consumer surplus is calculated according to the following formula:

$$\text{Total Annual Consumer Surplus} = \text{Annual Total Visitation} * \text{Average Consumer Surplus per Respondent} \quad (6.1.1)$$

Table 16 illustrates the total annual consumer surplus by using two different way of calculation. The upper part above the bold black line gives the average consumer surplus per respondent by dividing the respondents into locals and non-locals while the average consumer surplus per respondent in lower part below the bold black line is calculated according to aggregate regression from all the 43 zones. In view of incomplete flexible working hours in China, all the calculation use consumer surplus with 60% wage rate time cost taking into account the multi-purpose trip.

Results in Table 16 show that total expected annual consumer surplus by discriminating locals and non-locals is from 10.5 million to 21.7 million while the expected consumer surplus from putting 43 zones together is from 21 to 41.2 million per year, almost twice as much as the former.

However, both ways of calculation have advantages and drawbacks which are illustrated in Table 17. Dividing the respondents into locals and non-locals gives the smaller result which is better in view of conservative if the result will be used in the decision making for government, while aggregate regression is better when it comes to the theoretical support since the definition of locals is anyway a little bit arbitrary.

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Table 16: Result of average consumer surplus per zone and annual consumer surplus for TCM

Model	# of zones/ respondents	Mean consumer surplus per zone (Yuan)		Expected consumer surplus (25 th August - 12 th September) (Yuan)		Total expected consumer surplus (25 th August - 12 th September) (Yuan)	
		From	To	From	To	From	To
Locals (60% of time cost & multi purpose) (<500km)	12	6756	6796	81074	81555	199260	410994
Non locals(60% of time cost & multi purpose) (>500km)	31	3812	10627	118185	329439		
# of respondents in sample	493						
Per person						440	834
# of annual visitation*	26000						
Total annual consumer surplus						10508630	21675128
Aggregate (60% of time cost & multi purpose)	43	9229	18174			396854	781492
Per person						805	1585
Total annual consumer surplus						20929391	41214605

*The annual visitation is based on the expected visitation of Year 2004.

Table 17: Merit and short comings of the group division in TCM

Advantage	Dividing into locals & non-locals	Don't divide and aggregate 43 zones in total
Conservative	+	-
Stronger theoretical support	-	+

6.2 Consumer Surplus measures derived from the CV calculations

The number of respondents with positive WTP in the sample is 478 while the total sample size used in contingent valuation is 525. This implies that the probability of positive WTP = $478/525 = 0.91$. Therefore we can derive the following table presenting the result of media WTP and the total annual WTP.

Table 18 shows the mean and standard error of sample median positive WTP with interval data, mid point and the lower bound of double bounded data respectively. And annual WTP is provided with interval data. Here we use the bootstrap to calculate the standard error. As illustrated below, the annual total WTP for the visitors is about US\$ 0.17 million (1.41 million yuan) taking the zero willingness to pay into account.

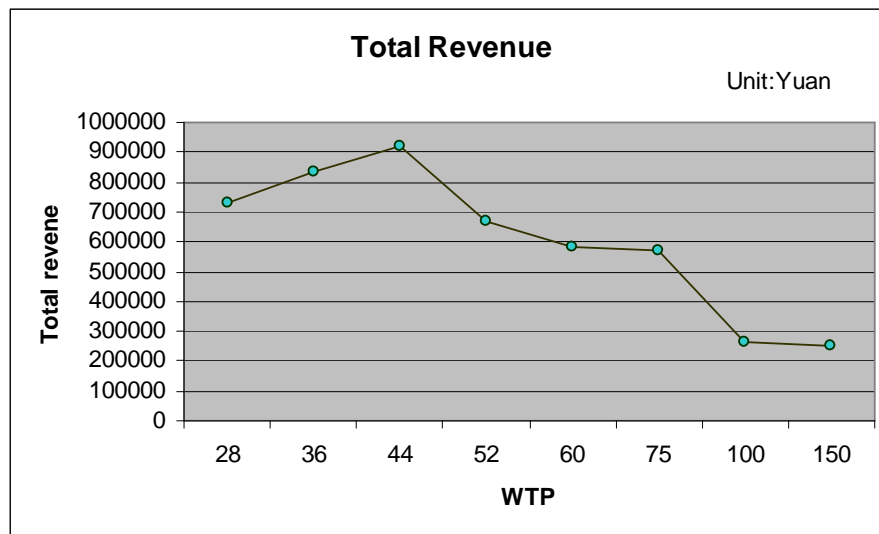
Table 18: Summary of results for annual WTP from the estimated CV functions

WTP	Sample Median (Yuan)	Annual WTP (Yuan)
Interval	59.52 (1.621673)	1.41 million (US\$ 0.17 million)
Mid point	65.51575 (1.621673)	-
Lower bound	58.89868 (1.375243)	-

6.3 Optimal fee after restoration

The optimal fee charged after restoration is the WTP level that will maximize the total annual revenue of the lake from boating and entrance. Figure 21 illustrates a rough total annual revenue curve at different WTP level. In the figure, we use the lower bound WTP i.e. the last “yeah” saying bid level. While the simple uncompensated demand at each entrance fee level is got by multiplying fee level charged with probability of “yes” at each bid level and with a baseline annual visitation number. As showed in Figur 21, the WTP level that maximizes the total annual income is around 44 yuan (US\$5.3) and the maximum total annual income from boating and entrance is about 921377 yuan (US\$111009) after restoration.

Figur 21: Maximum annual total revenue and WTP



7 Further discussion

7.1 Possible bias of the results

There are several points of the result need more explanation before applying them to a policy context.

- Total recreational value of the Lake Wuliangsuhai.

In the previous part of our study, we have already given the definition of the economic value and its classification. If we divide the lake into two according to time horizon, then one is present lake which is heavily polluted and another is the lake with improved water quality after restoration and will provide higher utility for the visitors. A rough description of the economic value of Lake Wuliangsuhai and its corresponding valuation method is given in Table 19

Table 19: Conclusion of total non-market value

	<i>Use value of users</i>	<i>Passive value of users</i>	<i>Passive value of non-users</i>
Present lake	TCM		
Improved lake	CV	CV	

The use value of users for Lake Wuliangsuhai in the current condition is provided by zonal single site TCM which is based on the respondents who realized the trip while use value and passive value of users for the improved lake are deducted from CV.

The WTP from CV survey is not only use value of users but also includes passive value of users. Since we ask the question “How much you are willing to pay (entrance fee) after the lake has been improved (in 10 years)?”. The respondents who want to pay higher entrance fee for the improvement may not only thinking of themselves getting more and better utility from

the improved lake quality but also be motivated by other reason other than their own use of the lake. For example, they may concern about the better condition for the wildlife there or importance to keep this lake in terms of biodiversity or better life for the local people and next generation in general. Thus WTP from CV in our sample is the sum of use value and passive value of users for the Improved lake. But it is difficult to distinguish the proportion between the two based on the data available.

However, we still miss at least three parts of the overall economic value of the lake if we want to evaluate the total recreational value of the lake. The missing parts are the passive value of users for the present lake, passive value of non-users for the present lake, and passive value of non-users of an improved lake. Therefore, we should bear in mind that the total economic value from TCM and CV in our survey is not the total economic value of the lake and is only part of it. Arbitrarily applying these data into cost and benefit analysis will shift the total economic value of the lake in term of recreation downwards.

- Possible bias from neglecting the substitute site.

Even all the lakes within 500km are man-made and much smaller and no comparable natural lake exists, we still can't rule out the possibility that they do have some substitute effect in the coming future if more attention and investment are put on these man made lake which therefore may reduce the recreational value of Lake Wuliangshuai due to the substitute effect. However, its recreational value will increase at the same time when the restoration project successfully continues and attracts more investment to improve the lake given the existence of substitution effect of others.

- Possible bias from sampling method.

Since the basic sampling method used in the survey is on-site sampling which means the entire respondents visit rate at least equals one, we have not considered those who have a desire to visit the lake, but have never done so, i.e. with option and or non-use values. So our study may have the truncated bias due to the way of sampling and final economic value may shift downwards due to the truncation bias

7.2 Comparison with other non market valuation studies in China

The absolute total annual value from non market evaluation, from both TCM and CV, are much smaller than two previous studies in China done by Day and Mourato(1998) and Du(2003). One reason is due to the different target. The target in Day and Mouratos' study is all the rivers in the Beijing area, while the target in our case is just one lake. And the target in Du's study is located in a place with much easier transportation and high density of population than Lake Wuliangsuhai. Another reason for the difference is due to the scope of population used in calculating WTP. Total annual WTP in our case only includes the on site visitors while the total amount of WTP in Day and Mouratos' included all the residents around the Beijing area. Also Du didn't take into account the multi purpose nature of visits in the zonal TCM, thus, consumer surplus in her study (US\$ 5.01 million) is about 2-3 times larger than the total consumer surplus in our case which takes the impact of multi-purpose into consideration.

Methodologically speaking, we use the payment card to elicit the WTP while Du used open ended question and Day and Mourato used dichotomous questions in CVM. Given the tendency of "yeah-saying" in China, Day and Mourato(1998) mentioned that " payment card maybe better in eliciting the true WTP", although " no validity test has been done to establish this assertion".

8 Conclusions

This study is aimed to estimate the total recreational value of improvement of the lake water in Lake Wuliangshuai in Inner Mongolia. We use single site zonal TCM to derive the present use value of the lake and CVM to derive the use and passive value of users. By combining CVM with TCM, we fill up a gap where use value of the future lake after restoration doesn't exist. The result of this study is based on the on-site sampling among 525 lake visitors. Questions related to both TCM and CVM were presented to the respondents.

The conclusions from the whole study can be drawn as follows:

-About 60% of lake visitors agree that the water quality is poor and has disagreeable smell while approximately same percentage of visitors still think that the wildlife area in the vicinity of the lake is well preserved (Table 4).

- “Boat sightseeing” and “Walking and enjoying the lake along the lake shore” are the most two popular activities for lake visitors (Figure 15). Although most respondents expressed that they enjoyed bird watching (Table 4), less than 10% of total time was spend on Bird Island in the lake for the particular purpose of bird watching. This may be due to the fact that Bird Island hasn't been fully developed and still in constructing. Similar story happens when it comes to visiting the Bird and Fish Museum. Most visitors visiting the lake went to the Bird and Fish Museum, but the total time spent there is very little.

-More than half of the lake visitors have been to the lake before (Figure 11). The more number of visits respondents had taken to the lake, the more WTP they offered for the lake restoration (Table 12) which is consistent with the result of other CV study.

- Around 30% of respondents go to the lake as a side trip or as part of a package trip (Figure 14).

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- In the TCM, although most social demographic variables don't seem to be significantly related to the lake visit rate, household monthly income *is* negatively correlated with the visit rate (Table 8) which implies that the lake in its present condition might be an inferior good. While in the CVM, the more income of respondents the larger amount of WTP for the lake improvement (Table 12).

- From the summary of the survey result, we found out that most respondents express environment concern (Figure 10) and WTP for the lake is positively correlated with the sense of environment (Table 12).

-Total consumer surplus derived from TCM for both locals and non-locals is from US\$1.2 (10.5 million yuan) to US\$2.6 million (21.7 million yuan)(Table 16) for present lake while the WTP from CVM for the improved lake is from US\$ 0.17 million (1.4 million yuan) (Table 18).

The choke price for locals for the current lake is US\$88.5 (734.6 yuan) (Table 14), while mean WTP per respondent for the improved lake is about US\$7.17 (59.52 yuan) (Table 18) with only 6.29% of consistent zero (Table 6).

-In addition, the maximum total annual income from boating and entrance is about 921377 yuan (US\$111009) and 44 yuan (US\$5.3) (Figur 21) is optimal fee level after restoration.

9 Policy Relevance

Our study is one part of Restoration Project of the Lake Wuliangsuhai. And the main purpose of the study is to estimate the recreational value of the lake and therefore to be used in the final cost and benefit analysis. Together with fishing, aquiculture and reed cutting, etc, recreational value of the lake is one part of the benefits of indirect use of the lake. By comparing the benefits of the indirect lake water use and the cost of different lake restoration measurements, the most effective and sustainable restoration plan will be given in the end and will be carried out by local government in the near future. Although in short run, the benefits from reed harvesting overwhelm that from ecotourism, there are several points to which one needs to pay attention concerning final policy implication according to these values.

- In view of the conservative design of the study, the total annual recreational value of the Lake Wuliangsuhai from TCM and CV may be underestimated comparing its true potential value after restoration. Especially, the non use value of non users which is not included in our study could be potentially very high.
- Although the total WTP is not very high in absolute value, the entire amount will be huge if we change the definition of visitors and put the potential visitors to the lake as whole population in China.²⁸
- Due to the limited data and horizon in analysis, we didn't include the benefits from the increase in fishery after restoration which actually was a rich resource for the lake in history. And the value of eco-system maybe large and more important compare to the economic value of the lake. For example, the value of storage service of the lake for flow attenuation from the Yellow River every spring could reach 90-150 million Yuan. While the value of direct uses of the lake is only from 45-70 million Yuan/year (Barton,2005). Therefore, it's obvious to see the importance of the environmental service of the lake.

²⁸ This assertion depends on a lot of different factors and the most important one is marketing,

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- Average WTP for the improvement of the lake is 59.52 yuan given interval data and the optimal fee charged for boating and entrance after restoration which maximizes the total income for the Fish farm is at about 44 yuan. Increasing the fee will incur two effects, income effect and substitution effect. In the earlier regression we have found out that there is a positive correlation between WTP and income, the income effect will increase the WTP of the visitors when their income increases in the future. Since there are few natural lake substitution sites for the Lake Wuliangshuai, we can neglect the negative substitution effect on visitors' WTP for Lake Wuliangshuai when the fee increases.

In addition, compare to the choke price for locals for the current lake which equals US\$ 88.5 (734.6 yuan), the increased boating and entrance fee is rather small and will not have much influence on deterring the visitors. Therefore, with an improved lake, 44 yuan is the fee level we are “quite confident” for maximizing revenue.

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11 Appendix

11.1 Appendix 1

QUESTIONNAIRE

Interview Location: _____

Respondent is: arriving / leaving the lake

NOTICE:

We are conducting a survey of visitors to Lake Wuliangshuai on behalf of the “Fish Farm” company. Your answers will help the company and the authorities improve the services offered to lake visitors. Your answers are completely confidential.

PART I: Lake Visitor Survey

1.1 What is your home Country _____

1.2 What is your home County _____

1.3 What is your home Zip code _____

2. Is the lake your only destination on this trip? (Destination: the main aim of your trip)

A. YES

B. NO (If NO, please specify all the other destinations for this trip)

2.1. _____

2.2 What's your departure place for Lake

Wuliangshuai? _____

2.3 What's the next place you are going to visit _____

3. Are you visiting the Lake for one or several days? (CHECK ONE)

____ One-day trip (Go to Box A)

____ Multiple-day trip (Go to Box B)

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BOX A: ANSWER THESE QUESTIONS
ONLY IF THIS IS A ONE DAY TRIP

4.1. How many hours do you want to / did you spend in the following activities respectively?

- _____ Boat sightseeing
- _____ Bird watching (bird island)
- _____ Enjoying the water by the lakeside
- _____ Bird and fish museum
- _____ Camel riding
- _____ Other(Specify) _____
- _____ Other(Specify) _____

GO TO BOX

BOX B: ANSWER THESE QUESTIONS
ONLY IF THIS IS A MULTI-DAY TRIP

4.2. Where did you / are you planning to stay at night (CIRCLE ONE)

- A. Hotel near the lake
- B Hotel in Wulatequanqi
- C. With family
- D. Other (specify:) _____

4.3 How many days do you plan to visit the lake area?

_____ (days)

4.4 How many hours do you want to / did you spend in the following activities during daytime respectively?

- _____ Boat sightseeing
- _____ Bird watching (bird island)
- _____ Enjoying the water by the lakeside
- _____ Bird and fish museum
- _____ Camel riding
- _____ Other(Specify) _____
- _____ Other(Specify) _____

GO TO BOX C

PLEASE TURN OVER

Recreational Valuation of Lake Wuliangsuhai

BOX C: For either one-day or multiple-day trips, please answer the following questions:

5. How did you come to the lake?

- a. Train
- b. car
- c. Plane
- d. Any combination of the way mentioned above ___+___+___+___

6. How long it take you to come to the lake from your home? _____ hours

7. How many people travel with you on this trip? _____

8. Is this the first time you have been to Lake Wuliangsuhai?

a. Yes →→ 9. How many times have you visited Lake Wuliangsuhai in the last 5 years?
___0 ___1-2 ___3-4 ___5-6 ___7-8 ___9-10 ___ more

b. No

10. How many times do you think you will visit Lake Wuliangsuhai **in 2005**?
___0 ___1-2 ___3-4 ___5-6 ___7-8 ___9-10 ___more

11. Have you visited **other** lakes or rivers in the **past 5 years** to do similar activities?

a. Yes →→ 12. How many times in the last have you visited **other** lakes or rivers to
conduct similar activities as this time **this year**?
___0 ___ 1-2 ___3-4 ___5-6 ___7-8 ___9-10 ___more

b. No

13. Approximately how much money did you spend **in total** for this trip? _____Kr

14. On your way to Lake Wuliangsuhai, how much money did you spend on

14.1 transportation for this trip? _____RMB

14.2 food en route _____RMB

14.3 lodging en route _____RMB

15. Here at Wuliangsuhai, how much will you / did you spend on: How much did you

15.1 entrance fees _____RMB

15.2 boat rental _____RMB

15.3 food _____RMB

15.4 lodging _____RMB

15.5 other _____RMB (please specify: _____)

PART II : Lake Perception Survey

The next questions concern your experiences and perceptions of Lake Wuliangsu Hai

A=Agree

D=Disagree

The next 5 questions relate to your decision to spend time at lakes and rivers in general

- | | | |
|-----------------------------------------------------------------------------------------|---|---|
| 16) Water quality affects your decision to visit lakes/rivers | A | D |
| 17) Boat sightseeing affects your decision to visit lakes/rivers | A | D |
| 18) Being able to watching wildlife/birds affects your decision to visit lakes/rivers | A | D |
| 19) Being able to fish affects your decision to for to visit the lake | A | D |
| 20) Facilities for visitors (e.g., visitor centre) affect my decision to go to the lake | A | D |

The next questions relate to your perceptions of Lake Wuliangsu Hai

- | | | |
|-----------------------------------------------------------------------------------------|---|---|
| 21) The water in the lake is very clear | A | D |
| 22) The water in the lake has a disagreeable smell | A | D |
| 23) Surrounding area of the lake is clean and well maintained | A | D |
| 24) I enjoy boat sightseeing on the lake | A | D |
| 25) I enjoy watching the birds on the lake | A | D |
| 26) Visitors throw too much rubbish on the ground / into the lake | A | D |
| 27) I would visit the lake more often if the water quality became better | A | D |
| 28) I would visit this lake more often if it was less crowded here | A | D |
| 29) I would visit this lake more often if it had better facilities. | A | D |
| 30) I would visit the lake more often if there was less rubbish in the surrounding area | A | D |

Part Three: Willingness to Pay Survey

Lake Wuliangshuai has until the 1980's provided visitors with a place to enjoy lake sightseeing, boating, bird watching, fishing and swimming. But during the last 20 years, the lake's water quality has become steadily worse so that today it is **not recommended to fish or swim** in the lake. The poorer water quality is due to pollution from fertilizers from agriculture, and waste water from industry and households in the Hetao Basin. The lake is also becoming smaller due to the water pollution (sedimentation and growth of reeds) and water originally for the lake being used for irrigation in the Hetao agriculture. If no action is taken now, in 10 years it will **not be possible to do boating or bird watching** at the lake.

The Fish Farm company, in cooperation with local authorities and industries, want to invest in actions to guarantee continued boating and bird watching, and make it possible to swim and fish in the lake in 10 years time. The actions include:

1. industry and cities investing in wastewater treatment to avoid bad smelling water, allow swimming and fishing in 10 years
2. FishFarm company buying water from the Yellow River Commission to maintain lake level
3. Fish Fram company dredging channels and cutting back reeds around lake to ensure continued boating

31. Would you be willing to pay a higher visitor fee on your next visit to the lake to contribute to these improvements? Keep in mind that industry and cities will pay their fair share, but the actions cannot be undertaken without contribution from lake visitors also.

1. yes, I would pay a higher fee
0. no, I would not pay a higher fee (GOTO33)

The Fishfarm wants to make sure they do not charge too much for these improvements in future lake quality.

32. How high would the visitor's fee have to be before you would no longer be willing to visit the lake and would go somewhere else? Keep in mind that you will continued to be able to boat sightseeing and see birds and in 10 years you will be able to fish and swim as well. Keep in mind the other travel expenses you will have on your next trip.

Would you still visit the lake if the fee was..? (CHECK AMOUNTS STARTING FROM LOWEST)

- ___ 8+20=28 RMB
- ___ 11+25=36 RMB
- ___ 14+30=44 RMB
- ___ 17+35=52 RMB
- ___ 20+40=60 RMB
- ___ 25+50=75 RMB
- ___ 30+70=100 RMB
- ___ 50+100=150 RMB
- ___ more.(Please specify)_____

33. Why are you not willing to pay a higher visitors fee?

(recode this to close ended answers in main survey)

Part Four Household Information

34. Gender

- a. Male b. Female

35 How old are you? _____

36..1 How many children do you care for in your household?

- a. 0 b. 1 c 2 d. more than two

36.2. How old are they? _____

37. What is the highest level of education you have completed?

- a. Primary school
- b. Junior high school
- c. Senior high school
- d. Bachelor
- e. Master
- f. Ph.D.:

38. What is your occupation: _____

39. Please indicate on this card the **total** monthly income in your household (SHOW CARD. INCLUDES YOURSELF AND MEMBERS OF YOUR FAMILY):

- | | | |
|----------------------|----------------------|----------------------|
| ___<8,000kr | ___8,000kr-16,000kr | ___16,000kr-24,000kr |
| ___24,000kr-32,000kr | ___32,000kr-40,000kr | ___40,000kr-48,000kr |
| ___48,000kr-54,000kr | ___54,000kr-63,000kr | ___>63,000kr |

40,If you go to a tourist attraction that is extremely dirty, what will you do then?

- A.Complain and decide never to come back
- B,Throw rubbish every where
- C,Keep the nature tidy and keep it as nature
- D Become a member of environmental organization and advocate others to protect nature

11.2 Appendix 2

As to the non-locals,

the formulas in calculating CS based on the log-log regression are as follows,

$$\begin{aligned}
 CS_2 &= N_i \int_{TC_i}^{\infty} e^{\alpha_0 + \alpha_1 \ln TC + \alpha_2 Income_i + \alpha_3 Gender_i + \alpha_4 Age_i + \alpha_5 Education_i} dTC \\
 &= - \frac{N_i}{\alpha_1 + 1} v_i TC_i
 \end{aligned}
 \tag{4.9}$$

and

formulas of consumer surplus for estimated visit rates

$$\begin{aligned}
 C\hat{S}_2 &= N_i \int_{TC_i}^{\infty} e^{\alpha_0 + \alpha_1 \ln TC + \alpha_2 Income_i + \alpha_3 Gender_i + \alpha_4 Age_i + \alpha_5 Education_i} dTC \\
 &= - \frac{N_i}{\alpha_1 + 1} \hat{v}_i TC_i
 \end{aligned}
 \tag{5.0}$$

And the formulas for total consumer surplus are the same as (2.8) and (3.0) respectively

The formula for locals are the same as (2.7),(2.8),(2.9),(3.0).

11.3 Appendix 3

Table 20: Result of log-log model for TCM

Ln (visitrate)		Model 5	Model 6	Model 7	Model 8
Ln(totalcost)	Coefficient t-value	-1.149016*** -7.67			
Ln(totalcost2)	Coefficient t-value		-1.132089*** -7.44		
Ln(totalcost_claimed)	Coefficient t-value			- 0.4800396** -2.30	
Ln(totalcost_oneaim)	Coefficient t-value				0.1146982 0.48
Householdmonthlyincome	Coefficient t-value	-0.0000531* -1.84	-0.0000532* -1.81	-0.0000347 -0.71	-0.0000891* -1.95
Gender	Coefficient t-value	-0.0647532 -0.09	-0.1437264 -0.19	-1.806822* -1.69	-2.080075 -1.84
Age	Coefficient t-value	0.0205682 0.97	0.0201022 0.93	0.0047054 0.15	0.00330508 0.10
Education	Coefficient t-value	0.0020653 0.04	0.0355334 0.59	-0.0434237 -0.49	-0.0952877 -1.04
Constent	Coefficient t-value	-5.385721*** -3.95	-5.998652 -4.40***	-7.79172*** -3.87	-9.846685*** -4.20
Adj-R2		0.6391	0.6258	0.1825	0.0713
F		F(5,37)=15.87	F(5,37)=15.05	F(5,37)=2.87	F(5,37)=1.65
Sample size		43	43	43	43

*** Significant level:1% ** Significant level:5% *Significant level:10%

Table 20 illustrates the results from log- log model. Generally speaking, the explanatory power is stronger in log-log models than that in semi-log models. The sign and the significant level of coefficient of different variables don't differ much than those in the semi-log models. The only difference is the absolute value of the coefficients. This is attributed to the difference in the functional forms of the two. However, when it comes to the consumer surplus, CS calculated from log linear models is much bigger than that from semi log models due to the difference in the functional form and therefore different way for calculating in integral.²⁹As mentioned above, in view of conservative, we use the consumer surplus from the semi-log models in the final welfare analysis.

²⁹ Consumer surplus calculated from Model 7 which is based on the stated travel cost is negative. As to this, we are not clear whether the result is due to the real bias from the poor awareness of the respondents of their travel cost or that from the way of calculating WTP.

11.4 Appendix 4

Table 21: Regression result from linear normal distribution

Number of obs = 478 Wald chi2(7) = 43.95
 Log likelihood = -1000.8122 Prob > chi2 = 0.0000

	Coefficient	Standard Error	z-statistic
lnincome	.139131	.0281189	4.95***
nov5yf	.0129372	.0077717	1.66*
noigroup	-.0026736	.0019473	-1.37
gender	.0734897	.0435838	1.69*
age	-.002405	.0017088	-1.41
edu	.0032265	.0064518	0.50
enconcern	.1098677	.0432055	2.54**
_cons	2.881891	.2325566	12.39***
σ	.4138316	.0141233	29.30***

11.5 Appendix 5

Table 22: Monthly distribution of visitors

Monthly visitation hypotheses	
May	150/day
June	400/day
July	400/day
August	400/day
September	150/day
October	150/day

11.6 Appendix 6

In Table 23 and Table 24, we give calculate the sample mean and standard deviation of WTP with and without outlier.

Table 23: The summary of WTP with outliers

	Sample size	Mean	Std.Dev.	Min	Max
Lowderbond WTP (with outliers)	519	56.102	33.422	0	150
Mid point WTP (with outliers)	519	116.236	1099.109	14	25075

Table 24: The summary of WTP without outliers

	Sample size	Mean	Std.Dev.	Min	Max
Lowderbond WTP (with outliers)	511	54.877	32.013	0	150
Mid point WTP (with outliers)	511	65.634	46.120	14	325