学校编码：**10384** 分类号________密级 ______

学 号：**15220151154715** **UDC**

硕 士 学 位 论 文

空气和噪声质量估值：选择模型法

Valuing Air and Noise Quality: A Choice Modeling Approach

Nolan Scott Reyher

指导教师姓名： **Prof. Min Qiang Zhao**

专 业 名 称： **国 际 贸 易**

论文提交日期： **2017 年 09 月**

论文答辩日期： **2017 年 11 月**

学位授予日期： 年 月

答辩委员会主席：________________

评 阅 人：________________

2017 年 11 月

厦门大学学位论文原创性声明

本人呈交的学位论文是本人在导师指导下,独立完成的研究成果。本人在论文写作中参考其他个人或集体已经发表的研究成果，均在文中以适当方式明确标明，并符合法律规范和《厦门大学研究生学术活动规范（试行）》。

另外，该学位论文为（　　　　　　　　）课题（组）的研究成果，获得（　　　　　）课题（组）经费或实验室的资助，在（　　　　）实验室完成。（请在以上括号内填写课题或课题组负责人或实验室名称，未有此项声明内容的，可以不作特别声明。）

声明人（签名）：

2017 年　　月　　日

厦门大学学位论文著作权使用声明

本人同意厦门大学根据《中华人民共和国学位条例暂行实施办法》等规定保留和使用此学位论文，并向主管部门或其指定机构送交学位论文（包括纸质版和电子版），允许学位论文进入厦门大学图书馆及其数据库被查阅、借阅。本人同意厦门大学将学位论文加入全国博士、硕士学位论文共建单位数据库进行检索，将学位论文的标题和摘要汇编出版，采用影印、缩印或者其它方式合理复制学位论文。

本学位论文属于：

（　　）1.经厦门大学保密委员会审查核定的保密学位论文，于　　年　　月　　日解密，解密后适用上述授权。

（ √ ）2.不保密，适用上述授权。

（请在以上相应括号内打“ √ ”或填上相应内容。保密学位论文应是已经厦门大学保密委员会审定过的学位论文，未经厦门大学保密委员会审定的学位论文均为公开学位论文。此声明栏不填写的，默认为公开学位论文，均适用上述授权。）

声明人（签名）：

2017 年　　月　　日

摘要

空气污染和噪音污染普遍存在于在世界许多城市，其对健康和环境造成的负面影响已有很多记录。地方政府需要保证公民健康，但其还需要同时促进经济增长，这往往会加重空气污染和噪音污染。本论文实施了选择实验调查，使用条件逻辑模型来研究空气质量和噪音质量对受访者选择居住地的影响。本论文的主要目的是估算提高空气和噪音质量所需要的福利值。结果显示，非中国受访者和那些声称他们关心空气污染的人对空气污染更为敏感。结果还显示，没有在噪声污染地区生活经历的受访者，声称关心噪音污染的受访者，以及女性这三类人对噪声污染更为敏感。根据受访者意愿支付金额数据显示来看，非中国受访者愿意为改善空气质量愿意支付的金额更高，那些不关心空气污染的人愿意支付的金额最少。关心噪音污染的人愿意为改善噪音污染支付的金额最多，不关心的噪音污染的人愿意为改善噪音污染支付的金额最少。

关键词：空气污染，噪声污染，选择实验，福利估算

Abstract

Air and noise pollution are prevalent in many cities around the world, and the negative health and environmental consequences have been well documented. Local governments are faced with the task of promoting the good health of its citizens as well as economic growth at the cost of increased air and noise pollution. The current study implements a choice experiment survey to examine how air and noise quality affect respondents' location choice decisions using a conditional logit model. The main purpose of this study is to estimate the welfare value of improvements in air and noise quality. Results show that non-Chinese respondents and those who stated that air pollution was a concern of theirs are more sensitive to air pollution. Results also show that respondents who had no previous experience living in areas with noise pollution, respondents who stated that noise pollution is a concern of theirs, and females are more sensitive to noise pollution. Willingness to pay estimates show that non-Chinese respondents are willing to pay the most for improvements in air quality while those who stated that air pollution is not a concern of theirs are willing to pay the least. For improvements in noise quality, those who stated that noise quality is a concern of theirs are willing to pay the most, while those who stated that noise quality is not a concern of theirs are willing to pay the least.

Key words: air pollution, noise pollution, choice experiment, welfare estimation

Table of Contents

Chapter 1: Introduction **6**

Air and Noise Pollution 6

Choice Experiment Background 6

Chapter 2: Literature Review **8**

Previous Research 8

Chapter 3: Empirical Framework **10**

Survey Design 10

Collection of Data 12

Model 13

Chapter 4: Results **15**

Conditional Logit Model Results 15

Welfare Estimates 20

Chapter 5: Conclusions **23**

References **25**

Appendix **29**

Survey Example 29

Acknowledgements **42**

Chapter 1: Introduction

1.1 Air and Noise Pollution

Living in a city can expose one to unhealthy living conditions due to air pollution and high levels of noise. The negative environmental and health effects are far ranging from long-term exposure to both air and noise pollution. Negative environmental effects from air pollution include emissions of greenhouse gasses, mainly carbon dioxide, which may contribute to a gradual warming of the earth's climate (Cline, 1991). Many studies have shown the negative health effects from long-term exposure to air pollution, including but not limited to, problems of the respiratory and cardiovascular systems, lung cancer, and even death (Kampa, Castanas, 2008). Long-term exposure to noise pollution has also been shown to have negative health effects, such as hearing loss (Kryter, 1994), cardiovascular problems, hypertension, and annoyance (Basner et al. 2014).

Policy makers and government officials are faced with the challenge of promoting economic growth at the cost of increased air and noise pollution while also mitigating health risks for civilians. Investigating the health effects of living in such conditions is relatively straightforward and easy to test. However, investigating the value of non-market goods, or environmental goods (ie. air quality, noise pollution, etc.) can be more difficult to investigate, as there are no direct markets or consumption behaviors to observe. Therefore, economists have implemented many different techniques over the years to estimate the value of environmental goods, which are highlighted in the next section.

1.2 Choice Experiment Background

For many decades, economists have estimated the value of non-market goods through two main estimation techniques: revealed preference and stated preference. The revealed preference method includes observing the consumption of related goods in order to estimate the value of non-market goods, such as the travel-cost and hedonic pricing method. The stated preference method, on the other hand, involves collecting information about preferences by directly asking respondents to make choices regarding a hypothetical situation. Stated preference methods have been widely used over the past 40 years to estimate the value of environmental goods.

One of the most widely used stated preference methods is choice modeling (CM), which falls under choice based conjoint analysis. In this method, a choice experiment is designed in which the respondent is given a choice between sets of alternatives with varying characteristics. The goal is to extract how these changes in characteristics affect preferences, and many economists have used CM choice experiments due to their ability to more accurately estimate the value of environmental goods compared to other stated preference methods (Mogas et al., 2002).

The focus of this study is to apply the choice experiment approach to estimate the value of improvements in air and noise quality as well as to investigate differences between groups of individuals in terms of reservation utilities and sensitivity to air and noise pollution. The intent is to add to the literature as well as provide information that could be used for policy decisions and/or urban development. The paper will proceed as follows; the next section will provide some background in the previous literature, section three will describe the model and methodology of this study, section four will provide the results, and section five will include conclusions about the results and suggestions for future research.

Chapter 2: Literature Review

2.1 Previous Research

Air and noise pollution is prevalent in modern cities and virtually inescapable to their inhabitants. The main source of air and noise pollution within a city originate from vehicle traffic (Small, Kazimi, 1995; Singh, Davar, 2004), but can also originate from other sources, such as, construction machinery, aircraft, landscaping equipment, and factories (Berglund, Hassmen, 1996; Birgitta, Lindvall, 1995). Negative health effects from air pollution include acute and chronic respiratory and cardiovascular problems, lung cancer, and increased mortality rates (Kampa, Castanas, 2008). Negative health effects of exposure to noise pollution include hearing loss (Kryter, 1994) sleep disturbance, decreased task attention, annoyance, increased chance of hypertension and cardiovascular problems (Basner et al., 2014), and a decrease in quality of life (Hede, Bullen, 1982; Schultz, 1978). Due to these concerns, research is warranted for the economic value of improvements in air and noise quality for policy decisions of local governments to promote both the health and well being of its citizens, as well as to promote economic growth.

Previous studies have attempted to estimate the value of air and noise quality. One such study by Wardman and Bristow (2004) used stated preference and contingent valuation methods to estimate the valuation of changes in traffic related noise levels and air quality. They examined the valuations in terms of the size and sign of the environmental change, the experienced level of the attribute, as well as various socio-economic factors. Another study by Day, Bateman, and Lake (2007) provided welfare estimates for peace and quiet through hedonic pricing methodology derived from property market data.

One of the most widely used modern methods for estimating the economic value of environmental goods, or non-market goods, is the contingent valuation method (CVM). The origins of the CVM approach for valuing non-market goods can be traced to conjoint analysis, which has been widely used in market research. Conjoint analysis can be described as, "the decomposition into part-worth utilities or values of a set of individual evaluations of, or discrete choices from, a designed set of multi-attribute alternatives" (Louviere, 1988, p. 93).

However, the shortcomings of CVM for accurately valuing environmental goods have been well documented (Carson et al., 2001). For example, CVM studies can be more susceptible to "yea-saying" (Mitchell and Carson, 1989), which occurs when a respondent just agrees with the interviewer or chooses the option which they feel is most socially acceptable or most in line with what the majority of people would choose, despite their personal preferences. Similar to yea-saying, CVM studies are also susceptible to respondents having biased choices due to "warm-glow", or the desire to choose the option which gives them moral satisfaction (Kahneman and Knetsch, 1992). These shortcomings tend to lead to inaccurate willingness to pay (WTP) estimates (Blamey et al., 1999). Another problem with CVM is that other options, or substitutions, are not obvious, and can be easily ignored by respondents.

Therefore, many researchers have preferred the use of choice experiments to more accurately estimate the value of environmental goods. One benefit of the choice experiment is that respondents are given repeated scenarios in which to choose their preferred set of alternatives, allowing for more accurate estimates of the importance, or value, of the characteristics being presented (Boxall et al. 1996). Another advantage is that welfare measures, or WTP values, can be estimated for various scenarios in which attributes of characteristics can be altered to obtain the WTP for that specific change. Choice experiments have been used to estimate the value of a wide range of environmental goods including air quality (Loehman, De, 1982; Yoo et al., 2008), noise quality (Arsenio et al, 2006), water supply options (Blamey et al, 1999), beach erosion control programs (Huang, Poor, and Zhao, 2007), and forest management techniques (Boxall et al., 1996), to name a few.

One possible issue with choice experiments is that, without careful construction, respondents can be forced into making choices they would not otherwise make, biasing results. In their study, Boyle et al. (2001), found that welfare estimates for changes in attribute levels for different groups were significantly different. This led them to conclude that a choice experiment with a "no choice" option, or "opt-out" option would be preferable. With a no choice option, respondents are not forced to accept choices that may bias results. For this study, a single choice conjoint analysis survey with an opt-out option is utilized.

Chapter 3: Empirical Framework

3.1 Survey Design

In order to determine which environmental topics were of most importance to the widest range of people, an initial survey was conducted. The survey consisted of a list of environmental concerns such as, air pollution, water pollution, endangered species, national parks, etc. Participants were asked to rank these concerns in order of importance to them. By a wide margin, the majority of people ranked air pollution and/or water pollution as the most important concerns to them. 72% of respondents chose air pollution as their first or second most important concern, while 78% chose water pollution as their first or second most important concern. Using this information, the final survey was constructed to reflect these concerns. However, problems arose when attempting to quantify water pollution as the majority of people in China substitute drinking water with bottled water, which has been purified. Therefore, the author chose to instead include noise pollution, as it is something people who live in a city are familiar with. Also, there is lacking in the literature an abundance of studies looking at the value of noise quality.

The final survey was designed with three factors; air quality, noise quality, and rent as a cost variable. These were used to reflect the environmental topics most people were concerned with and also familiar with living in a city. The air quality, noise quality, and rent variables all consisted of four levels, which are presented in Table 1. These levels were determined by researching average air pollution levels, noise pollution levels, and rent for Xiamen, China[1]. A small pre-survey was conducted to determine if the intervals of the levels were reasonable. Respondents were asked to make a choice between two different areas within a city in which to live, each area having varying levels of the three variables. To avoid status-quo bias, respondents were also given a “no choice” option in which they would continue to search for an area to live. The survey was designed using an orthogonal design to ensure that the attributes vary

[1] Averages obtained from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4350859/, https://www.travelchinaguide.com/climate/xiamen.htm, https://www.numbeo.com/cost-of-living/in/Xiamen

independently of one another. This was achieved using the statistical software R, and in the end there were sixteen variations of the pairs of choices. There were some obvious choices that contained lower air pollution, noise pollution, and rent, but this is not a concern as most of the choices contained more difficult trade-off decisions. This also helped to check to see if respondents were actually looking at the choices and not just randomly selecting areas. To avoid survey fatigue, in which respondents lose interest from having to answer too many questions, four different versions of the survey were constructed, each of which containing four pairs of choices, or blocks. The survey consisted of three parts. Part one included a short introduction and some background information about air and noise pollution. This section also included visual charts demonstrating varying levels of air and noise quality. The unit of measurement for air quality used was air quality index (AQI). The unit of measurement for noise quality used was decibels (dB). Rent was presented as Chinese yuan (CNY) per month. Section two included a detailed hypothetical situation for the respondents to use as their basis for making the decision. It ensured that respondents understood that the only difference between these areas were the air quality, noise quality, and rent. Also included in section two were the four pairs of choices in which respondents chose between the following choices: “Area 1”, “Area 2”, or “Neither”. Section three consisted of questions about respondents’ characteristics, such as, age, gender, nationality, etc. An example of the survey with all four versions of the blocks can be found in the appendix.

Table 1

Survey Attributes and Levels

Attributes	**Levels**
Air pollution [a]	25, 75, 125, 175
Noise pollution [b]	60, 70, 80, 90
Rent [c]	1700, 2000, 2300, 2600

[a] Average yearly levels. Unit: air quality index (AQI)
[b] Average daily levels (8:00 – 22:00). Unit: decibels (dB)
[c] Rent per month. Unit: Chinese Yuan (CNY)

3.2 Collection of Data

The survey was implemented in an online format as well as a paper format to increase responses and to increase access to a wider range of respondents. The online version was made using surveymonkey.com and shared primarily via Wechat, which is a social media platform used extensively in China. Also, to this end, there were English and Chinese versions of the survey. The paper surveys were mostly handed out on the campus of Xiamen University. The author contacted numerous professors and teachers assistants from different classes from different departments throughout Xiamen University to arrange times to come to classrooms to have students fill out the survey. The author also handed out surveys in the canteens and library on the campus of Xiamen University. The author also visited other areas of Xiamen in an attempt to get responses, but most people were not interested in filling out the survey outside of Xiamen University. A total of 381 surveys were collected and analyzed.

Table 2

Description of Variables

Variable	Description
Air	Air pollution level [a]
Noise	Noise pollution level [b]
Rent	Rent per month [c]
NC	=1 if “no choice” option was chosen; 0 otherwise
Chinese	=1 if Chinese; 0 otherwise
Female	=1 if female; 0 otherwise
Prev_Exp_Air	= 1 if respondent has previous experience living in an area with air pollution; 0 otherwise
Prev_Exp_Noise	= 1 if respondent has previous experience living in an area with noise pollution; 0 otherwise
Concern_Air	=1 if air pollution is a major concern for respondent when choosing where to live; 0 otherwise
Concern_Noise	=1 if noise pollution is a major concern for respondent when choosing where to live; 0 otherwise

[a] Unit: air quality index (AQI)

[b] Unit: decibels (dB)

[c] Unit: Chinese Yuan (CNY)

Table 2 provides descriptions of the variables. Air, Noise, and Rent all have four levels, which can be found in Table 1 and are based off of average air pollution levels, noise pollution levels, and rent for Xiamen, China. The rest of the variables are dummy variables and their descriptions can be found in Table 2.

Table 3

Summary Statistics

Variable	**Mean** [a]
Chinese	71.23%
Female	43.41%
Prev_Exp_Air	84.38%
Prev_Exp_Noise	82.47%
Concern_Air	75.55%
Concern_Noise	73.55%

[a] Percentage of respondents.

Table 3 provides the summary statistics for the variables of interest. Since these are all dummy variables, the means are presented as percentage of respondents belonging to that group. Another statistic of interest of interest would be age, which has a mean of 25.15, standard deviation of 6.52, minimum of 17 and maximum of 56. So most of the respondents are in their 20's. The average family income of respondents is 13,342 CNY/month with a standard deviation of 6,056 CNY/month.

3.3 Model

For this study, the conditional logit model is used to analyze the decision behaviors of respondents (Mcfadden 1973). We define the basic model with the following indirect utility functions:

$$\text{Eqn 1: } U_{ij} = \beta' x_j + \varepsilon_{ij}\ ,\ j = 1{,}2$$

$$\text{Eqn 2: } U_{i0} = \alpha_0 + \varepsilon_{ij}\ , j = 0$$

where each individual is denoted by i, each choice alternative is denoted by j, and x_j denotes a vector of alternative-specific attribute variables. Eqn 1 represents the two different choice alternatives between area 1 and area 2. Eqn 2 represents the no choice option. ε represents the error term and is assumed to follow type I extreme value distribution. Eqn 2 can be thought of as the threshold beyond which individual *i* will make a choice between one of these areas.

For the detailed specification of the basic model, the utilities can we written as follows:

$$U_{i1} = \beta_1 air_1 + \beta_2 noise_1 + \beta_3 rent_1 + \varepsilon_{i1}$$

$$U_{i2} = \beta_1 air_2 + \beta_2 noise_2 + \beta_3 rent_2 + \varepsilon_{i2}$$

$$U_{i0} = \alpha_0 + \varepsilon_{i0}$$

where U_1 is the utility level for area 1, U_2 is the utility level for area 2, and U_0 is the utility level for the no choice option. *air, noise,* and *rent* represent the levels of each variable for their respective areas. Also included in this paper is an extended model in which α_0 and x_j from the basic model were interacted with individual characteristic variables.

The following is the log-sum formula to compute welfare measures based on the conditional logit model (Bockstael, McConnell, Strand, 1991):

$$WTP = \frac{\ln\left(\Sigma_j e^{V(x_j^1)}\right) - \ln\left(\Sigma_j e^{V(x_j^0)}\right)}{-\beta_3}$$

where $-\beta_3$ represents the marginal utility of income, x_j^0 represents the attribute values associated with the initial state, and x_j^1 represents the attribute values under an alternative welfare scenario. For example, the first hypothetical scenario decreased (representing an improvement) the AQI level by 20 while keeping other levels unchanged. The second policy decreased (representing an improvement) the dB level by 2.5 while keeping the other levels unchanged.

Chapter 4: Results

4.1 Conditional Logit Model Results

Results for this study were analyzed using a conditional logit model. Table 4 presents the conditional logit results for Models 1-4. This table investigates how air pollution, noise pollution, and rent affect survey respondents' location choice decisions. Model 1 serves as the base model. As we can see, the coefficients for Air, Noise, and Rent are all highly significant and negative. It means that as air pollution, noise pollution, and rent increase, the utility level of the respondent in terms of his/her location choice decreases. NC captures the notion of the reservation utility. Its coefficient is highly significant and negative. The utility of living in an area with a certain level of air pollution, noise pollution and rent must be greater than the reservation utility to choose that area. It should be noted that the "no choice" option was chosen 16% of the time.

Models 2-4 of Table 4 interact the individual characteristics variables with NC in order to capture the group-specific reservation utilities. Model 2 adds the variables Chinese x NC and Female x NC. The coefficient for Chinese x NC is highly significant and has a negative sign, showing that Chinese respondents have a lower reservation utility. In other words, Chinese respondents are more willing to choose an area with higher levels of air and noise pollution relative to non-Chinese respondents. The coefficient for Female x NC is significant and has a positive sign, showing that females have a higher reservation utility relative to male respondents. This can be thought of as females being less willing to choose an area with higher levels of pollution. Model 3 adds the variables Prev_Exp_Air x NC and Prev_Exp_Noise x NC, which are the groups of respondents who had previous experience living in areas with air or noise pollution. As we can see, the coefficient for Prev_Exp_Noise x NC is significant and has a negative sign, showing that respondents who had previous experience living in areas with noise pollution have a lower reservation utility relative to those respondents who did not have previous experience living in areas with noise pollution. This makes sense, as having previous experience with something dangerous, like pollution or driving a car, makes it feel more normal so that subsequent experiences with it do not feel as scary or threatening. Model 4 adds the variables Concern_Air x NC and Concern_Noise x NC, which are the groups of respondents who stated