Income, Belonging and the Economic Value of Environmental Amenities: Evidence from Migrant Workers in China

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Selected Paper prepared for presentation at the 2018 Agricultural & Applied Economics Association Annual Meeting, Washington, D.C., August 5-August 7

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Abstract

To help mitigate the negative effects of adverse air quality, local residents' attitudes and behaviors in relation to environmental protection must be better understood. This paper sheds light on a subgroup of local residents, migrant workers. We examine how migrant workers value environmental amenities and what factors contribute to their environmental concerns. Place attachment, a concept borrowed from psychology, is employed to measure emotional bonds with local communities with the expectation that higher place attachment will lead to greater preference for environmental amenities. Survey data from Jiangsu Province is used to measure migrant workers' willingness to pay to protect local environmental amenities. The results show that about 72.5% migrant workers have an interest in protecting local environmental amenities with an average willingness-to-pay (WTP) of 22.63 yuan. Place attachment, in forms such as good life satisfaction, relationships with local citizens, owning property, more years living in the local community all contribute to higher WTP. We also find more environmental knowledge would increase migrant workers' concerns over local air quality. Results suggest that education programs and other policies oriented to improve place attachment can increase the willingness-to-pay by up to 3,742 billion yuan per month for the migrant worker population in Jiangsu. This could be a potential basis for a cost-sharing mechanism for environmental protection projects.

Key Words: Migrant workers, WTP, income, Place attachment.

JEL codes: O15, Q51, R11.

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1 Introduction

Migration from rural areas to urban areas in developing countries takes place as part of a larger process of economic transition (Todaro, 1969; VanWey, 2005). Meanwhile, rural–urban migration is also an important indicator of patterns of economic inequality and opportunity(Potts, 2006). Between 1990 and 2016 the proportion of China's population living in urban areas jumped up from 26% to 57%, and the majority contribution to such increases comes from massive rural labor migration. By the end of 2017, there are total 172 million migrant workers residing in urban area [2]. The large number of rural migrant workers occupies a noticeable part of local residents[3] in most big cities in China, e.g., 37.2% in Beijing and 40.5% in Shanghai by the end of 2016[4]. While the mainstream research of migration has long emphasized moving choices(Harris et al., 1970; Stark and Bloom, 1985), we have a much poorer knowledge of their staying behaviors(Clark et al., 2017). Studying staying becomes much valuable when population urbanization[5] has been accelerated in the National Plan(2014-2020) by the central government of China. The plan aims to expand urban residency permits to 100 million migrant workers by 2020. This raises important questions about staying: what the status quo of migrant workers' willingness to stay is; how their preference towards the local environmental amenities affect the decision in residing in the current communities. Understanding the nature of immobility and what underlies the tendency to stay could have significant implications for the 169 millions migrant workers themselves, vast communities, and government policy-makers.

Cities receiving massive migrant workers usually feature rapid industrialization which heavily relies on energy consumption, especially the heavy-polluting energy such as coal and petroleum. Thus, rapid urbanization, vast migration induced by labor-intensive industries and serious environmental pollution always coexist in the same city. Such pattern of development is also prevalent around the world such as Delhi(India), Riyadh(Saudi Arabia), etc. Since 2012, the smog issue has become a public event and most parts of northern and central China have experienced severe

[2]For further references the next url: `http://www.stats.gov.cn/tjsj/zxfb/201804/t20180427_1596389.html`

[3]For clarity, local residents includes citizens and non-citizens(e.g., migrant workers) depends on where their household registration are.

[4]For further references the next url: `http://www.bjstats.gov.cn/tjsj/tjgb/ndgb/201702/t20170227_369467.html` and `http://www.stats-sh.gov.cn/html/sjfb/201703/293816.html`

[5]Population urbanization indicates the process that more rural migrant workers get urban residential permit and live in cities areas permanently. This concept is contract to land urbanization which means the expansion of urban boundaries.

smog crises frequently[6]. Studies show that the heavy smog pollution not only reduces "subjective well-being"(Levinson, 2012) but causes severe diseases such as stroke, ischemic heart disease and lung cancer(Pope and Dockery, 2006; Lepeule et al., 2012; Kloog et al., 2014), which contributes to 1.6 million deaths/year in China(Rohde and Muller, 2015) and ranks as the fourth leading cause of death(Yang et al., 2013). Research on impacts of air pollution on migrant workers' subject well-being as well as their staying choice, however, has been severely limited. There are two potential reasons: on one hand, data about environmental concerns for migrant workers is missing because of their high mobility and on the other hand, migrant workers probably haven't shift their attitude towards to environmental protection because of their low economic status.

Public environmental awareness has been documented as a fundamental role in protecting environmental amenities in many developed countries such as the United States(Arcury, 1990). However, there are limited attentions of measuring public environment awareness of air pollution and the relationship between public environmental awareness and air quality prevention in a Chinese context(Wang et al., 2016). Huang et al. (2006) and Liu et al. (2009) conducted surveys on public's perception of the local environmental quality and both indicate the local citizens' great environmental concerns and high environmental responsibility. These researches, however, fail to pay attention to the environmental attitude of migrant workers in local communities. The *hukou* system (the household registration system) in China links people's receipt of social welfare to their place of birth and thus distinguishes urban residents into permanent urban dwellers and "outsiders" who come from rural areas, live and work temporarily in big cities. The residency system builds different relationships between residents and local communities and thus shapes their environmental concerns towards local environmental amenities differently. Without further documentation, there is no reason why the environmental preference of migrant workers should be identical to preference of local citizens. Thus, this study is designed to investigate the facts of migrant workers' environmental perception and behavior.

Just as most residents from other studies, migrant workers' environmental attitudes are potentially related some sociodemographic factors, such as gender, age, education, income and residence(Arcury, 1990; Alberini, 1997; Loehman and De, 1982). Residents with high education levels usually possess strong ability to acquire environmental knowledge and thus take more preventive measures against

[6]In 2013, peak value of PM_{10}(Particulate Matter) in industrial cities of Hebei was around 1000 $\mu g \cdot m^{-3}$ and the maximum hourly $PM_{2.5}$ mass concentrations in Beijing were 680 in $\mu g \cdot m^{-3}$(Tao et al., 2014; Wang et al., 2014), which belong to the level of "hazardous" level according to U.S. Environmental Protection Agency (EPA)'s standard.

air pollution(Wang et al., 2016). Besides, income is also believed to play a vital role in respondents' environmental concerns. Economic theories explain that when people live in a more developed region or have higher incomes, they would be willing to pay more for improving environmental quality(Huang et al., 2006; Del Saz-Salazar and Garcia-Menendez, 2001). This could be explained from two aspects: residents with higher income usually have a higher level of education and know better about environmental condition. Besides, rich people attach higher values to health. Typically, the income elasticity of environmental improvements from contingent valuation is consistently less than one(Kristrom and Riera, 1996; Flores and Carson, 1997) and many studies further pin down it to around 0.4 (Loehman and De, 1982; Alberini, 1997; Horowitz and McConnell, 2003).

Except for sociodemographic factors, fully understand of migrant workers' formulation of environmental concern also requires the knowledge of the emotional and cognitive bonds with a particular place(Scannell and Gifford, 2013), which has not yet been investigated with respect to migration in China. Place attachment is a widely researched concept in psychology which describe the values people confer on their surroundings, together with associated behavioral relationships with the place(Lin and Lockwood, 2014; Vorkinn and Riese, 2001; Brehm et al., 2012). As expected from past research, long-term residents and home owners report more positive place attachments. Studies show that place attachment is a potential influence on environmental concerns and even environmental action within a community (Wakefield et al., 2001; Vorkinn and Riese, 2001; Scannell and Gifford, 2013). Compare with local residents, migrant workers may have less emotional belongings, but this could still engender place-protective intentions. Therefore, it is worth to incorporate place attachment into the migrant workers' framework to discuss their perception and behavior.

The aim of this paper is to shed further analytical and empirical light on the migrant workers' environmental concerns. In particular, we study how migrant workers value environmental amenities or services and what factors contribute to their environmental concerns. We combine a survey data in 2016 with air quality information to model individuals' WTP and as a function of their demographic characteristics, incomes, place attachment, and the air quality, etc. The inflation model shows that migrant workers with high income are most likely care about air quality. Place attachment, such as life satisfaction and working length also contribute to migrant workers' interest in protecting air quality. In the negative binomial model, income has a "U-shape" relationship with WTP and the threshold point is about 2277 *yuan* of their monthly income. Higher level of life satisfaction, good relationship with local citizens and owning a property increase

WTP significantly. The results also indicate that when migrant workers plan to abandon their residential land and contracted farmland, their WTP also increases significantly. This paper also replace the air quality measurements and different model specifications to check robustness. The results are pretty consistent. Finally, aggregation of benefits from improved air quality for migrant workers population is presented.

The contributions of this paper are three-fold: first, this paper contributes to the literature by learning about the environmental concerns of the subgroup of local residents: migrant workers. This becomes very important in a centralized, top-down society because it usually has the problem of "adaptation deficit" (Moser and Ekstrom, 2010) in environmental policy. Thus, public participation of all local residents, including migrant workers should be well studied. Second, population urbanization requires information of migrant workers' willingness to stay and identifying migrant workers who can benefit from the policy first, composing the 100 millions by 2020. This paper links their willingness to stay with their environmental concerns and provide a guide for population urbanization policy. Finally, air improved program is always costly. Learning the benefits of migrant workers from a improved air quality could estimate the contribution of migrant workers population into environmental protection. This is helpful for policy makers to provide a cost-sharing mechanism.

The paper follows the arrangement: Part 2 is the theoretical valuation model. We use the compensating surplus to measure the WTP which incorporate the place attachment. Part 3 is about the data structure. We present the survey information, sample representation and air quality measurement in Part 3. Part 4 is the empirical model and estimation where we mainly use zero-inflated negative binomial model to estimate. Robustness checks and policy analysis are provided in Part 5 and Part 6, receptively. The last part is the conclusion and discussion.

2 Valuation Model and Option price

Valuing local public amenities and other non-market goods is one of the greatest challenges facing applied economics(Levinson, 2012). Methods of valuing local public amenities, such as air quality has been widely developed based on non-market valuation technology, including travel-cost model, hedonic pricing, contingent valuation and choice experiments(Flores and Carson, 1997). Hedonic model is not appropriate for this research because owning a property in local place is rather rare for migrant workers, around 16% according to National Bureau of Statis-

tics. Meanwhile, travel-cost model is also not suitable because migrant workers have a high rate of mobility and the most important incentive for migration still comes from economic factor: wage. Although challenged by the potential bias in response(McFadden, 1994), contingent valuation method(CVM) which collect people's willingness to pay directly is the most common method to implement(Cho et al., 2008).

To value the net economics of improved air quality for migrant workers, this section develops a simple model of valuation for nonmarket goods based on contingent valuation to explore the willingness to pay for improved air quality and what factors contribute their environmental concerns. To easily discuss and analyze quantity change of non-market good, we use the expenditure function, rather than indirect utility function to develop welfare measures.

2.1 Welfare measures for a change in air quality

Suppose migrant workers can generate utility from both market goods and non-market goods such as environmental amenities. Preferences are represented by an increasing, quasi-concave utility function, $U(X, Q|D)$, where $X = \{x_1, x_2, ..., x_n\}$ denotes a vector of all the n market goods, $Q = \{q_1, q_2, ..., q_k\}$ is the list of k non-market goods from which we distinguish one type of non-market goods: air quality[7] and D denotes the household and individual characteristics which affect their consumption. The feature of air quality, as well as most other non-market goods is that, quality at specific locations is effectively rationed(Q^0). Thus, the expenditure minimization, subject to obtaining a given level of utility(U^0) and non-market goods can be stated as follows:

$$\begin{array}{lrcll} \min\limits_{X} & P \cdot X & & & \\ \text{s.t.} & U(X, Q|D) & \geq & U^0 & \\ & Q & = & Q^0 & \\ & x_i & \geq & 0 & \forall i \in n \\ & q_j & \geq & 0 & \forall j \in k, \end{array} \tag{1}$$

where P is the prices vector for market goods X. The Hicksian demands of market goods from the optimization problem is a function of prices, non-market goods

[7]Most similar researches study the averting behavior to avoid the health damages associated with air pollition(Alberini and Krupnick, 2000; Alberini, 1997), these researches, however, fail to measure precisely the severity and nature of illnesses. Meanwhile, the respondent's scope for mitigating the effects of the illness from improved air quality is also unclear.

levels and level of utility: $X^* = X^h(P, Q, U|D)$. Thus, the expenditure function is

$$E(P, Q, U|D) = P \cdot X^h(P, Q, U|D). \tag{2}$$

Although each migrant worker can not unilaterally choose their preferred level of air quality, it can change due to society's choices(Champ2003). The increase in the amount of the air quality could represent acres of open space preserved, air protection regulation, or supports of pollution prevention researches. Let q_j denotes the air quality from a set of non-market goods Q and Q_{-j} refers to the non-market goods vector left after removing q_j. Thus $E(P^0, q_j^0, Q_{-j}^0, U^0)$ represents the status quo expenditure level and $E(P^0, q_j^1, Q_{-j}^0, U^0)$ is the expenditure level after a improved air quality($q_j^1 > q_j^0$). For an imposed air quality increase, the compensating surplus (CS) is an income decrements:

$$WTP = CS = E(P^0, q_j^1, Q_{-j}^0, U^0|D) - E(P^0, q_j^0, Q_{-j}^0, U^0|D). \tag{3}$$

This shows that individual's willingness to pay (WTP) for a reduction in pollution is the amount that must be taken away from the individual's income while keeping his or her utility unchanged.

2.2 Demand uncertainty and place attachment

A great amount of uncertainty exists regarding our willingness to trade money for non-market goods. For migrant workers, the *hukou* system determines that they are limited to access the urban residence and thus they have a high spatial mobility like "migrant birds". For example, migrant workers are more likely to move out the region than local residents for job reasons or subject well-being, especially the sense of belonging to the community. This constitutes a demand uncertainty in economic valuation, which further affects their willing to pay to improve local air quality.

The demand uncertainty of migrant workers is determined by the interactive connection between migrant workers and local communities involving physical and social dimensions (Gunderson and Watson, 2007). More specifically, places provide the conditions and features (such as jobs and high wage) that migrant workers need, which is called place dependence(Anton and Lawrence, 2016). Meanwhile, places can also become elements of identity subject to the pressure to maintain self-esteem, self-efficacy, continuity and distinctiveness(Breakwell, 1993). This more deep tie to place provide a fundamental component of a person's relationship with a place, which is named as place identity(Anton and Lawrence, 2016; Lin and Lockwood, 2014). Let an individual's subjective estimation of future demand of

improved air quantity be denoted by γ, which is a function of place attachment involving two dimensions: palce dependence: income(Y) and place identity (A).

$$\gamma = \gamma(Y, A|D) \tag{4}$$

Normalize γ to (0,1) where $\gamma = 1$ means that migrant workers will continue to reside in the communities and thus their demand of improved air quantity is q_j^1, whereas $\gamma = 0$ indicates that migrant workers are more likely to more out from the region where they are currently reside in in the future and their demand of improved air quality is q_j^0. Theoretically, there also exit supply uncertainty which indicates the possibility of implementation of intended air protection policy. The perspective of supply uncertainty, however, depends on various variables, such as the trust in government, cooperation among regional governments and technical feasibility which is not our primary interest. To be simplified and rule out the concerns of supply uncertainty, we inform respondents in the survey that the money they contribute to protect environment will be used properly. Based on equation (3) and (4), we have the measure of option price, which incorporates the demand uncertainty:

$$OP = WTP = E(P^0, q_j^1, Q_{-j}^0, U^0, \gamma) - E(P^0, q_j^0, Q_{-j}^0, U^0, \gamma). \tag{5}$$

Then an individual's WTP for improved air quality is defined generally as a implicit function:

$$OP = WTP = f(\triangle Q, Y, A, D), \tag{6}$$

where $\triangle Q$ represents the hypothetical change of air quality, Y is household income, A represents migrant workers' place identity and D denotes the household and individual characteristics. The function form of f will be discussed later in estimation part.

3 Data Description

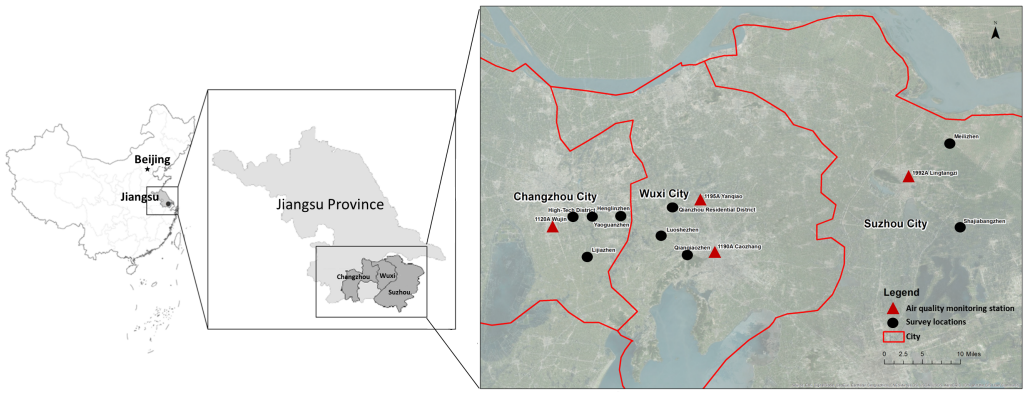
3.1 Survey area

Figure 1 indicates the survey area in a China map. Jiangsu Province is located in the middle of the east coast of China, whose southeast parts border Shanghai city and Zhejiang provinces. Because of its predominant location in the Yangtze River Delta, which is an most advanced industrial region in China, The southeast cities of Jiangsu Province are now one of the most developed regions in China with GDP of 4152 billion RMB (USD 639 billion, about 6% of China's total GDP) in 2015. The southeast cities are also one of the birthplaces of Chinese industry, historically oriented towards light industries, such as textiles and the food industry.

Because of the prosperous development in labor-intensive industries, the south regions have great demand for labor forces and attracts about 8 millions migrant workers from national wide. At the same time, the rapid industrialization in this region also results in serious air pollution. The annual average PM2.5 and average of the maximum daily PM2.5 for the five cities in the south of Jiangsu Province are 73.0 and 334.4 $\mu g \cdot m^{-3}$, respectively. All these five cities rank the first 40 most polluted cities in China[8].

The data used in this paper was collected by a survey in the southeast Jiangsu Province, China in 2016. The southeast parts are composed by Nanjing city, Zhenjiang city, Wuxi city, Changzhou city and Suzhou city. We applied stratified sampling method and select Wuxi, Changzhou and Suzhou in the city level. Three county-level cities are randomly selected from three of five southeast cities in Jiangsu. They are Wujin district from Changzhou city, Huishan district from Wuxi city and Changshu city from Suzhou city. All these survey areas must satisfied two conditions: (1)large population of migrant workers; (2)diverse business sectors.

Figure 1: Sketch map of survey area(a)China;(b)Jiangsu Province;(c)survey locations



3.2 Sample size and sample representation

One of the pivotal aspects of survey study is to calculate the sample size. In this study, the sample size is calculated based on the population size of migrant

[8]For further references the next url: `http://www.greenpeace.org/eastasia/news/blog/bad-to-worse-ranking-74-chinese-cities-by-air/blog/48181/`

workers in a specific city, confidence level and suitable margin of error[9]. Table A1 in Appendix shows items for sample size calculation, recommended sample size and actual sample size for three survey locations. The population of migrant workers in each survey area is constituted by local migrant local migrant workers and non-local migrant workers. The population of non-local migrant workers in each cities is the difference between the number of permanent resident population and the number of registered resident population. The calculation of local migrant workers is more complicate since there is no data from statistical bureau directly. We estimated this by learning the percentage of labor in Agricultural sector and the percentage of rural labor working in local areas. According to labor force report of Jiangsu Province[10], 28% of rural labor forces engages in agricultural sector and 83% of rural labor forces work in local area. Thus, the total number of local migrant workers equals to 28% $\times$ 83% $\times$ population. We select 3.5% of margin of error to generate a moderate sample size. The recommended sample sizes show that once we set the marginal of error and confidence level as equal to all these, the impact from total population on sample size is very limited. We set target sample size for each city is 800 and the actual sample sizes are list in the table.

To justify the representation of survey samples, we compare some demographic characteristics of the survey samples with national migrant workers population[11]. Table A2 shows that migrant workers in the survey samples are mainly male, young age, less educated labors. The biggest difference occurs in the types of industrial sectors. Specifically, 78.97% migrant workers in our survey engage in manufacturing sectors, which is over twice as much as national level's. It is reasonable because the southeast parts of Jiangsu Province has a strong manufacturing base, such as electronic and mechanical sector, high technology products, and integrated circuit and liquid crystal display. The south part is also the home of many of the world's leading multinationals in the field of electronic equipment, chemicals and textiles. Because of the high percentage of manufacturing labor forces, it is also acceptable that migrant workers in our sample have higher income and longer working time than the national migrant workers. In short, the survey samples are good representatives of national migrant workers.

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[9]The sample size calculation formulas here is $n = \frac{\frac{z^2 p(1-p)}{c^2}}{1+(\frac{z^2 p(1-p)}{Ne^2})}$ where N is the population size, e is margin of error, $z_{\alpha/2}$ is the critical value for the confidence level c, p is the fraction of responses.

[10]see `http://www.stats.gov.cn/ztjc/ztfx/fxbg/200511/t20051117_15868.html`

[11]The national Bureau of Statistics releases annual migrant workers report based on sampling survey of 236 thousands rural labor forces which covers all provinces since 2008

3.3 Environment condition and air quality index

Environmental amenities is one of the most important independent variables in this research as Equation (6) shows. Elegant as such the model might be, we are forced to adopt a simpler approach given data limitations. We could not observed the change of air quality because the scenario of improved air quality is hypothetical. Instead, we could observed the air quality and weather condition at the date and place respondents were surveyed. The China National Environmental Monitoring Center releases SO_2, NO_2, CO, O_3, PM_{10} and $PM_{2.5}$ as well as a comprehensive air quality index (AQI) every hour. AQI is a popular representative index to convert raw values for criteria pollutants into a single index to reflect air quality. The calculation of AQI may vary across countries because of the different components of pollutants, calculation formula as well as scale standard based on their own environmental condition. There is a comparison between the standards of two countries in Appendix and generally, the Chinese AQI scale is much "looser" than the U.S. standard.

The Figure 1 shows the distribution of air quality monitoring stations around the survey location. The geographically closest monitoring stations to each survey location are selected to record daily maximum AQI. Most of surveys were conducted from noon to the evening during which the AQI index reaches the peak (most polluted) in a day. To reflect respondents' intuitive sense of air quality, this paper use the maximum value of AQI on the day before survey day as the air quality measurement. The reason is that maximum value of AQI gives migrant workers fresh and deepest perception of air pollution risk. Several different measurements of air quality are proposed for robustness check later.

3.4 Place attachment

Recent empirical researches on place attachment have heavily relied on the psychometric scales to evaluate the affective and cognitive content of the person – place bonds from the perspective of sociology and environmental psychology (Jorgensen and Stedman, 2001; Billig, 2006; Scannell and Gifford, 2013, 2017). Typically, interviewee are asked about a dozen questions approved by consensus of the analysts-judges with 7-point or 5-point Likert-type response scales. To reduce the number of analysable variables and detect their relationships, most researches applied principal components analysis and factor analysis(Brown and Raymond, 2007; Clark et al., 2017). The psychometric scales are valuable to provide the insights of place attachment, but they are less able to link residential behavior to the content of place attachment(Clark et al., 2017). Meanwhile, factor analysis, along with principal components analysis have been criticized for decades because

of its ambiguousness of results and methodological issues(Fabrigar1999).

Although there is no consensus regarding the forms and sources of place attachment(Lin and Lockwood, 2014), it is generally accepted that place attachment has affective, social and physical dimensions. The questionnaire for this paper included a set of questions presenting the migrant workers' community connections, residential behavior and levels of satisfaction(see Table 1). Specifically, the community connections are measured from a set of questions, such as the relationship with local citizens, the numbers of local helpers when they are in trouble, the capability to speak local dialect. Residential behaviors are evaluated from actual behavior as well as subjective assessment. Actual behaviors include purchasing property in local communities and the time length of working in this area. Migrant workers are also requested to assess their current identity as either urban dwellers or "outsiders". Migrant workers are asked to state their satisfaction regarding their life in local communities. Besides, the migration type also affects their place attachment. Usually, migrations with whole family have highest psychologically investment in a place, then the migration with couple and the individual migration least. Rather than constructing the scale indices, all of these variables enter the model independently to address different aspects of place attachment.

Table 1: Summary Statistics

Item	Explanation	Category	Mean	Min	Max
Relationship	Relationship with local citizens	Categorical	3.48	1	5
Local helpers	Helpers from local communities	Dummy	2.76	1	5
Local dialect	Ability to understand local dialects	Categorical	1.18	1	3
Housing	Owning a property	Dummy	0.04	0	1
Working length	Years of working in this place	Numerical	6.98	0	30
Self-identity	Self-identified as local citizen	Dummy	0.07	0	1
Life satisfaction	Life satisfaction	Categorical	3.50	1	5
Family migration	Migration with whole family	Dummy	0.37	0	1
Couple migration	Migration with couple	Dummy	0.35	0	1
Observations	1621				

3.5 WTP measurement

The implementation of stated preference for the economic assessment of air quality is conducted through the Willingness to Pay (WTP). This techniques is based on hypothetical payment scenarios to capture people's desirability to pay for specific

aspects or the entirety of goods and services (Carson and Mitchell, 1995). The application of WTP in our study is conducted through questionnaire forms and open-ended questions for migrant workers.

In the questionnaire, the respondents are asked a screening question about self-evaluation of individual's role in air pollution control. Options are list from very important to not important at all by using five-level Likert Scale of importance. Only those who believe that individuals have an important(or very important) role in controlling air pollution will be asked further about their WTP. This screening question can mitigate the respondent bias by removing the potential contamination for WTP from those who suspect the contribution of individual participation. "Tax" is used as the payment vehicle of WTP because of its legalistic claim which potential requires respondents to answer it seriously. Besides, for most Chinese people, WTP is more likely the voluntary donation, in which they tend to refuse to contribute.

How important is the role of a individual do you think in controlling air pollution?

A. *Very important* ***B.*** *Moderately Important* ***C.*** *Of Average*
D. *Of Little Importance* ***E.*** *Not Important at all*

(If respondents choose A or B) *How much are you willing to be taxed per month to improve air quality, given the financial transparency:_____ yuan?*

The open-ended question is preferred towards a multiple choices setting in this study due to the potential biases emerging from the adoption of predetermined bids. It is acknowledged that similar biases may occur in open-ending questions when unrealistically high or low bids appear(Cameron and Quiggin, 1994). To this aim, an extensive introduction on the concept of economic assessment was offered to respondents by trained researchers. Further, screening question is applied and the outliers were excluded from the sample as a potential distortion of the final outcome.

3.6 Descriptive analysis

Table 2 shows the descriptive summary of variables used in estimation. The average of WTP for improved air quality is 22.63 *yuan* per month(about 3.56 dollars). This value is close to peasants' WTP but about half of overall WTP in Wang et al. (2016) 's study. Although Wang et al. (2016) also surveyed migrant workers, there are only 2% respondents from migrant workers' population. There are two main reasons to explain the difference of WTP with Wang et al. (2016) 's study:

first, Wang et al. (2016) collected data in Zibo city, Shandong Province where mining and petrochemical industries are dominant and heavy smog pollution is a very serious problem. Thus, respondents have stronger willingness to protect air quality and higher WTP. Besides, the respondents are younger and more educated. For example, respondents with college and above degree occupies 38.6% of total samples whereas 4.26% in our samples. Meanwhile, our respondents with 50 or more years old are more than double in their survey. Younger and more environmental knowledge also contributes more WTP.

The air quality varies within a rather wide range from 57 to 214, which indicate moderate condition to heavy pollution according to Chinese air pollution measurement. The average of AQI (104) in survey areas indicates "light pollution" which is unhealthy for sensitive groups. The migrant workers in the the samples have moderate relationship with local communities because the average values of first three indexes are close to the median. Although the average working length for migrant workers in the current place is about 7 years, the percentage of owning a property is very low(4%) and about 93% report their identities as farmers or migrant workers. Life satisfaction for migrant workers is on the average. Finally, there exists diverse types of migration. Specifically, 28.27% of respondents migrate individually, 34.88% migrates with couples and about 36.85% with whole family.

In the list of controlling variables, the table shows that about 72% respondents are male and their average age is 36.71 years old. Both education and self-report health condition are categorical variables with 5 levels. Specifically, the five levels in order for education are illiteracy, elementary school, middle school, high school, and college and above. Health conditions use the Likert-scale with very poor for the first level and excellent for the last level. The average education attachment is between middle school and high school. Most respondents report a good condition in their health and about 38.02% indicates smoking behavior in their daily life. When asked which is priority: environmental protection or economic development to reflect their environmental attitude, about 78.95% agree that protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs. The questionnaire also contains a set of questions about rural land rights. The results shows that the willingness to abandon their contracted land as well as residential land is very low. This address the tight connection between migrant workers with rural society.

Table 2: Summary Statistics

Variables	Mean	Std. err.	Min	Max
Dependent variable				
WTP	22.63	37.68	0.00	500.00
Independent variable				
AQI	104.16	33.63	57.00	214.00
Income(Log)	8.23	0.39	5.99	10.60
Place attachment				
Relationship	3.48	0.61	1.00	5.00
Local helpers	2.76	1.05	1.00	5.00
Local dialect	1.61	0.64	1.00	3.00
Housing	0.04	0.20	0.00	1.00
Working length	6.99	5.63	0.00	30.00
Self-identity	0.07	0.25	0.00	1.00
Life satisfaction	3.50	0.66	1.00	5.00
Family migration	0.37	0.48	0.00	1.00
Couple migration	0.35	0.48	0.00	1.00
Controlling variables				
Gender	0.72	0.45	0.00	1.00
Age	36.71	10.81	18.00	60.00
Educ	2.95	0.84	1.00	5.00
Health	4.38	0.59	1.00	5.00
Smoke	0.38	0.49	0.00	1.00
Environmental attitude	0.79	0.41	0.00	1.00
Abandon contracted farmland	0.06	0.24	0.00	1.00
Abandon residential land	0.02	0.13	0.00	1.00
Observations	1620			

4 Estimation

4.1 Model-ZINB

The distribution of WTP is generally skewed to the right with a large proportion of zeros and has a characteristics of count data. A zero-inflated model assumes that the zeros have two different origins in data-generating processes(DGPs): structural zeros and sampling zeros(Ridout et al., 1998; Hu et al., 2011). In this research, it is more appropriate to believe that there exists two types of migrant workers in terms of environmental attitude: migrant workers with no interest in protecting environmental amenities(named as "non-interest group") who always pay zero for WTP(structural zeros) and those with interest in protecting environmental amenities who could pay any positive numbers but not always(named as "interest group"). In the latter case, migrant workers may pay zero WTP(sample zeros) for some reasons such as economic capacity insufficiency, a plan of moving out etc. A Bernoulli distribution governs the binary outcome of whether a WTP is zero or positive realization and a discrete probability distribution (Poisson distribution or Negative Binomial(NB) distribution)[12] supports any other non-negative integers.

When count data is suspected to have "overdispersion" (variance is larger than the mean), the NB distribution is more appropriate than the Poisson distributions in modeling the nonnegative of WTP. Considering the facts that 27.47% of zeros in WTP and greater values of variance than its mean(see Table 2), this paper applied zero-inflated negative binomial (ZINB) regression model to handle both zero-inflation and overdispersion. The NB distribution looks superficially similar to the Poisson but with a longer, fatter tail. Both zero-inflated Poisson(ZIP) and the conventional NB model are applied to check the robustness later.

The ZINB model assumes that there two distinct data generation processes and these two regimes can be modeled independently. The logit model predicts excess zeros(structural zeros) and the negative binomial model models the count process. The result of a Bernoulli trial is used to determine which of the two processes is used. In this paper, structural zeros represent "no interest group". For migrant workers i, π_i indicates the probability of being "no interest group", whereas the other regime from which discrete WTPs are generated with a negative binomial model is chosen with probability of $(1 - \pi_i)$. In general:

$$WTP_i = \begin{cases} 0, & \text{with probability } \pi_i. \\ g(WTP_i|\mathbf{x}), & \text{with probability } 1 - \pi_i, \end{cases} \tag{7}$$

[12] All the normality tests rejects the null hypothesis of normal distribution.

where $\mathbf{x}$ is a vector of covariates in the NB model. The probability π_i is a function of the characteristics of migrant workers i with an implicit function form: $\gamma\mathbf{z}$, where $\mathbf{z}$ is the vector of zero-inflated covariates and γ is the vector of zero-inflated coefficients. Thus, the probability of $\{WTP_i|\mathbf{x}\}$ is

$$P(WTP_i|\mathbf{x},\mathbf{z}) = \begin{cases} \pi(\gamma\mathbf{z}) + [1-\pi(\gamma\mathbf{z})]\cdot g(0|\mathbf{x}), & \text{if } WTP_i{=}0 \\ [1-\pi(\gamma\mathbf{z})]\cdot g(WTP_i|\mathbf{x}), & \text{if } WTP_i > 0. \end{cases} \tag{8}$$

Generally, $\pi(\cdot)$ can be specified as either the logistic function or the standard normal cumulative distribution function (the probit function) and the logistic link function is adopted in this paper:

$$\pi(\gamma\mathbf{z}) = \frac{exp(\gamma\mathbf{z})}{1+exp(\gamma\mathbf{z})}. \tag{9}$$

The NB procedure models the non-negative count data:

$$g(WTP_i|\mathbf{x}) = \frac{\Gamma(WTP_i+\alpha^{-1})}{\Gamma(WTP_i+1)\Gamma(\alpha^{-1})}(\frac{1}{1+\alpha\mu_i})^{\alpha^{-1}}(\frac{\alpha\mu_i}{1+\alpha\mu_i})^{WTP_i}. \tag{10}$$

5 Results

Two types of tests are performed before looking at the estimated results. A likelihood-ratio test for $\alpha = 0$ comparing the ZINB model with the zero-inflated Poisson model is conducted and the results indicates that the ZINB is preferred to the Zero-inflated Poisson (ZIP) model becuase of the overdispersion. Besides, Vuong test is used to determine whether estimating a ZINB is appropriate over ordinary NB model[13] and ZINB is again preferred over ordinary NB because of the zero inflation. To confirm the results, the robustness check with different model specifications, including hurdle model, ZIP, and ordinary NB are conducted later.

5.1 Relevant or not

Table 3 shows the results from ZINB regression with and without a set variables of place attachment[14]. Inflation models in the two scenarios are estimated by a

[13]This paper uses **zinbcv**Desmarais and Harden (2006) in STATA which corrects the bias in estimation to perform Vuong test. Later, **zinb** is used for estimation because the **zinbcv** commend does not allow factor variables and time-series operators and results from both are almost identical

[14]To show the whole table into a single page, three variables of place attachments are omitted since they are not statistically significant in all cases.

logit model where the value 1 represents the "no interest group"(excessive zeros) and the reference group is the "interest group"(NB distribution). The WTP represents estimations from NB distribution. Overall, place attachments increase the fitness of estimations but the impacts to binary process and NB process are different.

The results show that in the inflation model, the set of place attachments affect the coefficients' magnitude but not the inferences of income as well as other demographic variables. As for the determinants of being excessive zeros, Table 3 shows that the log odds of being an excessive zero would decrease by 0.636 for every additional income. In other words, the more income migrant workers have the less likely that the zero would be due to no interest group. Put it plainly, the higher the income, the more likely that the migrant workers are interested in protecting environment quality. Life satisfaction and working length also have negative and significant impacts which means that migrant workers with higher life satisfaction and longer working length in current communities tend to care local air quality. Surprisingly, owing a property increases the probability of being "no interest group" which is contrary with other researches(cite paper). This could be explained that migrant workers may take environmental amenities into account when they are considering purpose a property in the local communities. But once they own a property, air quality is not a consideration any more and they are getting used to the local air quality.

The demographic factors show that elderly or healthier migrant workers do not express interests in protecting air quality. By contrast, migrant workers with more education attachment show more interests in air quality protection. High education level means stronger ability to obtain environmental knowledge which change environmental attitudes(Arcury, 1990). Migrant workers with smoking behavior are more likely to have air pollution concerns. This is consistent with the finding from variable of self-reported health condition. Lastly, migrant workers with an environmental-friendly attitude are less like to be in the "no interest group" and the log odds is very large. This confirms the consistence of respondents' attitude.

5.2 Determinants of WTP

The 2nd and 4th columns represent NB distribution without and with place attachment. The table shows that place attachments not only affect coefficients' magnitude of variables such as income, environmental attitude but change the inferences like education. The discussion below focuses on the NB model with place attachment.

The air quality affect migrant workers' willingness to pay for protection significantly. More polluted air quality increases their willingness to pay by 0.0019. Income turns out to have an "U-shape" relationship with their WTP. Specifically, migrant workers' WTP decreases when their incomes increase. Once the income exceed a threshold, their WTP increases as income increases. The turning point is around 2277 *yuan* per month (around 360 dollars). Suppose that migrant workers work 11 months on average, the turning point is around 4000 dollars per year. Place attachments overall have positive impacts on migrant workers' WTP. A higher level of life satisfaction in local communities increases WTP by 0.086 *yuan* holding others constant. Better relationship with local citizens increases migrant workers' WTP by 0.266 *yuan* and the impact is statistically significant at 1% significant level. The working length, the best predictor of place attachment as many papers showed does not have significant impact on WTP.

Among all place attachments, owning a property in local communities has the greatest impact whose coefficient is 0.468 *yuan*. Considering the positive impact of housing on binary choices, a heterogeneity impact of owing a property on migrant workers' environmental preference becomes clear. Owing a property in local communities brings down migrant workers' concerns about local air quality. This can be potentially explained by one of the core value and belief systems in Confucianism is "Property possession determines moral conscience"[15]. Put in other words, owing a property makes people live and work peacefully, and thus less concerns about environmental amenities. The data also provides an evidence that the average year of possessing a property is 5 and the longest year is 10. But as long as migrant workers concern environmental amenities, owing a property increases significantly their willingness to contribute environmental protections.

Land rights in rural area significantly affect migrant workers' choices and behaviors. The results show that migrant workers with the intention to abandon their contracted farmland increase their WTP by 0.3764 *yuan* and the impact is even larger for residential land, which further confirms the important meaning of property, even in rural area.

[15]Citation from *Mencius* which is one of the four Chinese classic texts.

Table 3: Estimation of ZINB model

VARIABLES	Without place attachment		With place attachment	
	WTP	Inflation	WTP	Inflation
AQI	0.002*	-0.000	0.002**	-0.000
	(0.001)	(0.002)	(0.001)	(0.002)
Income	-4.626**	-0.570***	-3.941**	-0.636***
	(1.993)	(0.190)	(1.856)	(0.188)
Income squared	0.304**		0.255**	
	(0.121)		(0.112)	
Life satisfaction			0.086*	-0.226**
			(0.050)	(0.100)
Relationship			0.266***	-0.096
			(0.055)	(0.118)
Housing			0.468**	1.130***
			(0.182)	(0.288)
Local dialect			0.050	0.188*
			(0.053)	(0.106)
Working length			-0.003	-0.037***
			(0.007)	(0.014)
Self-identity			0.038	0.444*
			(0.121)	(0.241)
Gender	0.019	0.213	0.097	0.220
	(0.088)	(0.159)	(0.086)	(0.162)
Age	-0.028	0.017**	-0.026	0.023***
	(0.023)	(0.006)	(0.023)	(0.007)
Age squared	0.000		0.000	
	(0.000)		(0.000)	
Educ	0.118**	-0.191**	0.077	-0.258***
	(0.049)	(0.088)	(0.049)	(0.087)
Health	0.106*	0.226*	0.092*	0.220*
	(0.058)	(0.121)	(0.055)	(0.119)
Smoke	-0.058	-0.342**	-0.057	-0.324**
	(0.078)	(0.148)	(0.075)	(0.151)
Envi. attitude	0.186**	-1.440***	0.143*	-1.422***
	(0.089)	(0.139)	(0.085)	(0.140)
Abandon contracted farmland	0.486***		0.376***	
	(0.117)		(0.098)	
Abandon residential land	0.811***		0.759***	
	(0.211)		(0.234)	
location = 1	0.321***	-0.047	0.259***	-0.067
	(0.096)	(0.156)	(0.092)	(0.159)
location = 3	-0.170**	-0.152	-0.191**	-0.282*
	(0.081)	(0.153)	(0.077)	(0.157)
Constant	20.312**	3.704**	16.741**	5.452***
	(8.213)	(1.711)	(7.698)	(1.697)
Observations	1,620	1,620	1,620	1,620

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6 Robustness

6.1 Robustness checking list

The results from estimation may be very sensitive to alternative specifications and thus the hypothesis are not robust. In this part, we discuss several potential sources which may weak our conclusions: AQI measurement, omitted variable, outliers and model specification. Meanthile, we conduct twofold robustness checks regarding to migrant workers' choice probability and WTP. We apply the same robustness checking list but different policy instruments.

The air pollution indicator in this paper is the maximum value of AQI of the previous day. To rule out the potential impact from the air quality measurement, we replace the AQI indicator by the mean and median value of AQI in previous survey day, as well as the maximum, mean and median value of AQI on survey day. Meanwhile, the U.S. Consulate (Shanghai) which is close to the survey locations(50 and 100 miles away) has an air quality monitor to measure PM 2.5 particulates. Since PM2.5 is a key part of AQI, and the PM2.5 from survey locations show the same tendency, we applied PM2.5 from the U.S. Consulate (Shanghai) as a proxy variable for AQI. In Table 3, we only report the maximum AQI on the survey day and PM2.5 from U.S. Consulate as two alternative measurements for robustness check since all the AQI indexes lead to very similar results. Migrant workers' subjective assessments of air quality could highly correlates to ambient temperature(Fang et al., 1998). Meanwhile, temperature may modify the impacts of of air pollution on heath(Koken et al., 2003) and thus affect migrant workers' WTP. Without specifying temperature, the variable of AQI would be endogenous and the estimation would yield biased and inconsistent. Thus, it is worth to check the robustness with ambient maximum temperatures on survey day.

The summary of data indicates the evidence of potential outliers of WTP. To the best of our knowledge, outliers in this study are not systematic which means that they don't belong to a different population than this paper want to study. Criterion cutoffs for outliers are computing based on a mean and a standard deviation of sample(Van Selst and Jolicoeur, 1994). In this paper, if the difference deviates by more than 3 SD from the mean of WTP, the observation then is marked as an outlier. The method of topcoding is applied for outliers which replace those extreme values with a constant. Results are reported in fifth column (Model 4). Finally, different model specifications could lead to disparate results. ZINB is superior to a conventional negative binomial when zero inflation is detected. The criteria for zero inflation, however is not consolidated. 29% zeros in dependent variable may be not sufficient evidence for excessive zeros. It is also worth to compare ZINB

and zero-inflated Poisson(ZIP) since Poisson regression models are the basis for the analysis of count data(Greene1994). Lastly, zeros observations may potential only come from one regime which infers the Hurdle model or two-part model. Thus, three alternative model specifications are presented: NB model, ZIP and Hurdle model.

6.2 Results for robustness

Table 4 shows the first regime of DGPs: the binary choice using a logit model except for hurdle model to determines whether the observed WTP are zeros. There are two difference between ZINB and hurdle model in the binary choice stage. First, hurdle model applies probit model while ZINB uses logit model. Besides, the reference of binary choice in hurdle model is zero whereas positive numbers in ZINB. To be consistent in signs, we modify the reference from zeros to positive WTPs in hurdle model. NB model doesn't apply in this part because it assumes that data only comes from one regime.

Table 4 only presents several key or policy oriented variables and the estimations show pretty robust features in ZINB accommodating alternative air quality measurement, data sources, outliers, omitted variable and model specifications. Such robustness also exists in a large scope taking all variables into consideration. Specifically, income, place attachment (e.g., life satisfaction and working length) and environmental knowledge(e.g.,education and environmental attitude) all lower the probability of being excessive zeros for migrant workers. In other words, migrant workers with high income, strong place attachment and better environmental knowledge would build up interests in environmental protection. The difference of magnitude of coefficients in hurdle model with other model specifications mainly come from the estimation methods: probit model and logit model.

The robustness checks for the second regime are presented in Table 5. The variables include income and income squared term, four policy choices which are not necessarily identical with the variables in the first regime of DGPs. In policy choices, both housing and relationship represent place attachment which is the connection with the urban life whereas two land variables indicate the connection with rural lives. Overall, all robustness choices except ZIP and NB produce very close effects with ZINB model.Such difference provides the evidences that data issues of zero inflation and overdispersion should be paid attention to in analysis. Meanwhile, the majority of models support the "U-shape" between income and migrant workers' WTP. The turning point of annual income lies between $ 3676 and $ 4030 for migrant workers in China.

7 Policy analysis and aggregation

This part focus on the post estimation and policy analysis. The main questions to be discussed here are why some part of migrant workers are not interested in environmental protection and how to build up a cost sharing mechanism with migrant workers' participation. Both the Table A3 and Table A4 provide direction for policy intervention.

7.1 Learn more about "non-interest group"

The "excessive zeros" of WTP represent no environmental concerns from migrant workers. In other words, the migrant workers with "excessive zeros" are out of the environmental market. Interpretational difficulties can be overwhelming in nonlinear functional forms such as logit model. Thus we calculate the marginal effects for the inflation portion of ZINB and only report the conference intervals for variables with statistical significance. Table A3 in Appendix shows that income in log form decreases the predicted probability of being "excessive zero" group by 10% holding other variables constant and its 95% confidence interval is between 4.5% and 16.4%. Migrant workers with strong place attachment such as higher life satisfaction and longer working length are more likely to have environmental concerns. Meanwhile, education attachment and environmental attitude contribute migrant workers' interest in environmental protection significantly.

To explicitly show the relationship between income and probability of being excessive zeros, we predict probability with income in Figure 2. The probability displays a clear decreasing trend when income increases. The impact of proposed increase of income above 7.65 has very limited impact on changing migrant workers' environmental attitude. This is because after the turning point around 7.72, most migrant workers already show interest in protecting environment and the marginal impact is decreasing.

In contrast, environmental knowledge such as high education and environmental attitude in Figure 3 increases migrant workers' interest significantly. This indicates that the reasons that some portion migrant workers don't show interests in environmental protection because of lack of environmental knowledge. With environmental education program through TV or newspaper, much larger percentage of migrant workers care environmental condition.

Figure 2: Predicted probability and environmental attitude

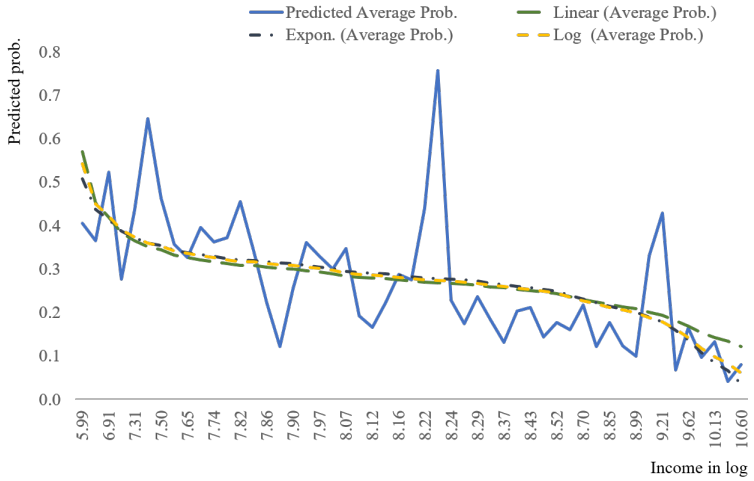
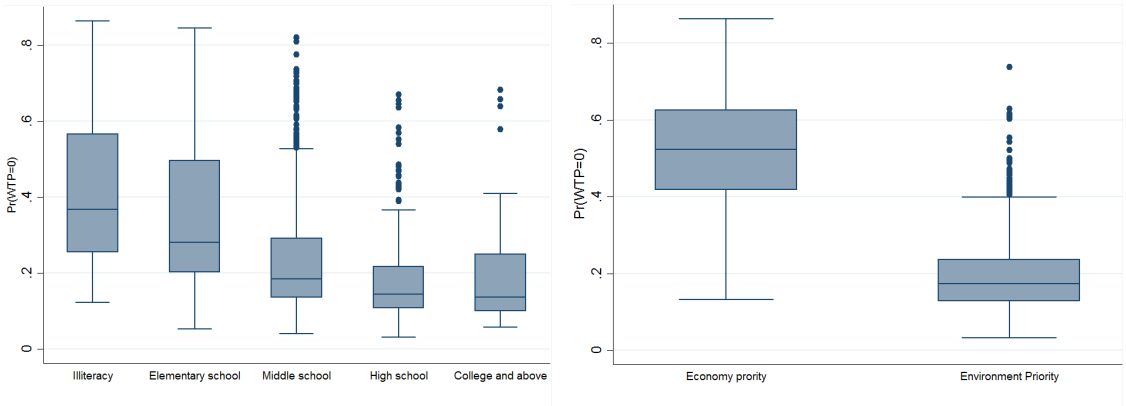


Figure 3: The trend of probability with education



(a) Education and probability

(b) Environmental attitude and probability

7.2 Police inference on migrant workers' environmental concerns?

The values of WTP measures migrant workers' environmental concerns. Thus, this part, we want to explore further the factors that affect migrant workers' WTP and proposal potential policy instruments. We provide a table in Appendix to show all the marginal effects.

Figure 4 shows the predicted WTP with different income levels. The graph shows that the predicted WTP roughly stays at the same level between 20 and 25

even though their income increases greatly. Thus, the impact of income on WTP is very limited for migrant workers.

Figure 4: Predicted WTP and income levels

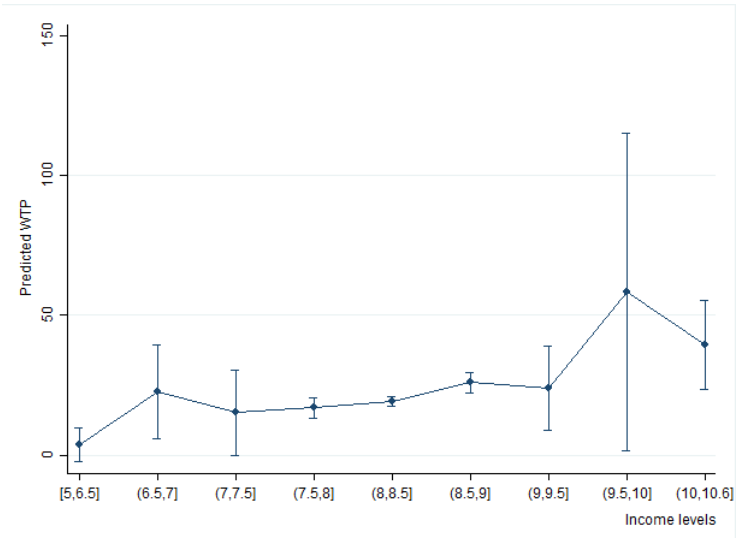
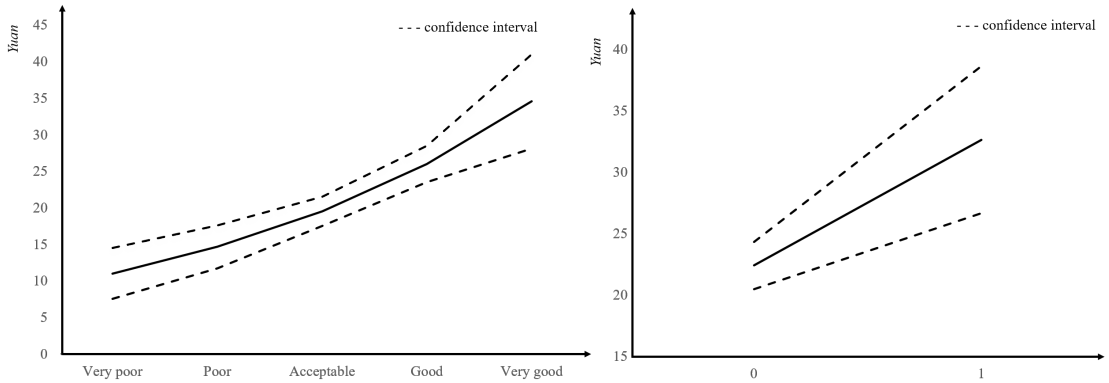


Figure 5 shows the relationships between predicted WTP and relationship and farmland as well. Specifically, migrant workers who have a better relationship with local citizens increase their WTP greatly from about 11 *yuan* to 34 *yuan* per month. If migrant workers plan to abandon their contracted farmland, their WTP increases by 10 *yuan* per month.

Figure 5: Prediction of WTP



(a) Relationship with local citizens (b) Abandon contracted farmland

7.3 Policy instruments and Aggregation:Estimating Social Benefits Aggregation

Environmental protection program, especially ambient air protection is always costly. This paper shows that migrant workers, as a important part of urban population can benefit from a potential air improved program and are willing to pay for such benefits. The current mean value of WTP is 22 *yuan* and about 72.5% migrant workers are willing to pay. Consider that our samples can represent the national migrant worker. The total migrant workers in China by the end of 2016 is 169.34 millions. The aggregate WTP for such amount of migrant workers is 2.78 billion yuan.

Education program can increase migrant workers' environmental knowledge and thus increases about 9.8% of total migrant workers into the "interest group". The total benefits increases by about 376 million. The impact from one more year in working length to the total benefits is only about 14 million. Any policy increases the relationship between migrant workers and local citizen can increase their WTP by 6 yuan per month and the total benefits and the total benefit from such policy is aggregated to 736 million. For land rights, we only focus on contracted farmland. The prediction shows that migrant workers who are willing to abandon rural farmland will increase monthly payment by 7.8 *yuan* and the total aggregation is 963 million.

Table 4: Policy analysis and benefit aggregation

	No policy	Choice process		WTP	
		Education program	working lengh	Relationship	Land rights
Percentage of interest group	0.725	0.823	0.729	0.725	0.725
		(+0.098)	(+0.004)	-	-
WTP (yuan per month)	22.629	22.629	22.629	28.628	30.471
		-	-	(+5.998)	(+7.841)
Total migrant workers(2016,million)	169.340	169.340	169.340	169.340	169.340
Total benefits(yuan,million)	2,779.502	3,155.622	2,793.648	3,516.199	3,742.563
		(+376.120)	(+14.156)	(+736.687)	(+963.061)
Total benefits(dollar,million)	440.492	500.099	442.733	557.242	593.116
		(+59.607)	(+2.242)	(+116.751)	(+152.625)

Note: Numbers in parentheses are the difference with the no policy scenario. Percentage of interest group is ratio of non-zeros WTP over total observations. The exchange rate is using 6.31.

8 Conclusion

Whether or not migrant workers concern their living environmental quality in urban communities could make big difference to their well-being and public policy options. The general arguments are negative which result in such situation that the environmental awareness of migrant workers are seldom emphasized in public participation and civic rights protection. This not only reduces migrant workers' willingness to reside in urban communities and increases their mobility, but blocks off the channels that migrant workers contribute the environmental protection. Meanwhile, given that the central government's National Plan(2014-2020) has already aimed to give 100 million migrant workers urban *hukou* by the year 2020 and this number increases to 250 million by 2026, there are desperate needs for information about migrant workers' willingness of integration and their environmental concerns to local air quality is a good indicator of willingness of integration.

This research shows that about 72.5% migrant workers have environmental concerns towards local air quality protection and are willing to take the high environmental responsibility. Meanwhile, migrant workers who do not show interest in environmental protection typically have information constraints and education programs which aim to provide more environmental knowledge increases the percentage up to 82.3%.Place attachment, such as working length in local communities and life satisfaction also induces them to pay more attention to local environmental amenities. Rural land factors are identified as "pulling" factors which weak their willingness to reside in urban area. However, this doesn't mean the government encourage migrant workers to give up their land property rights and cut the connection with rural society. In fact, more and more migrant workers are not willing to abandon their land rights because (1) rural land property serves as a social security net for senior migrant workers and (2)with the continued process of urbanization, land owners near cities can expect the central government to buy their land for a handsome sum sometime in the future.

Environmental protection projects are always costly. This research also proposal a potential cost-sharing mechanism which incorporating the contribution from migrant workers. The aggregated benefits from all migrant workers who concern air quality are up to 3 billion per month. This also requires education program to be implemented.

References

Alberini, A. (1997). Valuing Health Effects of Air Pollution in Developing Countries: The Case of Taiwan,. *Journal of Environmental Economics and Management*, 34(2):107–126.

Alberini, A. and Krupnick, A. (2000). Cost-of-Illness and Willingness-to-Pay Estimates of the Benefits of Improved Air Quality: Evidence from Taiwan. *Land Economics*, 76(1):37–53.

Anton, C. E. and Lawrence, C. (2016). The relationship between place attachment , the theory of planned behaviour and residents ' response to place change. *Journal of Environmental Psychology*, 47:145–154.

Arcury, T. A. (1990). Environmental Attitude and Environmental Knowledge. *Human Organization*, 49(4):300–304.

Billig, M. (2006). Is my home my castle? Place attachment, risk perception, and religious faith. *Environment and Behavior*, 38(2):248–265.

Breakwell, G. M. (1993). Social representation and social identity. *Papers on Social Representations*, 2(3):1–20.

Brehm, J. M., Eisenhauer, B. W., and Krannich, R. S. (2012). Community Attachments as Predictors of Local Environmental Concern: The Case for Multiple Dimensions of Attachment. *American Behavioral Scientist*, 50(February):142–165.

Brown, G. and Raymond, C. (2007). The relationship between place attachment and landscape values : Toward mapping place attachment. 27:89–111.

Cameron, T. A. and Quiggin, J. (1994). Estimation Using Contingent Valuation Data from a "Dichotomous Choice with Follow-Up" Questionnaire. *Journal of Environmental Economics and Management*, 27(3):218–234.

Carson, R. T. and Mitchell, R. C. (1995). Sequencing and nesting in contingent valuation surveys.

Cho, S.-h., Yen, S., Bowker, J., and Newman, D. (2008). Modeling willingness to pay for land conservation easements: treatment of zero and protest bids and application and policy implications. *Journal of agricultural and applied economics*, 40(1):267–285.

Clark, W. A. V., Duque-calvache, R., Palomares-linares, I., and Angeles, L. (2017). Place Attachment and the Decision to Stay in the Neighbourhood †. (November 2015).

Del Saz-Salazar, S. and Garcia-Menendez, L. (2001). Willingness to pay for environmental improvements in a large city. *Environmental and Resource Economics*, 20(2):103–112.

Desmarais, B. and Harden, J. (2006). *Testing for zero inflation in count models: Bias correction for the Vuong test*, volume 6.

Fang, L., Clausen, G., and Fanger, P. O. (1998). Impact of Temperature and Humidity on the Perception of Indoor Air Quality. *Indoor Air*, 8(2):80–90.

Flores, N. E. and Carson, R. T. (1997). The Relationship between the Income Elasticities of Demand and Willingness to Pay *. pages 287–295.

Gunderson, K. and Watson, A. (2007). Understanding place meanings on the Bitterroot National Forest, Montana. *Society and Natural Resources*, 20(8):705–721.

Harris, J. R., Todaro, M. P., R, B. J., and Todaro, M. P. (1970). Migration , Unemployment and Developmnent : A Two-Sector Analysis. *American Economic Review*, 60(1):126–142.

Horowitz, J. K. and McConnell, K. E. (2003). Willingness to accept, willingness to pay and the income effect. *Journal of Economic Behavior and Organization*, 51(4):537–545.

Hu, M. C., Pavlicova, M., and Nunes, E. V. (2011). Zero-inflated and hurdle models of count data with extra zeros: Examples from an HIV-risk reduction intervention trial. *American Journal of Drug and Alcohol Abuse*, 37(5):367–375.

Huang, P., Zhang, X., and Deng, X. (2006). Survey and analysis of public environmental awareness and performance in Ningbo, China: a case study on household electrical and electronic equipment. *Journal of Cleaner Production*, 14(18):1635–1643.

Jorgensen, B. S. and Stedman, R. C. (2001). Sense of Place as an attitude: Lakeshore owners attitudes toward their properties. *Journal of Environmental Psychology*, 21(3):233–248.

Kloog, I., Nordio, F., Zanobetti, A., Coull, B. A., Koutrakis, P., and Schwartz, J. D. (2014). Short term effects of particle exposure on hospital admissions in the mid-atlantic states: A population estimate. *PLoS ONE*, 9(2):1–7.

Koken, P. J., Piver, W. T., Ye, F., Elixhauser, A., Olsen, L. M., and Portier, C. J. (2003). Temperature, air pollution, and hospitalization for cardiovascular diseases among elderly people in Denver. *Environmental Health Perspectives*, 111(10):1312–1317.

Kristrom, B. and Riera, P. (1996). Is the income elasticity of environmental improvements less than one? *Environmental and Resource Economics*, 7(1):45–55.

Lepeule, J., Laden, F., Dockery, D., and Schwartz, J. (2012). Chronic exposure to fine particles and mortality: An extended follow-up of the Harvard six cities study from 1974 to 2009. *Environmental Health Perspectives*, 120(7):965–970.

Levinson, A. (2012). Valuing public goods using happiness data: The case of air quality. *Journal of Public Economics*, 96(9-10):869–880.

Lin, C. C. and Lockwood, M. (2014). Forms and sources of place attachment: Evidence from two protected areas. *Geoforum*, 53:74–81.

Liu, Q., Li, H.-m., Zuo, X.-l., Zhang, F.-f., and Wang, L. (2009). A survey and analysis on public awareness and performance for promoting circular economy in China: A case study from Tianjin. *Journal of Cleaner Production*, 17(2):265–270.

Loehman, E. and De, V. H. (1982). Application of Stochastic Choice Modeling to Policy Analysis of Public Goods : A Case Study of Air Quality. *The Review of Economics and Statistics*, 64(3):474–480.

McFadden, D. L. (1994). Contingent Valuation and Social Choice. *American Journal of Agricultural Economics*, 76(4):689–708.

Moser, S. C. and Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences*, 107(51):22026–22031.

Pope, C. A. and Dockery, D. W. (2006). Health effects of fine particulate air pollution: Lines that connect. *Journal of the Air and Waste Management Association*, 56(6):709–742.

Potts, D. (2006). Rural mobility as a response to land shortages: The case of Malawi. *Population, Space and Place*, 12(4):291–311.

Ridout, M., Demetrio, C. G., and Hinde, J. (1998). Models for count data with many zeros. *International Biometric Conference*, (December):1–13.

Rohde, R. A. and Muller, R. A. (2015). Air pollution in China: Mapping of concentrations and sources. *PLoS ONE*, 10(8):1–14.

Scannell, L. and Gifford, R. (2013). Personally Relevant Climate Change: The Role of Place Attachment and Local Versus Global Message Framing in Engagement. *Environment and Behavior*, 45(1):60–85.

Scannell, L. and Gifford, R. (2017). Place Attachment Enhances Psychological Need Satisfaction.

Stark, O. and Bloom, D. E. (1985). The New Economics of Labor Migration. *he American Economic Review*, 75(2).

Tao, M., Chen, L., Xiong, X., Zhang, M., Ma, P., Tao, J., and Wang, Z. (2014). Formation process of the widespread extreme haze pollution over northern China in January 2013: Implications for regional air quality and climate. *Atmospheric Environment*, 98:417–425.

Todaro, M. P. (1969). A Model of Labor Migration and Urban Unemployment in Less Developed Countries. *The American Economic Review*, 59(1):138–148.

Van Selst, M. and Jolicoeur, P. (1994). A Solution to the Effect of Sample Size on Outlier Elimination. *The Quarterly Journal of Experimental Psychology Section A*, 47(3):631–650.

VanWey, L. K. (2005). Land Ownership as a Determinant of International and Internal Migration in Mexico and Internal Migration in Thailand. *International Migration Review*, 39(1):141–172.

Vorkinn, M. and Riese, H. (2001). Environmental Concern in a Local Context: The Significance of Place Attachment. *Environment and Behavior*, 33(2):249–263.

Wakefield, S. E. L., Elliott, S. J., Cole, D. C., and Eyles, J. D. (2001). Environmental risk and (re)action: Air quality, health, and civic involvement in an urban industrial neighbourhood. *Health and Place*, 7(3):163–177.

Wang, Y., Sun, M., Yang, X., and Yuan, X. (2016). Public awareness and willingness to pay for tackling smog pollution in China: A case study. *Journal of Cleaner Production*, 112:1627–1634.

Wang, Y. S., Yao, L., Wang, L. L., Liu, Z. R., Ji, D. S., Tang, G. Q., Zhang, J. K., Sun, Y., Hu, B., and Xin, J. Y. (2014). Mechanism for the formation of the January 2013 heavy haze pollution episode over central and eastern China. *Science China Earth Sciences*, 57(1):14–25.

Yang, G., Wang, Y., Zeng, Y., Gao, G. F., Liang, X., Zhou, M., Wan, X., Yu, S., Jiang, Y., Naghavi, M., Vos, T., Wang, H., Lopez, A. D., and Murray, C. J. L. (2013). Rapid health transition in China, 1990-2010: Findings from the Global Burden of disease study 2010. *The Lancet*, 381(9882):1987–2015.

9 Appendix

Table A1: Sample size calculation

Index	Wujin(2015)	Huishan(2015)	Changshu(2015)
Population(permanent)	1,436,200	706,600	1,510,100
Population(registered)	930,345	493,500	1,068,200
Non-local migrant workers	505,855	213,100	441,900
Labor in Agricultural sector(%)	28%	28%	28%
Rural labor force	260,497	138,180	299,096
Labor working in local areas(%)	83%	83%	83%
Local migrant workers	216,212	114,689	248,250
Total migrant workers population	722,067	327,789	690,150
Margin of error (ME)	3.50%	3.50%	3.50%
Confidence level	95%	95%	95%
Recommended sample size	784	783	784
Target sample size	800	800	800
Actual sample size	807	801	748

Data sources: the Department Statistical Bureau in each cities. The percentage of labor in Agricultural sector and the percentage of labor working in the local areas come from the report in National Bureau of Statistics[a].

[a]see `http://www.stats.gov.cn/ztjc/ztfx/fxbg/200511/t20051117_15868.html`

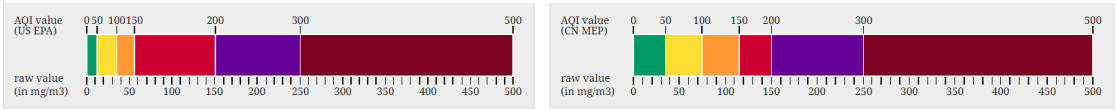
Table A2: Comparison the survey sample with the national migrant workers(2016)

Variables	Explanation	Survey sample	National level	Difference
Gender	Male	71.79%	65.50%	6.29%
	Female	28.21%	34.50%	-6.29%
Age	16-20	4.82%	3.30%	1.52%
	21-30	31.03%	28.60%	2.43%
	31-40	21.72%	22.00%	-0.28%
	41-50	28.34%	27.00%	1.34%
	51+	14.09%	19.20%	-5.11%
Education	Illiteracy	4.57%	1.00%	3.57%
	Elementary school	20.56%	13.20%	7.26%
	Middle school	54.94%	59.40%	-4.46%
	High school	15.68%	17.00%	-1.32%
	College and above	4.26%	9.40%	-5.14%
Job type	Manufacturing	78.97%	30.50%	48.47%
	Construction	6.78%	19.70%	-12.92%
	Wholesale and retail	1.53%	12.30%	-10.77%
	Transportation	2.94%	6.40%	-3.46%
	Accommodation and Restaurants	1.49%	5.90%	-4.41%
	Other service industry	8.29%	11.10%	-2.81%
Income	Overall		3275	795
	East	4070	3454	616
Working situaiton	Work day per week	6.49	6.20	0.29
	Work hour per day	9.6	8.5	1.1

Sources: National Bureau of Statistics.

The Figure 1 shows the comparison of Chinese AQI scale and American AQI scale. Basically, the Chinese AQI scale is much "loose". For example, if the raw value is 50 $\mu g \cdot m^{-3}$ for both US and China, the AQI in the US AQI scale is between 100 and 150, which is unhealthy for sensitive groups, whereas in China, it is between 51 and 100, which is moderate. The two scales will be identical when the rate values are greater than 150. Table A3 shows the marginal effects of variables for

Figure 6: Comparison different AQI scales between China and the US.



Sources: graphs from WAQI

the predicted probability of being “non-interest group”.

Table A3: The marginal effects for the predicted probability of being non-interest group

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
AQI	0.000	0.000	-0.040	0.966		
Income	-0.105	0.030	-3.440	0.001	-0.164	-0.045
Place attachment						
Life satisfaction	-0.037	0.016	-2.290	0.022	-0.069	-0.005
Relationship	-0.016	0.019	-0.810	0.416		
Local helpers	-0.003	0.011	-0.280	0.777		
Housing	0.186	0.046	4.000	0.000	0.095	0.277
Local dialect	0.031	0.017	1.780	0.075		
Working length	-0.006	0.002	-2.810	0.005	-0.010	-0.002
Self-identity	0.073	0.039	1.850	0.064		
Family migration	-0.033	0.028	-1.200	0.232		
Couple migration	-0.043	0.029	-1.490	0.136		
Demographic factors						
Gender	0.036	0.027	1.350	0.176		
Age	0.004	0.001	3.230	0.001	0.001	0.006
Educ	-0.042	0.014	-3.010	0.003	-0.070	-0.015
Health	0.036	0.019	1.860	0.063		
Smoke	-0.053	0.025	-2.140	0.032	-0.102	-0.005
Envi. attitude	-0.234	0.020	-11.790	0.000	-0.273	-0.195
Location. 1	-0.012	0.027	-0.420	0.672		
Location. 3	-0.046	0.026	-1.790	0.073		

Note: dy/dx for factor levels is the discrete change from the base level.

Table A4: The marginal effects for the WTP

	dy/dx	Delta-method Std. Err.	z	P>|z|	[95% Conf.	Interval]
AQI	0.039	0.019	2.040	0.042	0.001	0.077
Income	-79.017	38.905	-2.030	0.042	-155.270	-2.764
Income squared	5.310	2.355	2.250	0.024	0.694	9.926
Place attachment						
Life satisfaction	2.883	1.106	2.610	0.009	0.716	5.051
Relationship	5.998	1.281	4.680	0.000	3.488	8.509
Local helpers	0.799	0.701	1.140	0.254		
Housing	4.274	3.856	1.110	0.268		
Local dialect	0.125	1.165	0.110	0.915		
Working length	0.121	0.155	0.780	0.437		
Self-identity	-1.359	2.693	-0.500	0.614		
Family migration	0.890	1.857	0.480	0.632		
Couple migration	2.052	1.730	1.190	0.235		
Demographic factors						
Gender	0.952	1.912	0.500	0.618		
Age	-0.651	0.472	-1.380	0.168		
Age squared	0.003	0.006	0.480	0.634		
Educ	2.863	1.053	2.720	0.007	0.798	4.927
Health	0.846	1.245	0.680	0.497		
Smoke	0.381	1.673	0.230	0.820		
Envi. attitude	9.879	1.862	5.310	0.000	6.230	13.528
Abandon contracted land	7.841	2.020	3.880	0.000	3.883	11.800
Abandon residential land	15.816	4.885	3.240	0.001	6.242	25.390
Location. 1	6.401	2.340	2.740	0.006	1.814	10.988
Location. 3	-2.386	1.608	-1.480	0.138		

Note: dy/dx for factor levels is the discrete change from the base level.

Table A5: Robustness check: choice probability

Variables		Original	Model 1	Model 2	Model 3	Model 4	Model 5-1	Model 5-2
Income								
	Income	-0.636***	-0.648***	-0.635***	-0.654***	-0.632***	-0.353***	-0.616***
		(0.188)	(0.189)	(0.189)	(0.189)	(0.185)	(0.099)	(0.176)
Policy choices								
	Life satisfaction	-0.226**	-0.224**	-0.223**	-0.208**	-0.223**	-0.129**	-0.223**
		(0.100)	(0.100)	(0.099)	(0.101)	(0.098)	(0.054)	(0.093)
	Working length	-0.037***	-0.037***	-0.036***	-0.038**	-0.037***	-0.020***	-0.035***
		(0.014)	(0.014)	(0.013)	(0.013)	(0.013)	(0.007)	(0.013)
	Education	-0.258***	-0.260***	-0.250***	-0.263***	-0.255***	-0.141***	-0.248***
		(0.087)	(0.087)	(0.087)	(0.087)	(0.086)	(0.046)	(0.081)
	Environmental attitude	-1.422***	-1.419***	-1.409***	-1.410***	-1.412***	-0.823***	-1.368***
		(0.140)	(0.141)	(0.141)	(0.141)	(0.139)	(0.082)	(0.134)
AQI		-0.000			-0.001	-0.000	0.000	-0.000
		(0.002)			(0.002)	(0.002)	(0.001)	(0.002)
AQI-0			0.002					
			(0.002)					
PM2.5				0.005**				
				(0.002)				
Temp					0.041**			
					(0.018)			
Outliers						√		
Different models								
	Hurdle model						√	
	ZIP							√
Observation		1620	1620	1620	1620	1620	1620	1620

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table A6: Robustness check: WTP

Variables		Original	Model 1	Model 2	Model 3	Model 4	Model5-1	Model 5-2	Model 5-3
Income									
	Income	-3.941**	-4.027**	-3.933**	-3.940**	-2.969**	-3.889***	-1.962	-1.002
		(1.856)	(1.829)	(1.813)	(1.856)	(1.353)	(1.236)	(1.265)	(1.900)
	Income squared	0.255**	0.260**	0.254**	0.255**	0.194**	0.253***	0.134*	0.087
		(0.112)	(0.110)	(0.109)	(0.112)	(0.081)	(0.074)	(0.074)	(0.115)
Policy choices									
	Housing	0.468**	0.458**	0.471**	0.472***	0.333**	0.267*	0.529**	-0.022
		(0.182)	(0.183)	(0.183)	(0.182)	(0.156)	(0.158)	(0.211)	(0.218)
	Relationship	0.266***	0.271***	0.276***	0.266***	0.234***	0.250***	0.255***	0.270***
		(0.055)	(0.055)	(0.055)	(0.055)	(0.052)	(0.047)	(0.068)	(0.068)
	Contracted farmland	0.376***	0.374***	0.378***	0.377***	0.393***	0.543***	0.393***	0.314*
		(0.098)	(0.099)	(0.099)	(0.098)	(0.090)	(0.116)	(0.105)	(0.166)
	Residential land	0.759***	0.789***	0.799***	0.758***	0.731***	0.705***	0.669***	0.393
		(0.234)	(0.240)	(0.238)	(0.234)	(0.217)	(0.260)	(0.248)	(0.310)
AQI		0.002**			0.002**	0.002**	0.001	0.001	0.002*
		(0.001)			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
AQI-0			0.000						
			(0.001)						
PM2.5				0.001					
				(0.001)					
Temp					0.001				
					(0.008)				
Outliers						√			
Different models									
	Hurdle model						√		
	ZIP							√	
	NB								√
Observation	1621	1621	1621	1621	1621	1621	1621	1621	1621

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

9.1 Identify "non-interest group"

Zeros may come from either "non-interest group" group or NB distribution. The data shows that the mean of predicted probability of 0 WTP from "non-interest group" is 0.36 while the mean of predicted probability of 0 WTP from NB distribution is 0.022 with maximum of 0.072. This is a clue that the majority of zeros comes from "non-interest group" group. To be simplified, we assume that all 445 observations with zero WTP are from "non-interest group". If migrant workers do not show interest in protecting air quality because of lack environmental knowledge, the question then is how many percentage of migrant workers will alter their concerns if education program is installed.

To do this, a threshold of probability between "interest group" and "non-interest group" should be built. We set the median value of probability of being zero in non-zero WTP group as the threshold: 0.18. The marginal impact of environmental attitude of being non-interest group is -0.234. Thus, any observation with 0 WTP and probability of being non-interest group between 0.18 and 0.414(0.18+0.234) will change their attitude with environmental attitude holding other variables constant. This constitutes 159 observation of 445 zeros WTP. In other words, education program change alter about 9.81% migrant workers attitude.