Can money always talk? : implication for environmental compensation by international agribusiness

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Can money always talk?

Implication for environmental compensation by international agribusiness[1]

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Abstract

With the development of agricultural industrialization, the environmental issues of intensive animal farming are attracting increasing attention. Using survey data from 313 Chinese households living near the large-scale broiler farms of an international food company, this paper employs a contingent valuation method and discrete choice experiment to quantify the willingness to accept an air pollution compensation scheme. We find the following. (1) 42% of respondents have a nonmonetary preference for compensation; thus, the conventional contingent valuation method is unsuitable for application to them. (2) The results of a probit and tobit model show that in addition to income, "trust and perception" dominate decision-making based on willingness to accept; however, the effect of actual distance is weak. (3) Because of the positive externalities of roads, schools, and job opportunities, the combination of nonmonetary options is feasible and beneficial for both sides (the company and households) in the long term. Thus, from the perspective of the global value chain, it is worth studying nonmonetary compensation strategies in order to explore the sustainable development strategies of multinational corporations.

Keywords: willingness to accept; CVM; choice experiment; global value chain; pollution; China

JEL classification: F23, Q12, Q51

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1 Introduction

With the growth of large-scale broiler farms, the environmental issue of intensive animal farming is attracting increasing attention. For example, Karadurmus et al. (2012) develop the artificial neural network in order to predict the degree of groundwater pollution (the total amount of coliform) from nearby chicken farms. Comparing two typical broiler management systems (intensive broiler production vs. free-range broiler production), intensive broiler farming has always been proved to produce more pollution. For example, one microbiological analysis of Omeira et al. (2006) finds that broiler litter from intensive systems has higher coliform concentration, total bacterial count, and nitrogen, phosphorus, and zinc content than the litter from free-range broiler systems.

In terms of environmental influence, there have been many protests and conflicts between local residents and companies. In our case study here, local residents state that the serious environmental problem caused by farms not only reduces their quality of life but also brings health risks. Because local residents and the company could not reach an agreement over a compensation package, the people of several villages gathered to block the main road (the company's transport channel) and asked for compensation.

It is worth noting that many of the study's respondents said that they would not accept monetary compensation. A primary reason could be strong environmental awareness. In other words, they have refused to accept monetary compensation because the company produces a significant amount of environmental pollution. These respondents hope that the broiler farm will move. Moreover, they state that they will not accept monetary compensation because they were unwilling to sacrifice their personal physical health for a small amount of money. In this context, there are a large number of willingness-to-accept (WTA) analyses for ecological compensation (e.g., He et al., 2016); however, few focus on WTA for nonmonetary compensation. In our sample, more than 40% of local residents reject monetary compensation. Thus, the conventional contingent valuation method (CVM) is unsuitable for application to these households.

The objective of this paper is to quantify the ecological compensation measure (ECM) for rural households near a large-scale broiler farm. Our research sheds light on ECM by making several important contributions. First, we distinguish between the WTA with regard to monetary and nonmonetary ECM. Using a probit model, the CVM, and a discrete choice experiment (DCE), we analyze ECM choice decisions. Since the measurement of odor is quite difficult, we instead measure the actual and perceived distance as proxies in order to represent the actual and perceived status of air pollution. Interestingly, we find that trust and perception dominate WTA decision-making; however, the impact of actual distance is weak. This finding is our second contribution, suggesting that WTA analysis in the absence of psychological considerations may be fruitless. Third, the company we surveyed is a major foreign food enterprise. It is worth exploring this company's sustainable development strategy in a developing country with a micro case.

The remainder of the paper proceeds as follows. Section 2 and 3 include a description of the background, methodology and data. Section 4 discusses the results. Final remarks and considerations are offered in the conclusion, section 5.

2 Background

In developing countries, the broiler industry is expanding as global demand increases. In 2016, total broiler meat consumption was 87.64 million metric tons (ready to cook equivalent), an increase of 7.36% compared with 2012 (USDA, 2016). Meanwhile, robust foreign and domestic demand has bolstered broiler production and exports, and encouraged foreign direct investment (FDI) for the broiler industry in developing countries. For instance, the BRIC countries (Brazil, Russia, India, and China) contributed 38% of the broiler meat supply in 2016. In addition to the United States and the European Union, the three developing countries of Brazil, Thailand, and China are the top five exporters and accounted for 48% of global broiler export volume (USDA, 2016).

In recent decades, broiler production has undergone a major change toward agricultural industrialization. Take China for example: the industrialization of the broiler industry in China began in the late 1980s when a leading enterprise, Wens Food Group Co., Ltd., developed a production contract. As a leading enterprise, Wens produces 744 million yellow-feather broiler chickens and accounted for one-fifth of China's domestic chicken market in 2015. In the meantime, several international meat giants (e.g., Tyson and Cargill) have invested in China through vertical integration. For example, Tyson Dalong, established in 2001, is at the forefront of the company's efforts to implement advanced technology and methods to produce par-fried chicken products. Jiangsu Tyson Foods Co., Ltd., founded in 2008, is located in the Jiangsu province near Shanghai. This wholly-owned business is a fully integrated poultry complex with live production operations and processing capacity. Moreover, in 2011, Cargill Animal Protein (Anhui) Co., Ltd. invested 250 million USD to construct a vertically integrated poultry supply chain, covering feeding, hatching, breeding, and processing. This supply chain has the capacity to process approximately 65 million white-feather broiler chickens per year. From a nationwide perspective, in 2015 there were 21,183 farms that raised between 50,000 and 99,999 chickens, 6911 that raised between 100,000 and 499,999 chickens, 912 that raised between 500,000 and 999,999 chickens, and 564 ones that raised more than one million chickens. Compared with 2000, the numbers of these four grades of large-scale farms in China have increased by 24.4%, 42.7%, 82.8%, and 123.81% respectively.

The company we surveyed is an international producer and marketer of food, and supplies agricultural, financial, and industrial products and services. In 2011, the company began to invest in a vertical integrated supply chain to cater for the demand of downstream retailers (e.g., McDonalds). To date, it has built 18 broiler farms, eight breeding chicken farms, and four young chicken farms in Chuzhou City, Anhui Province, China. Investment for each broiler farm is 20 million RMB. Moreover, the annual production capacity of each breeding farm is approximately 2.5 million.

Company farms are located in 10 villages, all of which come within our field of

research. In each village, 35 households were randomly selected. Overall, 350 households were targeted and 313 of them finished the questionnaire. In the sample, most participants were male; 47.3% were older than 60 and net income per capita was 8,991 RMB (about 1,300 USD) in 2015.

The survey was conducted in August 2016 through face-to-face interviews. The questionnaire mainly consisted of six parts as follows. (1) The information relationship between the household and the poultry broiler farms in the vicinity of the respondents. (2) The contingent valuation method (CVM) survey. (3) The discrete choice experiment (DCE) for the ECM. (4) Information about the household's income and expenditure. (5) Demographic characteristics and labor time allocation. (6) Geographic information (GPS) of the nearby poultry farm and the household. Each questionnaire took approximately 20–30 minutes to complete.

3 Methodology and Data

3.1 Empirical estimation

3.1.1 Empirical model

Environmental quality is a typical nonmarket good that is difficult to measure. The literature often measures nonmarket goods and services in two ways. One is the CVM proposed by Randall et al. (1974). Studies on the analysis of the main factors affecting WTA are frequently conducted by CVM (e.g., Lindhjem and Mitani, 2012; He et al., 2016.). Moreover, Yacob et al. (2015) adopt CVM to analysis the WTA of households in Malaysia for the cyclic utilization of cooking oil. Their results suggest that family characteristics (e.g., incomes) and population characteristics (e.g., gender, age, and education level) have a significant impact on WTA (Yacob et al., 2015). It is worth noting that confirmatory factor analysis does not apply to people willing to accept nonmonetary compensation because their WTA, measured by CVM, is zero. Thus, we only conduct confirmatory factor analysis for people willing to accept monetary compensation. Moreover, there have been many studies on WTA, but few are concerned with WTA for pollution caused by livestock and poultry raising. Our paper fills the gap.

The other way of measurement is DCE. When the total value of each attribute of environmental goods is more important than that of the environmental goods as a whole, DCE is better than other stated preference (SP) methods (Bateman et al., 2002). An early study with DCE was applied to beaches (Adamowicz et al., 1994). DCE is often used in studies on willingness to pay (WTP) rather than WTA (Beharry-Borg and Scarpa, 2010; Penn et al., 2015). Recently, Brennan and Rensburg (2016) have investigated the compensation requirements for permitting wind farms to be built in Ireland. Their findings suggest that many of the research participants require less compensation as setback distance increases (Brennan and Rensburg, 2016). However, their research mainly focuses on the physical properties of the wind farm itself, such as the number of turbines, turbine height, and shortest distance from the wind turbine to the respondents, and involves no concrete nonmonetary compensation measures, for example investment in roads and schools. Nonmonetary compensation measures

are considered in our analysis.

From the household perspective, two types of WTA can be defined: (1) WTA for monetary compensation ($WTA_{monetary}$), indicating that the respondents have a monetary WTA from zero to some specific value; (2) WTA for nonmonetary compensation ($WTA_{nonmonetary}$), indicating that the respondents have non-pecuniary compensation (e.g., obtaining a job from the company).

In order to analyze the motivation of different WTA types, a probit model is first applied, with the matrix X including all the factors. In addition to considering the effect of distance and the psychological factor, we also include the heads of families and household characteristics. The conventional hypothesis assumes that the head of a family and household characteristics, for example income, age, education, and gender, are key factors that influence a respondent's WTA (Stumborg, 2001; Weersink and Raymond, 2007; Brennan and Rensburg, 2016).

The model can be written as follows:

$$\mathrm{P}(y=1 \mid x) = F(x, \beta) = \phi(x'\beta) = \int_{-\infty}^{x'\beta} \phi(t)dt \qquad (1)$$

Further, for the sample that has regular monetary WTA, the stated $WTA_{monetary}$ measured by CVM is also analyzed by a simple Tobit method. Thus:

$$WTA_{cash} = \beta_0 + \beta_1 \cdot Distance + \beta_2 \cdot Psychology + \beta_3 \cdot Z_1 + \beta_4 \cdot Z_2 + \pi \quad (2)$$

3.1.2 Measuring WTA by CVM

In the questionnaire, we used multiple-choice questions and a CVM to measure WTA (type and monetary value). See the appendix for details of how the questions were asked. In the total sample, 9.3% completed a specific nonmonetary compensation measure and 35.1% chose "N.". For the respondents who received monetary WTA, the mean value of WTA_{cash} was 446 RMB and the standard deviation was 535 RMB.

3.1.3 Explanatory variables

Actual distance to the company

The study of Bayko and Stoyanov (1999) suggests that microorganisms caused by the industrial breeding of farm animals could be dispersed by wind. In addition,

Jones et al. (2013) reveal that ammonia[1] (NH3) is a major source of atmospheric pollution caused by an intensive poultry unit. Moreover, it is difficult to judge and measure odor. Many countries across the globe, such as China, America, and Japan, manage the environment by relying on the test results of odor judges who identify and rank unpleasant smells.[2] Because it is difficult to judge and measure odor, in this study actual distance is used to represent the intensity of air pollution.

We use an electronic map to identify the geographical information (latitude and longitude) of each household and each broiler farm. Stata 13 software is used to calculate the actual distance from a household to each broiler farm. Because the scale of each farm differs, the actual distance is weighted in accordance with one plus the normalized value of each farm's scale. One is added to avoid the occurrence of negative values. The method of determining the weight is as follows:

$$Weight_i = \frac{area_i - mean}{s.d.} + 1 \qquad (3)$$

The actual distance is obtained from the geographical information (the latitude and longitude of each household and each broiler farm) and measured in four ways: 1) *distance to the nearest farm*, 2) *weighted distance to the nearest farm*, 3) *distance to all the farms*, and 4) *weighted distance to all the farms.* Based on the actual distance between households and broiler farms, we can obtain the shortest distance, the weighted shortest distance, the mean value of each household's different distances, and the mean value of each household's different weighted distances. In the subsample of respondents who accept monetary compensation, the means of the above four distance variables are 1.286, 1.153, 7.524, and 7.872 kilometers respectively. For the people who expect nonmonetary compensation, the means are 1.376, 1.386, 7.517, and 7.588 kilometers respectively (see Table 1).

[1] Ammonia is a colorless liquid or gas with a strong, sharp smell. It is caustic and can burn eyes, skin, and mucosa within a breathing organism.

[2] Demystify the special job "odor judge."-http://www.ahyouth.com/news/20120822/599757.shtml.

Table 1 Variables

	$WTA_{monetary}$		$WTA_{non-monetary}$	
	Mean	Std. dev.	Mean	Std. dev.
Monetary willingness to accept				
$WTA_{monetary}$	446.472	535.631	——	——
Actual distance				
Distance to the nearest farm	1.286	0.749	1.376	0.766
Weighted distance to the nearest farm	1.153	1.176	1.386	1.406
Average distance to all the farms	7.524	1.565	7.517	1.548
Weighted average distance to all the farms	7.872	1.716	7.588	1.539
Psychological factors				
Perceived distance to the farm(s)	1.477	2.340	1.605	4.049
Trust in company	1.860	1.030	1.496	0.794
Household head characteristics				
Gender of household head	0.721	0.449	0.805	0.398
Age of household head	58.231	12.726	55.917	13.489
Education level of household head	4.610	7.838	4.617	4.062
Health status of household head	2.185	0.822	2.320	0.782
Living location of household head	0.978	0.182	0.955	0.208
Household characteristics				
Household total income	21.835	22.955	38.011	48.563
Received compensation	0.100	0.301	0.143	0.351
Household size	3.406	1.845	3.556	1.574
Baby percentage	1.246	4.690	1.615	7.149
Elderly percentage	35.756	41.320	28.186	37.160
Drinking water from well	49.489	47.800	49.624	47.632

Psychological factors

Perceived distance to the farm(s)

Economists think that perception may impact WTA (Gadaud and Rambonilaza, 2010; Petrolia and Kim, 2011). A study by He et al. (2016) suggests that respondents of higher cognitive degree who consider the benefits of recycling have a stronger motivation to accept compensation and to recycle agricultural waste. Moreover, Zhou et al. (2015) find that consumers who believe that AI-infected chicken is fatal are

willing to pay more for safe chicken. Thus, we use perceived distance as the proxy variable of perception.

Perceived distance (*perceived distance to the farm(s)*) is obtained by asking the question "How far do you think is the nearest broiler farm?" The means of the perceived distance for the two subsamples (monetary and nonmonetary) are 1.477 and 1.605 kilometers respectively. It is worth noting that both the means and standard deviations of perceived distance are larger than those of the distance to the nearest farm. This finding suggests that within a certain scope, perceived distance is no different from actual distance, and that perceived distance appears to be much further than actual distance, once actual distance surpasses a set range. Moreover, about 30% of respondents state that the visual distance to the nearest poultry farm is less than 500 meters.

Trust in the company

Besides perceptive distance, the level of trust in the company is also considered. Levels of trust are supposed to influence WTA (Verdurme et al., 2003). By contrasting US and EU data, Lusk and Coble (2005) come to the conclusion that EU consumers, because of trust differences in governments, are more persistent in resisting genetically modified foods and thus show greater WTA. In order to measure residents' trust in the company, the following question is included in our questionnaire: "According to the environmental impact assessment (EIA) report, the company claims that its waste gas generated during production has reached the discharge standard (GB3095-1996, TJ36-97, GB14554-93, HJ568-2010), and that the impact of its pollutant emissions on the surrounding environment is within acceptable limits. Do you believe these statements?" Five alternatives are offered to the question: 1) strongly mistrust; 2) mistrust; 3) neutral; 4) trust; 5) strongly trust. Thus, residents' trust in the company is a collection of discrete values, ranging from one to five. It is worth noting that the results of descriptive analyses reveal that there is a pervasive distrust among respondents regarding the company because the means of the variables for trust in the two subsamples (monetary and non-nonmonetary) are 1.860 and 1.496 respectively.

Household head characteristics

Gender of household head

Studies have shown that gender influences WTA significantly (Beck and Hess, 2015). Bernard and Bernard (2009) find that men are willing to pay more for organic milk without bovine growth hormones and antibiotics than women. Thus, a dummy variable of gender is placed in our model. When the respondent is male, the dummy variable equals one and zero otherwise. The results of descriptive analysis show that men constitute 72.1% of respondents willing to accept monetary compensation and 80.5% of those expecting nonmonetary compensation.

Age of household head

Age of household head is used as a control variable because age is supposed to have a significant impact on WTA (Petrolia and Kim, 2011; Westerberg et al., 2013). The older a respondent, the more compensation he or she demands. The study of Amigues et al. (2002) also finds that the older the age group, the more likely they are to provide riparian land for habitat preservation. The average age of our respondents is about 58, reflecting the age situation in China's rural areas.

Education level of household head

Education level of household head is also included in our study because better-educated people are more concerned with the environment and hope for greater environmental improvements (Weersink and Raymond, 2007; Pan et al., 2016). Consequently, the education level of household heads is controlled in our analysis. The period of respondents' education, whether they accept monetary compensation or not, is shorter than five years on average.

Health status of household head

Studies suggest that compared with people in good health, people with poor health think that air quality is worse than it actually is (Pantavou et al., 2017). Because air quality is directly related to compensation for air pollution, the health status of household heads is taken into consideration. Identified by the respondents themselves, health status is measured with a discrete variable, the value of which ranges from one to three. Higher numbers indicate better health. In our data, the

average values of health status for those who accept monetary compensation and those who expect nonmonetary compensation are 2.185 and 2.320 respectively.

Living location of household head

Whether or not the respondent lives locally has a significant impact on his or her WTA (Blignaut et al., 2016). A study conducted by Penn et al. (2015) shows that the WTP of tourists and local residents regarding beach quality differ greatly. To be specific, local people are more concerned with beach overcrowding while tourists care more about water quality. Thus, a dummy variable, which equals 1 when the household head lives locally and zero otherwise, is included in the model. Most of our respondents always live locally.

Household characteristics

Household income

The literature shows that people with higher family incomes expect greater WTA (Franco et al., 2001; He et al., 2016). For this reason, *household income* is used in our analysis. In our data, the average annual household incomes are 21,835 RMB for respondents who accept monetary compensation and 38,011 RMB for those who prefer nonmonetary compensation.

Received compensation

Existing compensation from the company (*received compensation*) is also included. We include this variable mainly because the receipt of compensation enhances the positive impression of the company and impacts local residents' WTA. The variable is a dummy where one represents the prior receipt of compensation. In our analysis, 10% of respondents state that they have received compensation.

Household size

Zhao et al. (2013) suggest that demographics such as *household size* have an effect on WTA. Recently, the study of Blignaut et al. (2016) also states that the bigger the family, the higher the WTA of its members. On average, there are three to four members in each household in our sample.

Baby percentage

Population characteristics, such as the number of babies in a family, affect WTA (De Steur et al., 2010). Families with a higher proportion of babies are more concerned with the environment. The study of Dupont (2004) also suggests that such differences in environmental concerns prompt couples with children to pay a higher amount for water quality improvement in Hamiltonian ports than couples without children. We use the proportion of babies under three-years-old to construct a baby ratio variable. In our data, the proportion of babies in each family on average is approximately 1.5%, implying that the number of babies under three is very small.

Elderly percentage

Population characteristics, such as the number of elderly people in a family, affect WTA. The health status of the elderly is worse than that of young adults. Air pollution perceived by the elderly is more serious, resulting in higher WTA (Pantavou et al., 2017). Thus, the proportion of the elderly is included in our model. We use the ratio of people who are more than 60-years-old in households to represent *elderly percentage*. In our data, the proportion of the elderly in each family on average is about 30%, implying that the number of family members more than 60-years-old is significant.

Drinking water from well

The well water variable that we use is the proportion of those who drink water from a well. This variable reflects the dependence level on the environment. Higher dependence relates to a higher demand for compensation. Zhen et al. (2011) find that most respondents are willing to pay for improvements to the water quality of Poyang Lake. Further, how much they pay depends on their everyday lives and their reliance on the lake. In our data, the average ratios of respondents who accept compensation and who expect nonmonetary compensation, and who drink well water, are 49.489% and 49.634% respectively.

3.2 Discrete choice experiment for WTA

Most studies strongly assume that research respondents will only adopt a WTA approach in return for monetary compensation. This assumption is not accurate because respondents have other (alternative or complementary) nonmonetary WTA options (e.g., obtaining a job). Take the existing international system of compensation for oil pollution as an example. The system, supported by the vessel-induced oil

pollution insurance and oil pollution compensation fund, not only provides monetary compensation to seafood farmers and tourism operators; it is also committed to remedying water pollution (Popp, 2003; Dong et al., 2015). The Deepwater Horizon oil spill in the Gulf of Mexico is a case in point. In 2010, after the oil spill, the British Petroleum Company (BP) gave 20 billion USD to a compensation fund. This fund not only provides monetary compensation to pollution victims; it also supports pollution remediation.[3] Demski and Sappington (1999) suggest that without considering the nonmonetary component of compensation, conclusions drawn from estimation results may be misleading.

Studies about nonmonetary compensation can be divided into two parts: private and public goods. With regard to private goods, Fu et al. (2015) use the data of travelers who stay at upscale (four- or five-star) hotels in China in order to analyze nonmonetary compensation for hotel service failure. Their results show that for service failures, a combination of monetary and nonmonetary compensation is better than only monetary or nonmonetary compensation. In addition, nonmonetary compensation delivers higher satisfaction to travelers than monetary compensation. Further, the study of Duong and Evans (2016) suggests that male chief financial officers (CFOs) tend to choose riskier remuneration packages with fewer monetary and more nonmonetary components than their female peers (Duong and Evans, 2016). With regard to public goods, Lacetera and Macis (2010) conduct a randomized, controlled experiment in an Italian town. Their experiment shows that a substantial proportion of respondents declared that they would not be blood donors in return for 10 Euros in cash (Lacetera and Macis, 2010). Moreover, Villarroya et al. (2014) analyze in-kind compensation for road ecology without empirical methods. Overall, there are few studies on nonmonetary compensation for ecological environment.

Considering the limitation of CVM, the choice experiment (CE) is applied. The CE presented here focuses on ECM attributes and levels in order to help understand

[3] The British Petroleum Company establishes its first compensation fund for oil spills in the Gulf of Mexico. http://news.zj.com/detail/2010/08/10/1289057.html

respondents' compensation choices, especially for the nonmonetary WTA group. The company has implemented a series of ECMs in nearby villages. The ECMs mainly fall into two categories. The first is monetary compensation. The company gives broiler manure to village committees for free. The latter sell it and use the revenue to compensate households that live within 500 meters of the farm with 100 RMB per month. The villages that benefit are Wangji, Huangying, and Yutang.

The second ECM is nonmonetary compensation. The company has planted trees around the broiler farm in Beijian. In addition, the company has invested 1 million RMB to build 5.8 kilometers of road, pays 40 thousand RMB on road maintenance per year, and has invested in the installation of street lights and road signs. The villages that have benefited are Wangji, Huangying, Yutang, Beijian, and Dingcheng. Moreover, the company has donated 400 thousand RMB for water purification equipment for the Banta town primary school and given priority for employment to all local residents around its farms. There are 499 staff members in the thirty broiler farms in Banta, Laian County. The company can provide at most 50 new jobs in the near future. In addition, the company has invested 150 thousand RMB for a tap water system in Wangji, Hongji, and Dingcheng. The company also gives bags of chicken to poor households in all the villages around the farms and has constructed recreation facilities for local babies in Wangji.

According to the existing ECMs and the precepts of sustainable development (social harmony, environmental improvement, and economic development), we have selected the attributes by two criteria. First, the measures that have been implemented and may be further improved by the company, such as investing in roads and schools, providing jobs, and offering cash compensation. Second, the ECMs that have not been offered but respondents have asked for. Detailed descriptions of the attribute settings are as follows.

(a) Air purifier

To install an air purifier costs 10 million RMB. The company has only two options: to install an air purifier or not on each farm.

(b) Road construction

Based on the existing investment in roads, the attribute of investment in road

construction and maintenance in Banta town is set at zero, two million, four million, or six million RMB.

(c) School improvements

Building a primary school to the appropriate scale in the town requires approximately three million RMB.[4] We set investment in schools at zero, two, four, or six million RMB.

(d) Job opportunities

Considering the upper limit of job opportunities, the attribute of providing such opportunities for local residents is set at zero, 20, 40, or 60.

(e) Monetary compensation

We set monetary compensation at zero, 100, 200, or 300 RMB per month per person.

[4] An administrative village (population 2800) in Henan Province invested 3 million RMB in building a primary school that could hold 180 preschoolers and 260 pupils at the same time. The relevant news report is "Investing three million yuan in building Jiaxiang primary school." http://newpaper.dahe.cn/hnrbncb/html/2015-08/18/content_1301160.htm?div=-1.

Table 2 Attributes

Attribute	Definition
Air□purification	Invest 10 billion RMB in installing an air purifier on each farm in order to guarantee waste gas emission standards
	No air purifier
Road construction	Invest one-off payment of six million RMB in roads in the town
	Invest one-off payment of four million RMB in roads in the town
	Invest one-off payment of two million RMB in roads in the town
	Make no investment in roads in the town
School improvements	Invest one-off payment of six million RMB in schools in the town
	Invest one-off payment of four million RMB in schools in the town
	Invest one-off payment of two million RMB in schools in the town
	Make no investment in schools in the town
Job opportunities	Promise to hire 60 native villagers
	Promise to hire 40 native villagers
	Promise to hire 20 native villagers
	Do not promise to hire native villagers
Monetary compensation	0 RMB per month per household
	100 RMB per month per household
	200 RMB per month per household
	300 RMB per month per household

A typical choice set card in our questionnaire can be seen in Table 3. For example, the researcher asked the following.

“The company is going to rebuild the broiler farm that is located in your village. There are three sets to discuss.

“Set A: In addition to providing 100 RMB per month for your household, the company invests four million RMB to construct (or maintain) the local roads in your town and hires 20 local residents in your town to work in the company. However, the farm will not install an air purifier in your village or invest in school facilities in your town.

“Set B: In addition to providing 100 RMB per month for your household, the farm invests 6 million RMB to construct (or maintain) the local roads. Besides, the farm invests 2 million RMB to improve the local school’s facilities and hires 60 local residents in your village to work in the company. However, the farm will not install an air purifier.

“Set C: In addition to installing an air purifier, the farm also invests 6 million RMB to improve the school’s facilities and hires 40 local residents in your village to work in the company. However, the farm will not invest in the local roads or provide a subsidy for your household.

“With regard to the three options above, which one do you prefer? You can also choose D if you want none of the above.”

Table 3 Example of a choice set

Order	Air purification	Road construction	School improvements	Job opportunities	Monetary compensation
Option A	None	No payment	Four million RMB	20	100 RMB
Option B	None	Six million RMB	Two million RMB	60	300 RMB
Option C	Have	No payment	Six million RMB	40	0 RMB
Option D	Select none of the above				
Option					

Following Penn et al. (2015), we use the Sawtooth Software's randomized design to construct the CE (Sawtooth Software Inc., 2013). Only eight choice scenarios for each respondent have been included. Although each respondent faces eight fixed scenarios, the order of each scenario appears randomly.

In order to model the CE data, we rely on random utility theory and use discrete choice models built upon the theory. A conditional logit model is specified in equation 4.

$$P(y_i = j \mid x_{ij}) = \frac{exp(x_{ij}^{'}\beta)}{\sum_{K=1}^{J} exp(x_{ik}^{'}\beta)} \qquad (4)$$

The WTA for each ECM is estimated by the marginal rate of substitution (MRS).

$$MRS = -\frac{\beta_k}{\beta_p} \qquad (5)$$

where β_k refers to the parameter of interest and β_p to the parameter for monetary compensation.

4 Results

4.1 Probit regression

Actual distance

The results of the probit model are presented in Table 4. We use the actual distance to represent air quality because of the difficulty of quantifying odor.[5]

[5] In studies of air pollution, not only distance but also direction are considered. For example, while investigating the ammonia concentration at different distances to a breeding farm in the

Actual distance has no effect on the choice of compensation type. The coefficient of actual distance is insignificant, no matter what the distance type. Our results suggest that actual distance has no effect on WTA decision-making. This finding may arise from the fact that behavior is mainly based on perception and that objective measurements may be inconsistent with perceptions of environmental quality (Artell et al., 2013). Thus, the relationship between actual distance and the choice of compensation type is weak.

Psychological factors

Perceived distance

Compared with actual distance, the results of perceived distance suggest a similar conclusion. Perceived distance to nearby farms has no impact on the choice of compensation type.

Trust in the company

Estimation results show that the greater the degree to which respondents trust the company, the more likely it is that they will accept monetary compensation. Considering that respondents' trust in the company is represented by their degree of cognition regarding the EIA report, this result means that when residents think that environmental pollution is serious, they prefer nonmonetary compensation. Such a finding is in accordance with our expectations. In our survey, we find that if respondents think that the environment is heavily polluted by the company, they are unwilling to accept cash compensation. Instead, they want the company to move out. Some respondents state that nothing is more important than health; consequently, they are unwilling to sacrifice their air quality for a little money. This explains why respondents are unwilling to accept cash compensation when they think that the company is causing serious environmental pollution.

Other variables

(a) Gender has a significantly positive effect on the choice of compensation type. The results indicate that men are less likely to accept monetary compensation than women. This finding may be because, compared with men, women in rural areas crave money at a deeper level. Studies also note that while shouldering most of the burden of looking after babies and ageing parents, rural women have fewer income sources than rural men and so desire more money (He et al., 2016). Thus, cash compensation at the same level causes smaller increments of utility for men than women. Men prefer the company to offer nonmonetary compensation (e.g., install air

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southwest (upwind), Jones et al. (2013) find that the tested ammonia concentration in the southwest is lower than that in the northeast (downwind). In addition, ammonia concentration downwind and upwind takes on a synchronously decreasing trend with increasing distance. However, there is little wind because of the survey's duration; thus, the importance of wind direction is diminished. In order to make the results more reliable, wind directions, represented by dummy variables, are controlled in the robustness check. Based on the GPS information, we can orient farmers to the nearest breeding farm. The results show that wind direction has no impact on WTA. It may due to our survey was conducted in August so the wind direction can be ignored.

purification equipment) to improve air quality rather than simply offer monetary compensation.

(b) The coefficients for incomes show that respondents with higher total family incomes are less likely to accept monetary compensation. The likely reason is that the same level of monetary compensation brings smaller increments of utility to richer residents (De Steur et al., 2010). Besides, income influences environmental awareness and potential pro-environmental behavior: Those people who are richer are more worried about environmental issues than others (Altin et al., 2014; Delis and Iosifidi, 2016; Kiessling et al., 2017). Thus, richer residents are more concerned with environmental pollution and prefer that breeding farms should concentrate on solving environmental problems rather than simply offer cash compensation.

Table 4 Probit model for ECM selection

Variables	(1)	(2)	(3)	(4)	(5)
Actual distance					
Distance to the nearest farm	0.049				
Weighted distance to the nearest farm		0.069			
Average distance to all the farms			-0.007		
Weighted average distance to all the farms				-0.057	
Psychological factors					
Perceived distance to the farm(s)					0.009
Trust in the company	-0.235***	-0.229***	-0.236***	-0.237***	-0.234***
Household head characteristics					
Gender of household head	0.315*	0.328*	0.326*	0.355*	0.322*
Age of household head	-0.003	-0.002	-0.003	-0.003	-0.003
Education level of household head	-0.012	-0.011	-0.012	-0.012	-0.011
Health status of household head	0.086	0.094	0.082	0.078	0.080
Living location of household head	-0.257	-0.264	-0.260	-0.267	-0.261
Household characteristics					
Household total income	0.009***	0.009***	0.009***	0.009***	0.009***
Received compensation	0.192	0.194	0.179	0.167	0.189
Household size	-0.009	-0.013	-0.008	-0.010	-0.009
Baby percentage	-0.005	-0.004	-0.005	-0.006	-0.005
Elderly percentage	-0.0002	-0.0003	-0.0002	-0.0003	-0.0002
Drinking water from well	0.00002	-0.00002	0.00003	0.00002	0.00004
Constant	-0.078	-0.145	0.035	0.444	-0.016
LR Chi2	32.44***	33.57***	32.23***	31.92***	36.66***
Observations	313	313	313	313	313

4.2 Tobit regression for monetary WTA sample

Actual distance

The results of the Tobit model are presented in Table 4. Our results show that actual distance has no effect on monetary WTA, no matter what the distance type. A possible explanation is that actual distance differs from perceived distance. Environment is the product of perception, and people assess the value of the environment through their senses (Kweon et al., 2006; Whitehead, 2006). For this reason, the relationship between actual distance and monetary WTA is weaker than that between perceived distance and monetary WTA.

Psychological factors

Perceived distance

Compared with actual distance, perceived distance presents a different conclusion. Perceived distance has a significant negative effect on monetary WTA. If perceived distance increases by 1 kilometer, a household's monetary WTA would

decrease by 64.464 RMB. As aforementioned, we use distance as a proxy for air pollution. As distance increases, air pollution decreases (Jones et al., 2013). Thus, the negative coefficient for perceived distance means that residents expect less monetary compensation when the air pollution they perceive is lower. Our results also signify that environmental assessment is influenced by perception, and that considering perception factors helps to assess the value of the environment more effectively.

Trust in the company

Respondents' trust in the company appears to have a significant negative impact on monetary compensation. Results suggest that the greater the degree to which respondents trust the company, the less they expect in terms of monetary compensation. The recognition degree of respondents to the EIA report is used to reflect their trust in the company. Thus, the trust indicator reflects residents' subjective judgment of environmental pollution. When residents think that environmental pollution is negligible, or in other words they trust the EIA report, they expect less cash compensation.

Other variables

(a) Income has a significant positive effect on monetary WTA. If a household's total income increases by 1 RMB, monetary WTA increases by approximately 4 RMB. This finding is consistent with prior studies. De Steur et al. (2010) also indicate that richer people expect more ecological compensation than the average amount.

(b) Compared with the mobile population, permanent local residents expect more monetary compensation. Less local knowledge and a lack of sense of belonging may be a possible reason. The study of Kiessling et al. (2017) shows that because there is a large floating population, most of which lacks a master consciousness, the coastal pollution caused by rubbish in Antofagasta is more serious than in other areas.

(c) In addition, our results suggest that respondents who drink a higher proportion of well water expect more monetary compensation. A higher dependence on environmental quality and greater health risks may be a probable reason. To be more precise, the poultry-raising industry may cause water pollution, and people who drink a higher proportion of well water may have a higher health risk caused by the environmental pollution than others. Thus, such respondents expect more cash compensation.

Table 5 Tobit model regarding monetary WTA

Variables	(1)	(2)	(3)	(4)	(5)
Actual Distance					
Distance to the nearest farm	-66.800				
Weighted distance to the nearest farm		-20.064			
Average distance to all the farms			-8.958		
Weighted average distance to all the farms				-12.288	
Psychological factors					
Perceived distance to the farm(s)					-64.464***
Trust in company	-128.662***	-130.175***	-130.723***	-131.165***	-124.600***
Household head characteristics					
Gender of household head	-17.697	-27.050	-25.861	-26.027	-13.626
Age of household head	-0.307	-0.280	-0.212	-0.228	0.509
Education level of household head	4.561	4.275	4.402	4.484	3.076
Health status of household head	-5.937	-1.025	0.043	-1.193	1.554
Living location of household head	431.449**	430.050**	429.768**	429.949**	433.369**
Household characteristics					
Household total income	4.293***	4.236***	4.077**	4.020**	4.219***
Received compensation	-124.045	-115.729	-107.078	-109.114	-157.308
Household size	34.675	33.191	31.067	30.611	35.943
Baby percentage	-9.418	-9.174	-9.103	-9.148	-8.159
Elderly percentage	0.201	0.295	0.274	0.291	0.016
Drinking water from well	2.324***	2.292***	2.163***	2.107***	2.160***
Constant	-24.185	-82.487	-27.594	11.070	-82.709
LR Chi2	38.35***	36.78***	36.52***	36.73***	50.16***
Observations	180	180	180	180	180

Note: *** p<0.01, ** p<0.05, * p<0.1

4.3 Discrete choice experiment

The results from the conditional logit model can be seen in Table 5. The positive sign of the opt-out constant implies that respondents are dissatisfied with the choice sets that we offered and want other options instead. The absolute magnitude of air purification equipment's coefficient is the largest in both groups. This indicates that installing air purification equipment (a 10 million RMB investment) reduces WTA to the greatest extent. Monetary compensation has the expected positive sign, but the effect is relatively weaker than any other nonmonetary compensation.

At each level of attribute, there is a clear separation regarding the way in which the attribute affects the probability of choosing a specific alternative. With regard to the people who accept monetary compensation, the significantly negative sign of employing 20 villagers implies that an alternative that includes the provision of 20 job opportunities is less likely to be selected. Likewise, respondents are more likely to select an alternative that includes air purification equipment, an investment of four or

six million RMB in road construction, an investment of two, four, or six million RMB in school construction, and the provision of 40 or 60 job opportunities.

In a similar way to people who are willing to accept monetary compensation, the results for people who expect nonmonetary compensation show that air purification, school investment, road investment, and job opportunities are all important factors for the selection of a particular alternative, both as a determinant of increases and decreases in social welfare. Moreover, the coefficient magnitude suggests that investing the most amount of money, installing air purification equipment, and providing 40 job opportunities would maximize these people's welfare.

Table 6 Conditional logit model of the choice experiment

Attribute	$WTA_{monetary}$	$WTA_{nonmonetary}$
Opt-out constant	0.373**	0.968***
Monetary compensation	0.005***	0.002***
Air purification	0.989***	1.990***
Road investment two m	0.146	-0.205
Road investment four m	0.350***	0.139
Road investment six m	0.215**	0.289**
School investment two m	0.377***	-0.035
School investment four m	0.209**	-0.425***
School investment six m	0.480***	0.495***
Employment 20	-0.238*	-0.085
Employment 40	0.551***	1.046***
Employment 60	0.634***	1.001***
Observations	5760	4256
Chi2	860.11***	790.16***
R-squared	0.1482	0.1873

Table 7 Marginal WTA for poultry-farming attributes

Attribute	$WTA_{monetary}$	$WTA_{nonmonetary}$
Air purification	-206.819	-1232.093
Road investment two m	-30.435	126.833
Road investment four m	-73.087	-85.776
Road investment six m	-44.932	-178.970
School investment two m	-78.850	21.386
School investment four m	-43.772	263.135
School investment six m	-100.354	-306.276
Employment 20	49.753	52.545
Employment 40	-115.229	-647.835
Employment 60	-132.664	-619.845

WTA is calculated by dividing the coefficients of the attribute by the payment vehicle. To be specific, the marginal WTA for installing air purification equipment is obtained by dividing 0.989 by 0.005 (the coefficient of air purification and monetary compensation in Table 6). An ideal poultry farm, with installed air purification equipment, a four million RMB for investment in roads, a six million RMB investment in schools, and 60 job opportunities would prompt people who accept monetary compensation to reduce their compensation demand of 512.924 RMB per month, which accounts for 27.6% of total family income. An ideal poultry farm, with installed air purification equipment, a six million RMB investment in roads, a six million investment in schools, and 40 job opportunities provides residents who expect nonmonetary compensation with approximately 2365.174 RMB of value per month, which accounts for 74.4% of total family income. In general, air purification is worth the highest for each group.

4.4 Cost and benefit analysis

In order to find out whether it is worth promoting the reconstruction of breeding farms, we conduct a simple cost-benefit analysis. There are 700–1,000 households in each village. We assume that there are 700 households in each village and that 40% have a nonmonetary WTA. Thus, there are 4200 monetary WTA households and 2800 nonmonetary WTA households in total. The upper limit of the company's environmental sustainable development budget is 3 million RMB for each year which accounts for about 0.175% of the company's total asset (about 1.715 billion RMB). The rate is much higher than the national average rate which is about 0.075% (in 2015, the investment completed in the treatment of industrial pollution in China is 77 billion RMB, and the total assets of industrial enterprises in China is 102,339 billion RMB). So we believe the budget of the company is reasonable.

First, we analyze the costs and benefits of installing an air purifier. Since the cost of installing an air purifier is 10 million RMB, the installation of air purifiers on all farms requires a total of 300 million RMB in the first year. Assume that these air

purifiers can work for 10 years (ignoring the asset depreciation rate). For people who are willing to accept monetary compensation, installing an air purifier can produce a utility worth 206 RMB a month each. For those people who prefer nonmonetary compensation, installing an air purifier is worth 1232 RMB a month each. The total utilities are worth 419.8 million RMB to all households (assuming the annual discount rate is 5%). However, it is impossible to invest 300 million to install air purification equipment (ten times the 10 years' budget), even though the benefit is high.

Then, we take one reconstruction program as a case study in order to analyze its costs and benefits. Assume that the reconstruction scheme is a combination of (a) an investment of four million RMB in building roads, (b) a six million investment in schools, and (c) 40 job opportunities in the first year. As shown in Table 7, for people willing to accept monetary compensation, the scheme can produce utilities worth 288 RMB a month each. For those willing to accept nonmonetary compensation, the scheme is worth 1038 RMB a month each. If the scheme can be implemented for 10 years, it can bring utilities worth 400.46 million RMB to all households (assuming the discount rate is 5%). Assuming that providing jobs costs the company nothing, the total costs and benefits of the scheme are 10 and 400.46 million RMB respectively. Given that the company's 10 years budget for environmental improvement is 30 million RMB, this scheme is feasible.

5 Conclusions

Based on micro survey data of 350 respondents living near the large-scale broiler farms of an international food company, the CVM and DCE methods are employed to investigate residents' willingness to accept farms' air pollution. Three main conclusions can be drawn from the results of this study.

First, 42% of respondents have a nonmonetary WTA; thus, the conventional CVM is unsuitable for application to them. Besides, the results of the probit model show that in addition to income, "trust and perception" dominate WTA decision-making; however, the effect of actual distance is weak. Our results also suggest that monetary compensation may not satisfy every household because nearly half are reluctant to accept monetary compensation. These people are characterized by the following features: 1) higher incomes; 2) a low level of trust in the company; 3) a stronger sense of environmental protection; and 4) a greater health-conscious attitude. Because inappropriate compensation measures lead to a waste of manpower and financial resources, and to damage to the company image, the company should take

monetary and nonmonetary compensation measures into consideration simultaneously.

Second, because of the positive externalities of road investment, school investment, and job opportunities, the combination of these nonmonetary options is feasible and beneficial for both sides (the company and households) in the long term. Thus, a broiler-raising company should enhance investment in local public infrastructure. The externality of doing so is significant because investment in local public infrastructure not only helps to enhance the company's brand image; it can also benefit more residents.

Third, our results show that besides income and place of residence, trust and perception have a significant impact on people's expected value of monetary compensation. Thus, enterprises can gain favor among residents by increasing rural greening and organizing friendship activities. These help to decrease household's requirements for monetary compensation.

Beside the analyses above, we also offer some other policy suggestions as follows. With regard to the foreign-funded enterprises that meet emission standards in a host country, governments should act to protect residents' legitimate rights and interests more effectively. The government should try to ensure that local residents have a clear understanding of the company's impact on the surrounding environment. In order to achieve this, local governments should conduct professional testing of environmental pollution and inform farmers of the results. This approach would help to guide residents to evaluate environmental pollution from enterprises correctly and reduce disputes resulting from asymmetric information. Besides, local governments should provide a regular free medical checkup for residents in order to reduce their perceived risks.

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Appendix

Question 1: “Considering the air pollution caused by the broiler farm(s) nearby, could you accept a monthly monetary compensation?” If the answer is “Yes,” 12 alternative answers for the bid value are provided: “*A. 0 RMB; B. 10–50 RMB; C. 51–100 RMB; D. 101–150 RMB; E. 151–200 RMB; F. 201–250 RMB; G. 251–300 RMB; H. 301–350 RMB; I. 351–400 RMB; J. 401–450; K. 401–500; L. (Fill in a specific amount) above 500 RMB.*” If the answer is “No,” there are two alternative answers for the respondents to select: “*M. I accept nonmonetary compensation (fill in a specific nonmonetary compensation measure); N. I accept nonmonetary compensation but am not sure about the specific measure.”*