Metropolitan residents’ willingness to payment and factors affecting low-carbon agricultural products: an empirical analysis on low-carbon vegetables in Shanghai

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Abstract. In this paper, we investigated the willingness of metropolitan residents to pay for low-carbon agricultural products. By developing low-carbon agricultural products, carbon emission would be reduced significantly. Using the contingent valuation method, this paper explored Shanghai residents’ willingness to pay for vegetables with carbon labeling. The results of multiple regression model and logistic regression model are as follows: while 91% of respondents were willing to buy vegetables with carbon labels, they were only willing to pay an additional fee of 6% for low-carbon vegetables. Secondly, gender, education level, awareness of carbon labeling, habits to buy vegetables in a traditional market, large supermarket chains, and community supermarket would significantly affect the respondent’s willingness to buy low-carbon vegetables. Thirdly, family structure, household disposable income, awareness of carbon labeling and habits to buy vegetable in large supermarket chains would significantly affect the respondent’s willingness for an additional pay. It is necessary to increase publicity for promoting the construction of low-carbon agricultural products market. Appropriate channels must be selected for the sale of low-carbon agricultural products because of the effect of vegetation buying habits to “willingness to buy” and “willingness to an additional pay”. Due to the low level of additional payment of low-carbon agricultural products, producers need to reduce production costs of low-carbon agricultural products by developing circular agriculture.

1. Introduction
Food is a daily necessity of human life; a certain amount of greenhouse gases are emitted during every step, namely, production, processing, transportation, selling, etc. For example, carbon dioxide (CO₂) is directly emitted during the production of agricultural machinery, chemical fertilizer, pesticides,
farm equipment (plastic greenhouse). To increase agricultural production, deforestation is being carried out extensively. This indirectly increases CO_2 emissions. According to a study conducted by Vermeulen et al [1], 19–29% of global greenhouse gas emissions come from various processes of food production and consumption. Approximately 47–61% of food-related carbon emissions are associated with agricultural production in China. About 9–18% of greenhouse gas emissions are associated with agricultural production. According to a study conducted by Hu et al [2], the amount of CO_2 emissions rose at an annual average speed of 1.52% from the year 2000 to 2015 in China thanks to increasing agricultural production. According to a paper presented by China’s Climate Change National Independent Contribution (INDC) Program, CO_2 emission intensity would be reduced by 60–65% in China [3] by the year 2030 compared to that in 2005. This paper was formulated and submitted to the Secretariat of the United Nations’ Framework Convention on Climate Change (UNFCCC) by the Chinese Government in 2015. To reduce carbon emissions associated with agricultural production, low-carbon agriculture must be practiced with definite guidelines. With this strategy, reduction targets can be defined for energy-saving emission.

Presently, 525 types of products with carbon labels have been defined in the carbon labeling program of the British government in 2007. According to a corporate responsibility report issued by Tesco in 2011, 59% of respondents purchased low-carbon products [4]. Climate change is a reality today and various campaigns have been held to increase awareness about this issue among the public; a carbon labeling system that reflects carbon footprint of products has been popularized among the public. In a study conducted by the Gallup organization [5], 72% of EU citizens support the carbon labeling system and believe that carbon labels should be mandatory in the future. According to the Information and Product Labeling Economic theory proposed by Cohen and other researchers [6], the main approach of carbon labeling would be to transform “certification” to “search”. With this approach, consumers can make comparisons and more decisions to achieve maximum personal utility. To correct market failures of publicly listed commodities, the product labeling system has to reduce information asymmetry through information disclosure. Similar researches and case studies have been conducted in China and all over the world. These studies have shown that some consumers are willing to pay through the product labeling system to reduce carbon emissions: in the view of product labeling, the Energy Star Labeling Scheme [7] would reduce carbon emissions by 22.1 million tonnes in 2006. According to studies conducted by Ward et al [8], respondents are willing to pay an additional $ 249.82–349.30 for refrigerators that have received the Energy STAR label. Factors such as price, product characteristics, gender, educational background, and income, would affect respondents’ willingness to buy these products. In Xiao Jianhong’s and other research studies [9], ecological labeling of marine ecological products has been conducted. These studies point out that gender, age, educational level, and income would significantly affect the willingness of respondents to pay for “Eco-labeled” marine ecological products. Gadema’s and other researchers carried out a survey of 428 supermarket shoppers in the UK: [10] 72% of people preferred to buy carbon-labeled goods. On the other hand, 89% of people have a relatively low cognitive degree of carbon labeling. Respondents’ preferences for the purchase of low-carbon products are based on the following factors: age, educational level, attitudes towards environmental protection, taste, price, and quality of low-carbon products. Brécard and other researchers [11] performed a study to understand
“eco-labeling parameters” of fish in Europe. Gender, age, education, income, and living areas (urban or rural) would have a significant impact on the demand for Eco-labeling. Ying Ruiyao and other researchers [12] performed a survey to know the willingness and motivation of urban residents to pay for low-carbon agricultural products. The contingent valuation method and comparison method were performed on the data collected from Tianjin, Shandong, and Jiangsu provinces in China. They found that the average willingness of urban consumers in China to pay for pork with low-carbon properties was 7.74 yuan/kg. Consumers would buy food with low-carbon properties based on two motives: altruism motive and self-interest motive. Age, occupation, and income levels would on the whole affect the willingness of urban residents to consume low-carbon agricultural products. Zhou Yingheng and other researchers [13] performed a study in Nanjing province to determine whether urban consumers were willing to purchase low-carbon pork. In this research study, the average consumers were willing to pay 3.95 yuan for low-carbon pork. Consumers’ willingness to pay for products would depend on the following factors: low-carbon pork prices, awareness of low-carbon agricultural products, household income, family population, and level of education. In relevant research studies, questionnaire surveys have been conducted and the data has been analyzed using contingent valuation method and scenario experiment method. This is because carbon labeling or ecological labeling is still not popular in different areas and different regions. In fact, the market of low-carbon products is still in nascent stages of development. Related research studies mainly focus on foods consumed by residents, such as pork, seafood (including fish), and other agricultural products. Very few studies have been conducted on low-carbon vegetables. Most related research studies mainly consider “willingness to buy” as the explained variable, while “willingness to pay” was considered as the explanatory variable. Very few research studies [14] consider both the variables at the same time. This sort of relational-comparative analysis would provide more useful inspirations for market construction.

The willingness to buy (WTB) and the willingness to pay (WTP) for low-carbon vegetable (LCV) were more likely to be influenced by personal characteristics, cognitive degree of carbon labeling, vegetable consumption habits, and other factors. By analyzing the influence of these factors, we can effectively develop LCV market. By comparing the differences between the influencing factors of WTB and WTP, we put forward some suggestions for the establishment of LCV market.

2. Methods
It has been pointed out that per capita energy consumption of urban residents was 3.4-4 times that of rural residents. Moreover, urban residents were well aware of low-carbon products. On the other hand, rural residents were not quite aware of low-carbon products [15]. Therefore, it is more significant to determine low carbon consumption among urban residents. Besides, rural residents mainly purchase vegetables for self-sufficiency; therefore, they purchase few vegetables. It is difficult to build a hypothetical market of low-carbon vegetables. Urban residents usually purchase vegetables, so it is possible to build a hypothetical market of low-carbon vegetables. Therefore, we performed our research study on urban residents.

Shanghai is located in the estuary of Yangtze River (N 31° 14 ', E 121 ° 29 ') in China. Owing to a subtropical monsoon climate summer here is characterized with high temperature and lots of rain. On the other hand, winter has moderate temperature and little rain. The permanent population of Shanghai city was 24,152,700. Shanghai residents have a preference for vegetables, especially green leafy
vegetables. According to statistics in Shanghai Statistical Yearbook, per capita vegetable consumption had an annual growth of 0.38% from 2010 to 2015. Per capita fresh vegetable consumption was 236.83 kg in 2015. Shanghai is a city with high population density, high per capita income, and high consumption of vegetables; it is the biggest metropolitan city in China.

In this study, WTB and WTP for LCV were considered as explained variables. Gender, age, educational qualifications, family structure, cognitive degree of carbon labeling, and personal vegetable consumption habits of respondents were regarded as explanatory variables. To obtain data from research study, we used a questionnaire based on the contingent valuation method. Binary logistic regression model was used to analyze factors influencing residents’ WTB LCV. Multiple regression model was used to analyze factors influencing residents’ WTP for LCV. Then, we compared the connections and differences of the two factors, namely, WTB and WTP for LCV.

The research data mainly takes the questionnaire network as its carrier. The instant messaging software, Wechat, was used to deliver the questionnaire to subjects and obtain requisite results. The sample size was usually 500–1000 for regional surveys. For correlation or causality surveys, sample sizes were usually greater than 30. Our survey was conducted between April 28 and July 4, 2017. During this period, 771 questionnaires were issued but only 759 questionnaires were received; the effective ratio was 98.44%. The questionnaire mainly consisted of four parts: basic information of respondents, cognition of low-carbon agricultural products, willingness to pay for low-carbon agricultural products, preferences, and vegetable consumption habits of residents. To determine residents’ WTP for LCV, we investigated whether they were willing to buy vegetables with carbon labels (WTB) and how much they were willing to pay (WTP) for carbon-labeled vegetables. Table 1 presents basic characteristics of residents included in this survey.

| Basic characteristics          | Classification indicators | Percent (%) |
|-------------------------------|---------------------------|-------------|
| Gender                        | Male                      | 43.74       |
|                               | Female                    | 56.26       |
| Age                           | 18-25 years old           | 12.12       |
|                               | 26-35 years old           | 38.34       |
|                               | 36-40 years old           | 18.84       |
|                               | 41-55 years old           | 24.11       |
|                               | 56-60 years old           | 2.64        |
|                               | 61-65 years old           | 3.16        |
|                               | More than 66 - year - old | 0.79        |
|                               | Junior high and below     | 1.71        |
|                               | Senior high school        | 5.40        |
| Educational level             | Junior college            | 9.88        |
|                               | Undergraduate             | 41.63       |
|                               | Graduate and above        | 41.37       |
| Whether the family has minor | Yes                       | 45.32       |
| children                      | No                        | 54.68       |
3. Results and discussion

3.1. Shanghai residents’ WTP for LCV

Although 91% of respondents had the WTB LCV, their WTP for LCV was limited. Nobody had the WTP more than 50% of extra fees for LCV; more than 85% of respondents were not WTP more than 50% of extra fees for LCV; 67% of residents were WTP 10% of surcharge to buy LCV. The results indicate that the average WTP for LCV was 1.06 standard units, i.e. 6% of the additional WTP.

3.2. Factors influencing WTP based on binary logistic regression model

In this study, regression calculation was carried out with STATA software (Cabit Information Technology Co. Ltd, Shanghai, China). The WTB (whether people are willing to buy LCV) was considered as explained variable and the three influencing factors, i.e. the respondents’ personal characteristics, cognitive degree of LCV, and their vegetable-buying habits were considered as independent variables. Based on the regression model, we conclude that several factors have a
remarkable effect on the WTB for LCV, including gender, levels of education, and cognition of buying LCV. The survey was conducted in vegetable markets, large chain-supermarkets, and small community supermarkets.

More women were WTB LCV than men. Influenced by the traditional social concept of "Men outside, women inside", women played a very important role in household consumption and family life. Compared with men, women were more eager to know about the vegetable production. Compared to men, woman collected information more systematically. Thus, women have stronger WTP for LCV than men. Higher the education level, higher would be WTB for LCV. With an improvement in education levels, people have gained a more profound knowledge of carbon emission and the harm of greenhouse effect. They also have a clearer understanding of how the living environment can be improved immensely with the consumption of LCV. All these factors play a very active role in environmental protection. In general, highly educated people prefer to consume LCV. Moreover, LCV consumption was less in lower-educated people. In terms of cognitive situation, residents who know LCV were obviously more willing to buy it as compared to people who didn’t know about LCV; however, the respondents’ WTP for LCV does not really depend upon their level of understanding low carbon levels. To improve residents' WTB for LCV, it is more important to let more respondents know about vegetables with low carbon label. It is not really necessary to know the exact meaning of carbon labels. Respondents who purchased vegetables from morning markets, large chain-supermarkets, and small community-supermarkets had higher WTB for LCV. This implies that the market value of LCV was higher in these locations. Channels as online and telephone purchase as well as vegetables directly bought from farmers’ hands were less suitable for selling LCV. We conclude that the emerging online to offline (O2O) model and the customer to customer (C2C) model did not suit the selling condition of LCV. In the current phase of economic and urban development, the business to customer (B2C) model was more suitable for the consumption of LCV.

3.3. Factors influencing the willingness to pay extra fees based on the multiple regression model

The price (LOP for LCV) was fixed as an explained variable and other influencing factors, including respondents’ personal characteristics, cognitive degree of LCV, vegetable-buying habits, etc. were considered as independent variables in this study; multiple regression calculation was carried out with the help of STATA software. Regression model results show that several factors have a significant impact on the LOP for LCV. These factors are as follows: minor children, family population, annual disposable income of the family, cognition of LCV, and the habit of purchasing vegetables in large chain-supermarkets.

From the perspective of family structure, families with minor children have lower LOP for LCV consumption. In a family with minor children, education is a major expense. Since higher education is expensive, price allocation for food consumption is limited. Education of minor children is the biggest expense in Shanghai. In some families, direct spending on education accounts for more than half of the total child-rearing expenditure. Besides, families also spend a sizeable amount of money in renting property near the school, which can be considered as indirect costs (immovable property) of education. Thus, the consumption structure of such families also changes dramatically. In case of hypothesized household income, an increasing number of direct and indirect costs of education is bound to affect food consumption choices. Larger the family population, more willing they will be to pay for a higher
level of LCV. This is mainly influenced by the scale of family economy—larger the family size, lower would be the proportion of food consumption in the entire family. Therefore, they are more suitable to raise LOP for LCV. From the perspective of annual disposable income of families, each increase of 10,000 yuan would increase the residents’ LOP for LCV by 0.41%. By increasing the families’ annual disposable income, LOP can be improved for LCV. Families with high income pay for precious commodities. In terms of cognitive situation of low carbon vegetables, residents knowing about LCV obviously have higher LOP than the ones who do not know about it. However, the extent of understanding of low-carbon labels does not affect the respondents’ LOP for LCV. From the vegetable consumption places of residents included in this survey, residents who choose large supermarket chains as their main channel of vegetable consumption have higher LOP for LCV. This implies that if the price of LCV is slightly higher than general vegetables, there would be better sales for low-carbon labeled vegetables at large supermarket chains.

3.4. Empirical results discussion
The results indicate that although the degree of cognition is a mutual factor that affects both WTB and LOP, there are three differences between factors that affect WTB and LOP for LCV.

Among residents in Shanghai, gender and education levels significantly affected WTB for LCV, but they have no significant impact on the LOP of Shanghai residents. This implies that women and residents with high-level of education are more likely to buy LCV, yet the levels of payment (LOP) may not be defined.

Secondly, family situations would greatly affect Shanghai residents’ LOP for LCV, but they have no remarkable effect on their WTB for LCV. This indicates that three factors, namely, families with no minor children, families with a larger population, and families with higher level of annual income, have a higher LOP for LCV. On the other hand, WTB would not be affected by these factors. The characteristics of respondents were divided into two types: personal characteristics and family characteristics; the former ones have an overt influence on WTB, while the latter ones tend to affect LOP to a much greater extent.

Residents who are used to buying vegetables at large supermarket chains have both higher WTB and LOP for LCV. This implies that large-scale chain supermarket is a primary location to promote LCV. Conversely, people who are used to buying vegetables in vegetable markets, morning markets, and small community supermarkets have higher WTB but that of LOP are not as strong as their WTB. The habit of buying vegetables in other sites of the remaining population doesn’t have a remarkable effect on their LOP and WTB. The possible reasons are as follows: the business to customer (B2C) model— is more suitable for LCV consumption; the investigated sample of this model is relatively smaller, which may result in a relatively larger deviation from results.

4. Conclusions

4.1. Main conclusions
By surveying Shanghai residents’ consumption of LCV, this study explores Shanghai residents’ WTB and LOP for LCV. Then, the influencing factors of their WTB and LOP were analyzed using the binary logistic model and the multiple regression model. The main conclusions are as follows:
Shanghai residents have a certain degree of WTB for LCV, but their LOP is not high. In this study, 91% of respondents are willing to buy vegetables with carbon labels, but their average level of willingness to pay is only 1.06 standard units. In other words, they are willing to pay 6% additional fees for LCV.

Many factors influence Shanghai residents’ WTB and LOP for LCV. There are both connections and differences between these factors:

(1) The degree of cognition affects their WTB and LOP simultaneously, and it has the same direction of function; (2) personal characteristics, such as gender and levels of education, etc. have a significant influence on their WTB but have no effect on their LOP. Conversely, family characteristics, such as family population, whether the families have minor children or not, and the amount of household disposable income, have a significant influence on their LOP, but they have no effect on their WTB; (3) people who are used to consuming in large supermarket chains have overt WTB for LCV and higher LOP, while those who consume in vegetable markets or morning markets as well as small community supermarkets have higher WTB.

4.2. Future works

Low-carbon lifestyle was popularized and carbon emission was reduced by promoting the consumption of LCV. Related market guidance and policies were drafted with respect to the following three aspects: the first step was to gain good publicity for low-carbon agricultural products, including LCV in an effort to increase the cognitive degree of low carbon agricultural products among residents, which will continue to improve their WTP and LOP. The second one is to take the large supermarket chains as primary and principal channel to promote the consumption of LCV. At the same time, conventional markets, morning markets and small community supermarkets, etc., should be considered as important channels that promote its consumption by enlarging the coverage of consumers. To realize the production of LCV, strive to develop recycling agriculture and other modes of agricultural production. All of these will, in turn, take an effective control of its cost, thereby changing the production means that only depend on chemical fertilizers and pesticides and avoiding the increase of cost associated with the reduction of output.

In this study, e-questionnaire was adopted in the questionnaire survey process. Limited by the transmission route of the e-questionnaire, the sample’s regional distribution is uneven. Hence, further research can be completed by performing a more targeted supplemental study on the spatial equilibrium distribution of sample collection.

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