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Trade-offs between Shopping Bags Made of Non-degradable Plastics and Other Materials, Using Latent Class Analysis: The Case of Tianjin, China

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Abstract

Tianjin, China's fifth largest city, suffers from severe environmental problems due to a high prevalence of plastic bag usage. This problem occurs in China's other major cities as well. On June 1, 2008, a law requiring large retail stores in China to charge for bags was enacted in an attempt to curtail plastic bag consumption. As a result, many plastic bag manufacturing plants were closed. However, because of the wide-spread usage of plastic bags, they are still being manufactured and consumed. It is possible that the current plastic bag cost of 0.3 CNY is too low to change customers' consumptive behavior. The purpose of this study is to explore people's attitudes regarding the substitution of plastic bags with bags made from alternative materials, and their willingness to pay for such substitutes. This study used a conjoint choice experiment to measure Tianjin residents' preferences for degradable and non-plastic materials bags. The results show that most people do not like non-degradable plastic bags and would use bags made of other materials if they were sold at a reasonable price. Based on the latent class and socio-demographic segmentation results, there are preference distinctions among age groups. Also, there are niche markets for paper, cloth, and degradable plastic bags where costs are of a lesser concern in consumer decisions. Manufacturers can use this information to more efficiently manufacture appropriate bags for different markets. This will help maximize revenue while continuing to meet demands.

Keywords: white pollution, plastic bag ban, conjoint choice experiment, willingness to pay, latent class analysis, China, degradable plastics, cloth, paper

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Introduction

Pollution from the over-use of plastic bags is extremely damaging to the environment. These bags are costly to recycle, pose a danger to wildlife and take over 300 years to photo-degrade in a landfill. Plastic bags first came into use in the developed world during the 1980s. Now a worldwide problem, they have become very popular with consumers in developing countries, as they are cheap, strong, lightweight, and functional. Users perceive them as a clean way of carrying food and other items (Worldjute.com). It has been estimated that around 500 billion plastic bags are used worldwide every year. Only about one in 200 of these is recycled. Discarded plastic bags produce numerous harmful effects. They release toxins into the environment, stay in landfills for hundreds of years while breaking down, and they get into our food supply when animals ingest the plastics. Furthermore, the toxic chemical ingredients needed to make plastic produce pollution and the energy needed to manufacture and transport the disposable bags creates additional greenhouse gas emissions.

As knowledge of environmental pollution grows, prohibiting or discouraging the use of plastic bags has become a global imperative. As early as 1994, a number of countries began introducing legislation to ban the use of plastic bags. France unanimously passed a law in 2005 to ban all non-biodegradable plastic bags by 2010 (Environment Daily 1962, 2008). In 2006, Italy also passed a similar law banning the use of non-biodegradable bags. In densely populated Hong Kong, the government promoted a hugely successful 'No Plastic Bag Day' campaign in 2006. Participating retailers recorded an over 40% decrease in plastic bag usage (China Daily 2006). On March 28, 2007, San Francisco's City Council became the first U.S. city to ban the use of plastic bags at large supermarkets (Nzherald.co.nz. 2007).

In China, home to one-fifth of the world's population and a fast growing economy, the consumption of plastic bags per capita is expected to grow exponentially in coming years. Unless China begins to curtail its widespread consumption or finds alternative to plastic bags, the worldwide environmental implications could be devastating. There are a number of remedial measures, which could be taken to offset consumption of plastic shopping bags. These include: reusing plastic bags, choosing biodegradable alternatives, or using reusable cloth or paper bags (Googobits.com 2009).

Background

Thin plastic bags are commonly used in China. In 2007, China's supermarkets reported consumption of 50 billion plastic bags (China Packaging Industry 2008). They are so common that the sight of plastic bags everywhere has led to the creation of the phrase *bai se wu ran*, or "white pollution", due to the most common color for plastic bags. Plastic bags are made from petroleum, a non-renewable resource. According to a survey by the China Plastics Processing Industry Association, manufacturing one billion super-thin sacks per day for one year requires 37 million barrels of oil (Zaleski 2008). To prevent this white pollution, the Chinese government has launched a campaign to slow down demand for plastic bags. Since June 1, 2008, China has banned the production of super-thin plastic bags (defined as less than 0.025 mm or 25 microns thick) and has banned supermarkets and larger retailers from giving out free plastic bags (Notice of the State Council on limiting production, sales and use of plastic bags, 2008). It is predicted that the ban will effectively drop consumption by two-thirds (Sohu.com 2008). However, some experts argued that the prediction is far too optimistic because shoppers are still willing to pay for them at the current price of 0.3 Chinese Yuan (CNY) per bag. This is very cheap, considering that cloth bags can cost as much as 3.0 CNY. Additionally, the price demand for plastic bags is quite inelastic. According to Dr. Atiq Rahman, Director of the development think tank Bangladesh Center for Advanced Studies, “The trouble is [that] the plastic bag has become an integral part of life. We have learned [from Bangladesh’s experience] that to say absolutely no to them is not an option. Most supermarkets and small shops now use paper bags, but there is still a demand for the very flimsy, thin plastic ones.” (Vidal 2008). Experiences from Bangladesh and other countries show that charging for plastic bags and banning production might not totally stop the use of plastic bags. Furthermore, the ban also creates negative economic consequences. China’s largest producer, Huaqiang Company, has already discontinued all manufacturing operations and closed down many small factories which produce plastic bags, resulting in the lay-off of many employees (SolveClimate.com 2008). Critics of banning plastic bags question whether substituting with bags made out of biodegradable or other materials will ever deliver net substantial environmental, social or economic benefits. However, perhaps with information on consumer willingness to pay for alternative-material bags, entrepreneurial bag manufacturers could be attracted to lessen the economic upset created by a ban on free plastic bags. Clearly, if 1.3 billion Chinese people continue to use plastic bags on a regular basis, there will be dire consequences on China’s environment, as there already is in the major cities of Beijing, Shanghai, Guangzhou and Tianjin. Actions must be taken to reverse this destructive trend, before its impacts become irreversible.

Objectives

The objective of this study is to determine consumer preferences for shopping bags made from alternative materials and to determine the tradeoffs among the important purchasing attributes for the purchaser of these alternative-material bags. Specifically, these research objectives are: (1) to evaluate the attributes of shopping bags which are important to consumers, (2) to determine the socio-economic demographics which might affect their buying preferences, and, (3) to discuss the results and marketing implications. To accomplish the objectives, a survey was conducted to ascertain consumer preferences for bags made of alternative materials and to see which combination of price and other bag attributes are preferred by consumers. This information can assist the manufacturers in producing more environmentally acceptable, yet still profitable bags. To accomplish the objectives of the study, we: (1) developed a conjoint choice experiment survey to collect data on consumer preferences, (2) conducted the survey and collected data from several markets in Tianjin, (3) analyzed the data with latent class method and, (4) made conclusions and examine the implications.

Method

In this study, we used a Conjoint Choice Experiment (CCE) to find out Tianjin consumer preferences for different types of shopping bags. The following paragraphs summarize previous studies using CCE and describe how the design of the CCE was developed.

Conjoint Choice Experiment (CCE)

We used a conjoint choice experiment for this study. The CCE technique was initially developed by Louviere and Woodworth (Louviere and Woodworth 1983). As an empirical method, CCE originated in market research and transportation literature and has only relatively recently been applied to other areas, such as the environmental studies discipline (Hensher 1994). Since the mid-1990s CCE has been increasingly applied to various environmental problems. It has been used for valuating environmental amenities such as recreational moose hunting in Canada (Adamowiczet al., 1994; Boxall et al., 1996), woodland caribou habitat enhancement in Canada (Adamowicz, et al. 1996), preferences for deer stalking trips in Scotland (Bullock, et al., 1998), and remnant vegetation in Queensland (Blamey et al. 1999). A summary of environmental applications is given in Hanley, Mourato, and Wright (Hanley et al., 2001).

The CCE technique is based on the idea that any good can be described in terms of its attributes or characteristics, and levels of these attributes. In our case, the attributes of alternative materials shopping bags are: costs, materials used to make the bags, number of times a bag can be reused, and the length of time it takes a bag to degrade naturally in the environment. The potential impacts from changing these attributes might influence purchasing decisions. Using CCE can tell us which attributes are significant determinants of the values people utilize when purchasing shopping bags. This information also tells us their willingness to pay for bags made with alternative materials. With this information, bag manufacturers can decide whether it is profitable to make bags using alternative materials instead of plastic.

Why Choose the Conjoint Choice Experiment (CCE)?

This study was conducted through a survey of Tianjin residents (approximate population 10 million) in China using a conjoint choice experiment method to elicit willingness to pay for alternatives to plastic bags. A conjoint choice experiment approach directly asks for respondents' preferences based on a set of structured survey questions. The approach measures the value of environmental goods and services by asking about hypothetical scenarios and their valuations such as alternative bag materials and shorter times for a bag to degrade in nature.
A relatively new concept in environmental valuation, a conjoint choice experiment is an evolved form of the more traditional conjoint analysis introduced in the 1980's. While the traditional conjoint analysis presents all the choices to respondents at one time, in conjoint choice experiment models, respondents typically are asked to evaluate two profiles at a time with varying levels on each attribute. It then asks the respondent to pick the profile that they would most prefer from that set (Chan-Halbrendt et al. 2007).

Experimental Design of CCE

Table 1 shows the design stages of a CCE (Cattin and Wittink 1982; Green and Wind 1975; Halbrendt et al., 1991).

Table 1. Design and Estimation Stages for a Conjoint Choice Experiment

Stage	Description
1 Selection of attributes	Selection of relevant attributes related to purchasing shopping bags. This is done through expert interviews and literature review. The interviews also help to identify the possible environmental impacts (attribute outcomes) important to respondents associated with using bags made of different materials, as well as the monetary cost of the bag.
2 Assignment of attribute levels	After identifying the important attributes, the range of each attribute is determined through literature review and expert interviews. The levels should be realistic, practically achievable, and span the range over which we expect respondents to have preferences.
3 Choice of experimental design	Statistical design theory is used to combine the levels of the attributes into a number of alternative program profiles to be presented to respondents. Depending on how many choice sets and/or profiles are included in the experiment, one can have either complete or fractional factorial designs. In our case, we have a fractional factorial design to reduce the number of attribute level combinations while allowing the efficient estimation of the effects of the individual attributes ('main effects').
4 Construction of choice sets	Using a software program, the profiles identified by the experimental design are then paired and grouped into choice sets to be presented to respondents. In our study we used a program purchased from Sawtooth Software, Inc.
5 Method of collecting preference data	Choice of administering the survey either by face-to-face interviews or by mail surveying is dependant on the complexity of the topic and project budget. This study chose face-to-face interviews as this survey approach is better for enhancing respondents understanding.
6 Data estimation	Decide on the choice of the estimation method to achieve project objectives. One can use traditional logit analysis or latent class approach. In our study, we chose a latent class approach, as we believe this is a more appropriate estimation tool when dealing with people generally of heterogeneous backgrounds.

Literature reviews and interviews were conducted in order to identify the important attributes consumers consider when substituting plastic bags and the levels of those attributes. Literature reviews involved reading papers in the relevant field and searching information on the Internet. In-depth interviews involved discussion with randomly selected residents. The first step of our CCE design was to find the product attributes and levels. Studies such as Tang et al., (Tang et al. 2003) and Wang and De (Wang and De 2008) have shown that attributes such as materials, costs, number of reuse times, degradable period and extent of damage to the environment are important factors for consumers when they make their shopping bag choices. After an extensive literature review and interviews, the four most important attributes selected were: (1) type of material used to make the shopping bags, (2) cost of a single, medium sized bag (which holds approximately 6 kilograms) (3) number of times the bag can be reused, and (4) how long it takes for the bag to degrade naturally in a landfill. The rationale for these attributes was as follows:

1. *Material*. Through the literature review (Tang et al., 2003) and direct observation in the city, we have decided on four types of material: non-degradable plastic, degradable plastic (distinguished from non-degradable bags by a logo), paper, and cloth.

2. *Cost.* Cost is a vital economic factor that often affects consumer decision making. When deciding on the levels of this attribute, the researchers collected the prices of plastic, paper, and cloth bags from many large supermarkets and retail stores. The average price per bag ranged from 0.3 to 3.0 CNY. Supermarkets in Tianjin currently charge 0.3 CNY for a medium-sized plastic bag. A cloth bag of comparable size costs 3.0 CNY, and a paper bag costs about 1.5 CNY. Thus, the levels used for this study are 0.3, 1.5 and 3 CNY per bag.

3. *Number of times a bag can be reused.* The levels of this attribute were determined by randomly interviewing 30 consumers in Tianjin city. Interviewers asked random consumers how many times they use each kind of bag (non-degradable and degradable plastics, cloth, and paper) before they throw it away, and the answers were mostly 1, 5 and 30 times. For this study, the levels selected were 1, 5, and 30 times.

4. *Degradation time for bag materials*. How long it takes a certain material to degrade was identified as an important environmental attribute through the literature review. Degradable plastics, paper and cloth degrade in the natural environment between 45 to 90 days (Tang et al. 2003). Non-degradable plastics take a much longer time to degrade. Therefore, the chosen levels for this attribute were: 0.125, 0.25 and 100 years (representing long term persistence).

Table 2. Attributes and Their Levels

Attributes	**Levels**			
Material	Non-degradable plastics	Degradable plastics	Cloth	Paper
Cost/bag (CNY)	0.3	1.5	3	
Times to reuse	1	5	30	
Degradation (year)	0.125 (1.5 months)	0.25 (3 months)	100 years	

The third and fourth stages of designing the CCE involve choice of experimental design and construction of interview questions to be presented to survey respondents. Program profiles are constructed by selecting one level from each attribute and combining across all attributes. In this study, there are four attributes, of which one has four levels (bag material), and the rest have three levels each. Thus, the number of possible profiles totaled 4x3x3x3 or 108. A complete factorial design would use all the 108 profiles, which is undesirably difficult for respondents to evaluate. Instead, a fractional factorial design was utilized. A fractional factorial design is a sample of attribute levels selected from a full factorial design without losing information, to effectively test the effects of the attributes on respondent's preference (Halbrendt et al. 2007). The most commonly used method of constructing fractional factorial design in conjoint measurement is the orthogonal array. Orthogonal arrays build on Graeco-Latin squares by developing highly fractionated designs in which the scenario profiles are selected so that the independent contributions of all main effects are balanced, assuming negligible interactions (Green and Wind 1975). This study constructed different profiles based on degrees of freedom requirements to estimate all of the main effects within the orthogonal design (Louviere 2000). From all possible profiles, pairs of profiles were randomly developed and separated into 7 sets with 12 pairs each using software developed by Sawtooth, Inc. Having only 12 pairs to evaluate from ensure the duration of the surveying exercise does not adversely impact a respondent's responses.

For data collection, the designed experiment was carried out. All seven sets were administered in approximately equal proportion (i.e. each set to about 30 of the 205 respondents). Respondents were then presented with one set of 12 pairs of profiles from which to make their choices. The experiment requires respondents to choose one product profile from each pair. Table 3 shows an example of a pair of product profile scenarios from which the respondents chose.

Table 3. Example of a Pair of Product Profile Scenarios

Attributes	Program A	Program B
Material	Non-degradable plastics	Cloth
Cost/bag (CNY)	0.3	3.0
Number of Times to Reuse	5	10
Degradation Period (year)	100	0.25 (3 months)

Data Collection

Survey Location

Tianjin is a modern industrialized city typical of Chinese urban areas. International tourist influence is less than in other metropolitan cities such as Beijing and Shanghai. The survey was conducted mainly in supermarkets and vegetable and fruit markets, and respondents consisted of a random selection of Tianjin residents.

Table 4. Survey Locations and the Respective Sample Size

District, City of Tianjin	Survey Location	Sample size
Nankai	Renrenle Supermarket	30
	Good Harvest Supermarket	30
Hebei	Carrefour Supermarket	30
	Vanguard Supermarket	28
	Milan Supermarket	27
Heping	Vegetable Market	30
Hedong	Vegetable Market	30
Total		**205**

Sample Population

Two hundred and five surveys were completed during 11 days from June 10th to June 20th, 2008. Every fifth person was selected to conduct the face-to-face interview. As almost everyone has experience using a shopping bag and has basic knowledge of the different bag materials, it was not difficult to explain our experiment and administer the survey. Table 5 shows the socio-demographics of respondents as compared with the Census data of Tianjin residents. In the survey, about 60.5% of the respondents were female and 39.5% were male, whereas the general population Tianjin is 49.6% female and 50.4% male. The gender distribution of the respondents has more females and does not exactly match the demographic characteristics of Tianjin. There were also more young respondents in the sample. Generally, in China, women and younger people shop more than men and older people. The household income of respondents is somewhat similar to the household income of Tianjin residents. Forty-eight percent of the respondents have a monthly household income less than 3,000 CNY, thirty-one percent have a monthly household income between 3,000 to 5,000 CNY, and twenty percent of the respondents have a monthly household income over 5,000 CNY. In comparison to the educational background of Tianjin residents, the respondents have the following training: Proportions of respondents possessing an elementary school diploma (19.0%) and junior high school diploma (31.7%), matched the demographic characteristics of the Tianjin population, while more respondents had high school diplomas (48.8%) and less had a college degree or above (0.5%). Typically more educated people do less shopping for food and dry goods for daily consumption. Overall, the survey respondents are shoppers from different socio-demographic background and in most instances matched well with Tianjin residents' profiles, except that they are younger and more respondents have a high school education.

Table 5. Socio-demographics of Survey Respondents and Tianjin Residents.

		Survey Respondents (%)	**Tianjin residents (%)**
Gender	Female	60.5	49.6
	Male	39.5	50.4
Age*	16-29	41.9	25.4
	30-39	20.0	17.4
	40-49	17.1	21.8
	50 and over	21.0	35.4
Income	<￥3，000	47.8	40.0
	≥￥ 3，000 to <￥5，000	30.7	40.0
	≥￥ 5，000	21.5	20.0
Education	Elementary school diploma	19.0	21.9
	Junior high school diploma	31.7	37.7
	High school diploma	48.8	21.9
	College degree and above	0.50	14.1

*People under 16 were not interviewed because they are still in secondary school.
Source of Tianjin resident's data: Tianjin Census Book 2007 (ISBN 978-7-5037-5127-1/F 12427)

Sample Size

Based on an analysis of 21 CCE studies, Orme, (2006) concluded that increasing the number of choice sets for each respondent can obtain statistical gains similar to a greater number of respondents. Thus, Orme (2006) recommends that a general sample size range from 150 to 1,200 respondents. This study is based upon 205 surveys, which are within the range recommended by Orme's study, and each respondent was provided with 12 choice sets from which to choose.

Survey Instrument

The survey questionnaire consisted of two sections. Section one was the set of 12 pairs of shopping bag profiles from which respondents choose. Section two consisted of questions regarding the respondents' socio-demographic and economic background such as age, income, education and other characteristics. Section one data provided the attribute-specific preferences. The data was analyzed using latent class analysis software Latent Gold Choice, Version 4.0 developed by Statistical Innovations Inc.

Survey Technique

Data were collected using face-to-face interviews. To establish a minimum level of knowledge on the issue prior to conducting the survey, a brief description of the law banning plastic bags and its potential impacts was read to every respondent regardless of her/his knowledge of the law and its environmental impacts. Each respondent was then given 12 pairs of product profiles with differing levels of attributes and asked to select one from each pair. The response rate for the survey was 80%.

Conjoint Choice Model Using Latent Class Analysis (LCA) Approach

Conjoint choice method using latent class analysis is an improvement on the traditional (i.e. one class) aggregated model. The standard aggregate model generally suffers from violations of the independence of irrelevant alternatives (IIA) problem, which distorts the predictions of market niches. Latent classes account for the different segments with different utility preferences and IIA holds true within each segment. This resolves the problem and improves market niche predictions. (Vermunt and Magidson 2000).

LCA is used to evaluate respondent choice behavior by capturing both observable attributes of choice and unobservable factors found in the heterogeneity of individuals' behavior (Greene and Hensher 2003; Milon and Scrogin 2006). In other words, respondents are placed into distinct classes (groups) based on their choices when answering the conjoint choice experiment questions. In LCA studies, the probability of making a specific choice among a pair of product profiles is based on the perceived value of product attributes, and covariates of respondents (such as respondent's age and income) (McFadden 1974). The value respondents placed on product attributes and respondents' socio-demographic factors were major factors evaluated in this study. In a conditional logit model, the probability (Pni) that individual n chooses profile i can be represented by the following equation (McFadden 1974):

$$(1) \qquad P_{ni} = \frac{\exp(\eta X_{ni})}{\sum_{h=1}^{I} \exp(\eta X_{nh})}$$

Where η denotes a scale parameter, usually normalized as 1.0. X_{ni} is the deterministic component that is assumed to be a linear function of explanatory variables. Equation (1) can be represented as equation (2) for LCA:

$$(2) \qquad P_{ni} = \frac{\exp(\eta \beta Z_{ni})}{\sum_{h=1}^{I} \exp(\eta \beta Z_{nh})}$$

Where Z_{ni} are explanatory variables of X_{ni}, including a profile-specific constant, product attribute of profile i, and socio-demographic factors of respondent n. β is a vector of estimated parameter coefficients.

In a latent class analysis, respondents are sorted into M classes (groups) in terms of individuals' choice of observable product attributes, and the unobservable heterogeneity among the respondents. The value of estimated parameter coefficient β is different from class to class because this parameter coefficient is expected to capture the unobservable heterogeneity among individuals (Greene and Hensher 2003). Then the choice probability of individual n belong to class m (m = 1, …, M) can be expressed as equation (3):

$$(3) \qquad P_{ni\,|\,m} = \frac{\exp\left(\eta_m \beta_m Z_{ni}\right)}{\sum_{h=1}^{I} \exp\left(\eta_m \beta_m Z_{nk}\right)}$$

Where η_m is the class-specific scale parameter and β_m is the class-specific estimated utility parameter.

The first step of the latent class analysis was to determine the optimal number of distinct classes for the dataset. Using the Bayesian Information Criterion (lowest BIC value for best results) first proposed by Schwartz (Schwartz 1978), it was shown that the five-class model was needed to provide the best grouping for the dataset.

Results

LCA Model Specification

The probability for individual n in class m choosing shopping bag i is measured by two types of characteristics: (1) shopping bag attributes, including cost (C), bag materials (M), number of reuse times (T) and time it takes to degrade naturally (D); and (2) individual socio-demographic factors, including age (A), gender (GE), household income (HI), education (ED) and household plastic bag consumption per week (CO). The preference model is specified in equation (4).

$$(4) \qquad P(i) = f\,(C, M, T, D, A, GE, HI, ED, CO)$$

where:

P (i) = Probability of choosing product profile A vs. B,

C = Shopping bag cost, taking values of 0.3 CNY, 1.5 CNY, or 3.0 CNY.

M = Types of materials, biodegradable plastics, degradable plastics, paper, and cloth.

T = Number of reuse times, taking values of 1, 5 and 30.

D = Time it takes for the material to naturally degrade, taking the values of 1.5 month, 3 months, and 100 years.

A = Age group: 16 to 18, 19 to 29, 30 to 39, 40 to 49, 50 and above.

GE = Gender: Male or Female.

HI = Household income group (per month) : <3,000 CNY, 3,000 to 5,000 CNY, and > 5,000 CNY.

ED = Educational attainment group: elementary school diploma, junior high school diploma, high school diploma, bachelor degree and above.

CO = Plastic bag consumption per week, per household: <10, 10 to 20, and >20.

Latent Class Analysis

The results in Table 6 show the estimated parameters, signs and their significance levels for each class. Of the four attributes shown, the significant attributes that determined the bag choice for

Table 6. Parameter Estimates of the Five Classes

Attributes	Class 1	Class 2	Class 3	Class 4	Class 5
Material					
Cloth	0.1483	-0.0064	1.3825**	0.4491*	-0.0624
Degradable plastics	0.2626**	0.6057**	0.0947	0.0918	-1.1506
Non-degradable plastics	-0.2565*	-0.7898**	-2.9304**	-0.9790**	-0.9627
Paper	-0.1544	0.1905	1.4533**	0.4381	2.1756**
Cost	-0.0971*	-0.1378	-0.1642	-0.6943**	-2.8350**
Reuse Times	0.0016	0.0442**	0.0100	0.1278**	0.0470*
Degradation	-0.0040**	-0.0445**	-0.0120**	-0.0117**	-0.0131

* significant at 0.05 level, **significant at 0.01 level.

Class 1 are degradable plastics (+ sign) and non-degradable plastics (-), cost (-) and degradation period (-). Therefore, Class 1 respondents prefer bags made of degradable material, lower cost, and less time for the material to degrade naturally. These signs are expected and significant at the 0.05 or 0.01 levels. For Class 2, the significant attributes found in this group are degradable (+) and non-degradable plastics (-), reuse times (+), and degradation period (-). Again, the signs are expected and they are all significant at the 0.01 level. Cost has the expected negative correlation in this class, but was not significant. Class 2 respondents prefer degradable plastics and bags that can be used many times, and do not prefer non-degradable plastic bags that take a long time to degrade. Cost and bags made of either cloth or paper are not important for this group. For Class 3, the significant attributes are cloth (+), non-degradable plastics (-), paper (+), and time it takes to degrade (-). These parameters are all significant at the 0.05 level. In Class 4, all parameters except for degradable plastics and paper are significant and have the expected signs. Class 5 respondents do not prefer high cost (-). They prefer paper (+), and higher number of times the bag can be reused (+). These parameters are significant at the 0.05 or 0.01 level.

A relative attribute importance (RI) test for all the attributes was calculated to determine their rankings within each class (Table 7). Calculating the relative importance of different program attributes is a way to examine the weight the public places on each attribute. In this case, the RI of the four program attributes, Cost (C), Type of Material (M), Number of Reuse Times (T), and Time it takes to Degrade (D), was examined for each class. The methodology of estimating the RI is detailed in the article by Halbrendt et al (1995).

Denote *i* as an attribute, and the relative importance of attribute *i* (RI_i) is measured by the ratio of the range of utility change estimates of different levels of the attribute *i* (UR_i) over the sum of such ranges for all attributes of the product $\sum UR_i$

$$RI_i = 100 \times \frac{UR_i}{\sum_{i=1}^{n} UR_i}$$

where, RI_i is the relative importance of attribute i, UR_i is the utility range of attribute i.

Table 7. Relative Importance of Each Class in Percent and Significant Socio-demographics

Program Attributes	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Material	42.29%	18.62%	69.36%	17.46%	24.36%
Cost	21.35%	4.97%	7.02%	22.91%	56.05%
Times	3.67%	17.10%	4.6%	45.32%	9.98%
Degradation	32.69%	59.31%	19.02%	14.31%	9.61%
Significant Socio-demographics	All ages except 40-49	Ages 16-18	Not significant	Ages 40-49	Not significant
% of Respondents	30.30	26.60	19.10	16.24	7.76

Respondents in the same class share similar utility, however, each class put different weights on each attribute. In order to find out the respondent characteristics of each class, we evaluated the significant socio-demographic information according to the classes. The only significant demographic variable is age, which is so for three out of the five classes. This signifies that age has a large influence on consumer preferences for shopping bag attributes. Below is the summary of the results of each class by attribute importance and age.

Class 1 is the largest group with 30.30% of the respondents. Respondents in this group are less likely to be between ages of 40-49. This is the *'degradable plastics'* group. They prefer degradable plastic bags, favoring materials (42.29% relative importance), which degrade quickly and are low cost (21.35%).

Class 2 is the environmentally conscious, *'idealist'* and younger age group, with 26.59% of the respondents. The respondents from this class mainly come from residents aged between16-18 and they place a significant weight on how long it takes for the bags to degrade naturally in a landfill (59.31% relative importance) with little regard to cost (4.97%).

Class 3 places the type of material as the most important decision attribute, with 19.10% of the respondents. Respondents in this class place about 70% of the weight on the type of material used to make the bags. They prefer paper and cloth bags and are generally less concerned with the number of times the bags can be reused or the cost of the bag. This is the *'no plastics'* group.

Class 4 has 16.24% of the respondents. Respondents in this class are between ages 40-49. They are the *'practical'* consumption group who care much about the number of times the bags can be reused (45.32% relative importance). They also place importance on the cost (22.91%). The consumers in this group generally are the principal wage earners in their families. This group shops frequently and prefers cloth bags, which can be reused numerous times.

Class 5 is the *'cost conscious'* group, with 7.76% of respondents. Cost is the most important attribute of their choice (56.05% relative importance), followed by the type of material used to make the bags (24.36%). They prefer paper bags and care less about the degradation time (9.61%) and reuse times (9.98%) of the bags.

Valuation of Alternative Materials Used to Make Environmentally Friendly Bags using Expenditure Equivalent Index (EEI)

One of the purposes of this study is to examine respondents' willingness to pay for alternative materials, which would have environmental and economic implications. Holding other attributes and their levels constant while independently changing the significant bag materials for each class, the expenditure equivalent index (EEI) of this attribute can be estimated. EEI is used to measure the change in price corresponding to the change in product attribute, which in this study is the bag material (Payson, 1994).

This study uses equation (5), which was developed by Payson (1994), to calculate the EEI of alternative materials for the five classes.

$$EEI_j = 1 - \frac{\sum_{j=1}^{J} \beta_j B_j}{\theta C} \qquad (5)$$

Where, β_j is the estimated parameter for the attribute j, B_j is the change of the levels in the attribute j, θ is the estimated parameter for cost, and C is the base level of cost. In this case, the base level of cost is 0.3 CNY, which is the cost of non-degradable plastic bags. Using the baseline as a comparison, the EEI shows the proportional changes in respondents' average willingness to pay (WTP). Thus, a respondent's WTP for alternative materials, which have corresponding environmental implications, can be calculated by multiplying the EEI with base cost of 0.30 CNY. The results are presented in Table 8.

Table 8. WTP for Shopping Bags Made with Alternative Materials to Non-degradable Plastics

Attributes	**Class 1**		**Class 2**		**Class 3**		**Class 4**		**Class 5**	
	EEI	*WTP*	*EEI*	*WTP*	*EEI*	*WTP*	*EEI*	*WTP*	*EEI*	*WTP*
Non-Degradable Plastics (Base case)	1.00	0.30	1.00	0.30	1.00	0.30	1.00	0.30	1.00	0.30
Degradable Plastics	10.01	3.00	15.65	4.70	--	--	--	--	--	--
Paper	--	--	--	--	30.50	9.15	--	--	3.56	1.07
Cloth	--	--	--	--	29.07	8.72	3.16	0.95	--	--

Note. -- means that WTP was not calculated as the parameter for this material in the specific class was not significant.

The baseline bag used for EEI calculation is the current non-degradable plastic bag at 0.3 CNY per bag that can be reused 3 times, and takes a long time to degrade. The table shows that Class 1 and Class 2 are willing to pay more for degradable plastic bags, Class 3 and Class 5 are willing pay more for paper bags, and Class 3 and Class 4 are willing to pay more for cloth bags. The table also shows that for degradable plastic bags, the range of additional WTP per bag is from 3.0 to 4.7 CNY. For cloth bags, the range of WTP is from 0.95 to 8.72 CNY, and for paper the WTP range is from 1.07 to 9.15 CNY. The WTP range is largest for paper, followed by cloth and then degradable plastics, which has a much smaller range. Class 3, the *'no plastics'* group, stands out as the group of respondents that are willing to pay a lot for cloth and paper bags. Since the degradable plastics material is not significant in this class, it be can considered that respondents in this class do not care for plastics whether they are degradable or not. Also, it appears that certain consumers are willing to pay at least 1.0 CNY more for cloth or paper bags. Finally, degradable plastic bags are quite popular with a large segment of the population, as 56% of the respondents are willing to pay between 3.00 to 4.7 CNY more per bag. From these results, manufacturers can compare the WTP with their own production costs to decide which alternative materials would be best for producing an environmentally friendly bag, while also targeting the right market and continuing to make a profit.

Conclusions

The results of this study can provide crucial information to bag manufacturers and marketers, who should capitalize on the market information provided to maximize their revenues. Specifically, the age factor has a large influence on consumer preferences for the type of shopping bags Chinese consumers buy or use. As a producer and marketer of bags, it might be a good strategy to discover where the different age groups shop. Large modern shopping malls are often frequented by the younger generations, who, according to this study, clearly prefer biodegradable plastics. For a majority of the respondents, cost was negatively correlated, as was expected. Thus, it is crucial for bag manufacturers who produce for large markets to be cost conscious, although it should be noted that some consumers might be willing to pay more if the bags are made of an environmentally friendly material. When thinking about producing bags using alternative materials, bag manufacturers should gauge the willingness to pay generated from this study against their production costs structure.

The implications of the results clearly emphasize the need to find a substitute for non-degradable plastic bags, particularly in light of the current ban on giving out free plastic bags at large retail stores. Due to the distinct characteristics of plastics (water-proof, easy to carry, etc), many people will choose degradable plastic bags as a replacement. For others, cloth or paper bags are a consideration. In fact, as cloth bags can be made from a wide range of patterns, it has become fashionable among young people to carry a self-designed cloth bag while shopping. Business people have also taken advantage of this trend by giving out free environmentally friendly shopping bags with advertisements and company logos on them. One thing is for sure: China's economy and environment will gain from using less fossil fuels and switching to other types of materials to manufacture bags.

Until now, China's plastic bag ban has been carried out for more than a year with success. According to a recent report from China Chain Store & Franchise Association, consumption of plastic bags in China's supermarkets has been dramatically reduced by 66% (WWW.NEWS.CN). However, the current ban excludes thin bags used in open markets in the cities. Furthermore, although most supermarkets are located in large cities, we must not forget plastic bag consumption in rural areas, which contain 55% of the Chinese population (National Bureau of Statistics of China). Rural residents believe it is practical to use plastic bags for holding poorly packaged or unpackaged items such as fresh produce and cooked foods. Therefore, to promote using less plastic bags throughout China, the government must focus on adopting different strategies for open and rural markets such as closing down illegal plastic bag manufacturers; educating rural residents about the harmful effects of using plastics and encouraging people to carry reusable containers when they shop for fresh produce.

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