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Can Stated Preference Methods Accurately Predict Responses to Environmental Policies? The Case of a Plastic Bag Regulation in China

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Abstract:

This study investigates the validity of using stated preference (SP) estimates to predict policy effects on plastic bag consumption. Before implementation of a plastic bag regulation, when bags were still free of charge, we utilized an SP survey to elicit consumers' contingent bag consumption in certain possible pricing scenarios. Following implementation of the regulation mandating charging for bags, we conducted another survey to collect actual consumption information. We thus have unique data to compare stated and revealed consumption. The comparison results show that consumers' behavioral reactions to a policy change can be predicted reasonably well with SP techniques.

Key word: China; contingent behavior; external validity; plastic bags; revealed behavior; stated preference

JEL codes: C91, D12, Q53

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1. Introduction

The designs of many important economic policies – e.g., tax policies, price policies, migration policies, and even social security policies – often rely on their expected effects. Accurately predicting potential effects of policies, therefore, is important since implementing improper policies is costly, and it is often difficult to adjust policies after they have been implemented. Thus, the validity of predicted policy effects is an important area of research. The more accurately policy effects can be predicted *ex-ante*, the easier it is to design policies or to select them from a large number of available alternatives.

If similar policies have been implemented elsewhere, one can forecast the effects of a policy based on past experiences. However, if a policy is new or if the experiences from previous policies are inadequate, there are two main alternatives to predict the effects of the policy: survey methods and experimental methods. Survey methods, with merits of describing the situation closest to reality and obtaining direct reactions from subjects in the field, are the most common methods for investigating the potential effects of policies. However, the question of the external validity of survey estimates remains. On the other hand, experimental methods, despite usually providing better incentives for subjects to reveal preferences by mirroring policy change situations in experimental environments, also have their shortcomings. For example, field experiments, if not too difficult to be applied, may suffer problems such as high time demand and/or large expenses (Burtless, 1995), and lab experiments may suffer more serious external validity problems due to difficulties in creating consistent test conditions for many policies (Levitt and List, 2007). Although lessons have been learned from a number of studies concerning the external validity of these methods, very few studies have examined the prediction accuracy by making use of a real policy change. In the present paper, we conducted two rounds of surveys in the *ex-ante* and *ex-post* counterpart situations created by implementation of an environmental regulation regarding plastic bag consumption in China. The aims of this article are (1) to investigate the possible discrepancy between predicted, i.e., stated contingent behaviors elicited

from a pre-policy survey, and actual behavior revealed by a follow-up survey after the policy was implemented and (2) to address what factors influence the direction and magnitude of the potential bias.

Similar market-based plastic bag regulations have been implemented in several countries, with mixed results. The policies have achieved success in reducing plastic bag consumption in developed countries such as Denmark (Danish EPA, 1999) and Ireland (Convery *et al*., 2007); while seemingly similar policies have rapidly lost effectiveness in developing countries like South Africa (Hansson *et al.*, 2007). In June 2008, the Chinese government implemented a nationwide environmental regulation against the use of plastic shopping bags[1]. The key feature of the regulation is to force all shops to charge for plastic bags, and each shop can set the price of the bags at a level no less than their own acquisition costs (Chinese Ministry of Commerce *et al*., 2008; Chinese National Development and Reform Commission, 2008). There were no major economic changes or relevant actions or publicity campaigns with respect to the use of plastic bags[2] during the period between our two surveys, so the changes in behavior were clearly due to the new regulation.[3] We used a stated preference (SP) method in the *ex-ante* survey to elicit consumers' contingent behavior of plastic bag consumption, and then recorded their actual revealed behaviors using the *ex-post* survey.[4] Then we compared the two behaviors and analyzed the external validity of the SP survey estimates.

Due to the difficulties of finding opportunities to conduct tests using real policy changes, very few studies investigate the prediction validity of SP estimates by predicting effects of a real

[1] In the remainder of this paper, "plastic shopping bag" is abbreviated to "plastic bags" or "bags" in most places.
[2] Public campaigning for the reduction of plastic bag use occurred before June 2008 when the regulation had not yet been implemented.
[3] We obtained detailed information about monthly sales income and plastic bag consumption from half of the supermarkets where the surveys were conducted during a two year period from January 2007 to December 2008. The data demonstrates invariability of monthly free plastic bag consumption and monthly sales income, while the consumption of plastic bags dwindled drastically immediately after the regulation implementation with stable consumption both before and after the implementation. From the supermarket data, we do not find seasonal effects in the plastic bag consumption. For more information, see He (2010).
[4] Apart from reducing the number of plastic bags consumed, the regulation also changed other types of behavior related to plastic bag use, such as carrying more goods in each plastic bag, more reuse of the bags, and use of more substitutes. It is worth noting that the reduction in plastic bag consumption is part of the confound effects of the regulation. This discussion is beyond the scope of the present study; for more details, see He (2009).

policy change.[5] Instead, the main criteria used to test the validity of SP predictions are built on results from revealed preference (RP) methods[6] or experimental methods. As for the comparisons between SP and RP results, e.g., Carson *et al*. (1996) provide a meta-analysis of 83 studies of quasi-public goods containing 616 comparisons between results from SP and RP methods. They find that, on average, SP methods provide lower estimates than do RP methods. Nevertheless, since estimates from RP techniques measure the desired quantity but still with error,[7] the reliability of using the RP estimates as criteria to determine the validity of SP estimates could be problematic. In recent years, experimental estimates and real market data have increasingly been used to serve as comparison criteria for SP estimates. Shogren *et al*. (1999) in a natural field experiment compare the mail survey and lab experimental estimates with the actual consumer purchase of irradiated chicken, which had recently appeared on the market. They find a significantly higher level of acceptance of the irradiated chicken in both the survey and the lab estimations than in the real retail market, and that the estimates of consumers' choices are closer to the real behavior in the market when the prices are higher. Similarly, Lusk *et al*. (2006) find that more moralistic and pro-social preferences are stated in a framed field experiment than in a natural field experiment's real-world setting regarding antibiotic-friendly pork consumption. On the other hand, Chang *et al*. (2009) examine the accuracy of estimates from three preference elicitation methods (hypothetical choices, non-hypothetical choices, and non-hypothetical rankings) for environmentally-friendly consumer goods and organic food and find that estimates from all methods show a high level of external validity. It is worth noting that most previous studies concerning external validity have used goods that were new to consumers, and the researchers have tried to provide the new items a prominent shelf position or even an introduction to the good or a reminder in their positions, which is likely to attracting consumers' attention and therefore induce more purchases. Additionally, since the comparison criteria in previous studies

[5] The only study we are aware of is Lampi and Orth (2009). The authors examine the validity of SP estimates by examining the change in composition of museum visitors and by making use of a real public policy change,

[6] Revealed preference methods refer to the hedonic pricing method, the recreation demand and travel cost method, the averting behavior method, the cost of illness method, etc.

[7] For more detailed discussions, see, e.g., Mitchell and Carson (1989) and Carson *et al.* (1996).

are usually market shares in a single grocery store during a relatively short period, the criteria could be made more reliable by obtaining data from a wide range of time frames and situations.

There are two main explanations for the possible discrepancy between predicted behavior stated in surveys and subsequent actual behavior. The first explanation is respondents' uncertainty about their preferences due to, e.g., unfamiliarity with the situation they are being asked about *ex-ante*. Gradual learning later on can thus lead the respondents to display different preferences. The second explanation is respondents' strategic behavior aiming at somehow influencing the policy. For example, a respondent could intentionally state systematically biased preferences regarding the value or the consumption of the goods or services when asked *ex-ante*. The design of this study tries to take into account the aforementioned two sources of possible prediction bias. By utilizing a well-known everyday good, the surveyed respondents were already familiar with the good. We conducted the *ex-ante* SP survey close to the regulation implementation date when most of consumers were well aware of the forthcoming policy and its content. This made the respondents more likely to state their real preference to the given policy change rather than to present strategic answers in an effort to influence the policy. Our goal with the design is to diminish the possible discrepancy between the predicted and actual behavior. In addition, the consumption decisions were made by a wide range of ordinary citizens in various types of shops with substantial variations in major demographic variables. We use a publicly known environmentally-harmful good so that we can further take respondents' incentives to perform more pro-socially into account, an incentive present in many SP studies.

In addition to noting the potential advantages of using a naturally occurring policy change as a tool, it is also important to note the disparities between our study and standard SP studies. First, based on plastic bag pricing information, we investigated consumers' contingent behavior at three likely prices but did not randomize their presenting order in the hypothetical scenario. Second, since the bags are likely to be necessary goods for people, this study considers the number of bags consumed rather than willingness to pay for them. Third, while most SP studies push respondents

to make choices regarding a policy change that is new to them, respondents in this study, well-informed about the forthcoming policy before being involved in the survey, might have already thought about how to respond. Despite the discrepancies, our study at least captures the difference between hypothetically stated responses without monetary payoff and actual revealed consumption behavior with real costs in real market situations.

Overall, our findings suggest an accurate prediction of the survey SP method, which enhances confidence in forecasting potential policy effects with survey methods. The remainder of the paper proceeds as follows: Section 2 introduces the experimental design and the econometric model and Section 3 discusses the data. The results are reported in Section 4 and Section 5 concludes the paper.

2. Methodology

2.1. Experimental design

With a between-subject design, intercept surveys were conducted at the exit of shops, both *ex-ante* and *ex-post* the policy change. Both surveys needed to be conducted in the same shops and during the same time of day in order to obtain comparable samples. In addition to it being easier to recruit different subjects from the same sample pool than to recruit the same subjects for both surveys conducted at different time, another advantage of using a between-subjects design is that it avoids correlation of the answers from using the same subjects in both surveys.

The *ex-ante* survey was conducted one month before the implementation when most citizens were well aware of the forthcoming regulation. Thus, the questions in our survey could be easily understood and handled by the subjects.[8] In the *ex-ante* survey, apart from collecting the information about subjects' characteristics and their actual consumption of plastic bags at zero

[8] At the time of the *ex-ante* survey, more than 80% of the subjects in the survey reported they knew about the regulation before the survey. However, we interviewed both consumers and shop managers about whether behavioral changes with respect to plastic bag use appeared after dissemination of the news of the forthcoming regulation, and none of the interviewees reported that any change had occurred, which is consistent with the evidence from the supermarkets' formal record. For more details, see He (2009).

price, a series of valuation questions[9] were asked to elicit consumers' contingent behavior with respect to plastic bag consumption at certain hypothetical prices contingent on perfect enforcement of the regulation.[10] Figure 1 shows the structure of the questions.

<Figure 1 to be here>

In the *ex-ante* SP survey, rather than directly asking about the respondents' predicted bag consumption, we focused on investigating their free bag consumption and predicted reduction behavior given certain prices with perfect regulation enforcement, and then calculated the predicted bag consumption. Since the regulation allows the individual shops to set their own prices for plastic bags, yet at a level no lower than the acquisition cost, it was too difficult to forecast accurate prices for the plastic bags in the shops before the regulation. We set the predicted most likely average price to 0.5 Chinese Yuan Renminbi (yuan) per bag in consultation with experts in plastic bag manufacturing, retail trade, and the government sector.[11] We expected that there would be some price variation occurring in the market after the implementation due to the price being set by individual shops. We therefore included another two possible prices, 0.3 and 1 yuan, in order to cover the effects of a wider range of price fluctuation on bag consumption. Specifically, beginning with giving the main hypothetical price 0.5 yuan, the enumerators asked the subjects to choose among three options, "the same use," "reduce use," and "stop use." If the option "reduce use" was chosen, the specific percentage reduction range needed to be answered. Based on the responses to the main hypothetical price, one or both of the two other price options were asked.

Given the structure of the questions, subjects could make 11 possible patterns of choices. Two of the choices are inconsistent and are marked with crosses in Figure 1. All subjects first

[9] See Appendix 2 for the questions asked in the *ex-ante* survey questionnaire.
[10] Although we understood that perfect enforcement of the regulation would be highly unlikely, we kept the perfect enforcement condition throughout the valuation questions for simplicity of cognition reasons. We then asked detailed questions about the actual regulation enforcement faced by each respondent in the *ex-post* survey so that we would be able to control for differences in the enforcement of the regulation.
[11] We considered all the information we had before the regulation when the *ex-ante* survey was about to be conducted, such as the cost of plastic materials for making plastic bags, the cost of transporting the bags, implementation preparation by the government sector, retailers' attitude toward cooperating with the enforcement and towards profiting from the charging, and other relevant information we had at that time.

gave their responses to the major price of 0.5 yuan, while fewer subjects then responded to the 0.3 yuan price and even fewer responded to the 1 yuan price. However, bearing in mind that plastic bag demand is non-decreasing in price,[12] we can complement many responses at the non-answered prices and construct a more complete dataset by utilizing the following two deduction rules: First, when a higher price was given, if a subject answered that she would consume the same amount of plastic bags as before when the price was zero, we deduce that she would also consume the same amount at lower prices. Second, if a subject answered that she would stop using plastic bags when a certain price was given, we deduce that she would also stop using the bags at higher prices.

The *ex-post* survey was conducted about four or five months after the regulation implementation in order to make sure that citizens had enough time to adjust to the regulation. In the *ex-post* survey, we collected information about the average price of paid-for plastic bags faced by subjects and about subjects' bag consumption and socioeconomic characteristics.[13] The survey was conducted in the same shops during the same daily time periods as in the *ex-ante* survey. After the implementation, two of the three hypothetical prices turned out to be the common plastic bag average prices faced by consumers while the price of 1 yuan has rarely been faced. Therefore, only the 0.3 and 0.5 yuan prices are applied for the tests in this paper. As expected, the actual enforcement is not perfect and varies across regions, residential areas, and types of shops. In order to control for the variation in enforcement, we recorded extra information about each subject's percentage of paid-for bags out of her total number of consumed plastic bags. We further recorded each subject's actual percentage reduction in bag consumption in the shops that charged for bags, as compared to their consumption when these shops provided bags for free[14]. We then can use the extra information to adjust the actual plastic bag consumption under imperfect

[12] The third most common choice pattern in Table 4 below demonstrates the negative correlation between plastic bag consumption and price.
[13] See Appendix 2 for the questions asked in the *ex-post* survey questionnaire.
[14] For example, a consumer's weekly bag consumption was 100 free bags before the regulation and 20 paid-for bags and 60 free bags afterwards since some shops did not enforce the regulation. Therefore, the consumer's actual percentage reduction in the shops that charged for bags is 50% (= bag consumption reduction / (free bag consumption *ex-ante* - free bag consumption *ex-post*) = 20 / (100 - 60)).

enforcement into a measure of consumption under the assumption that all shops charging for bags by using the methods presented in Section 2.2.

2.2. Hypothesis

The main purpose of this study is to compare consumers' pre-regulation predicted consumption behavior with their actual consumption afterwards; therefore, we have the null hypothesis that consumers' predicted bag consumption is equal to their actual bag consumption. In order to test this hypothesis, we need to have the following information: their predicted consumption ($\boldsymbol{Q_p^P}$) of plastic bags under certain hypothetical prices before regulation implementation, and their actual consumption ($\boldsymbol{Q_p^A}$) of plastic bags when were faced with the same but real prices after the implementation. In the *ex-ante* survey, given a certain price (e.g., ***p=0.5*** yuan) in the hypothetical scenario with perfect enforcement "if all shops charge for plastic bags," we elicited the *ex-ante* predicted total bag consumption ($\boldsymbol{Q_{p=0.5}^{P\_total}}$). Since in the hypothetical scenario all bags are charged for a price, the predicted free bag consumption ($\boldsymbol{Q_{p=0.5}^{P\_free}}$) is zero and the predicted total bag consumption is equal to the predicted paid-for bag consumption ($\boldsymbol{Q_{p=0.5}^{P\_paid}}$).

$$\boldsymbol{Q_{p=0.5}^{P\_total} = Q_{p=0.5}^{P\_paid} + Q_{p=0.5}^{P\_free} = Q_{p=0.5}^{P\_paid} + 0 = Q_{p=0.5}^{P\_paid}}$$

In the *ex-post* survey, we recorded the actual total bag consumption. Given the complex situation of regulation enforcement afterwards, we need to adjust the *ex-post* actual total bag consumption ($\boldsymbol{Q_{p=0.5}^{A\_total}}$) by taking the imperfect enforcement into account. We obtain the *ex-post* adjusted actual total bag consumption ($\boldsymbol{Q_{p=0.5}^{A\_adjusted\ total}}$) through the following procedure:

Since the regulation failed to be perfectly enforced, i.e., some shops still provided the bags for free after the implementation, the *ex-post* actual total bag consumption is equal to the sum of

the *ex-post* actual paid-for bag consumption bought at average price p ($Q_{p=0.5}^{A\_paid}$) and the *ex-post* actual free bag consumption ($Q_{p=0.5}^{A\_free}$).

$$Q_{p=0.5}^{A\_total} = Q_{p=0.5}^{A\_paid} + Q_{p=0.5}^{A\_free}$$

As mentioned in Section 2.1, we recorded individual consumers' percentage of paid-for bags out of total bag consumption. This enables us to identify both of the components of the *ex-post* actual total bag consumption.

$$Q_{p=0.5}^{A\_paid} = Q_{p=0.5}^{A\_total} * \textit{percentage of paid-for bags}$$

$$Q_{p=0.5}^{A\_free} = Q_{p=0.5}^{A\_total} * \textit{(1 - percentage of paid-for bags)}$$

In general, consumers would only use some (but not all) of the free bags if they were required to pay for them. Since we recorded individual consumers' actual percentage reduction in bag consumption in the shops that charged for bags (***actual percentage reduction from p=0 to p=0.5***), we can adjust the *ex-post* actual free bag consumption in the shops that did not charge for bags to the *ex-post* actual free to paid-for bag consumption ($Q_{p=0.5}^{A\_free\ to\ paid}$).[15]

$$Q_{p=0.5}^{A\_free\ to\ paid} = Q_{p=0.5}^{A\_free} * \textit{(1 - actual percentage reduction from p=0 to p=0.5)}$$

Then we can estimate the *ex-post* adjusted actual total bag consumption ($Q_{p=0.5}^{A\_adjusted\ total}$) conditional on all shops charging for plastic bags.

[15] An underlying assumption is imposed for the adjustment of the *ex-post* actual free bag consumption, i.e., if shops that still provide free bags start to charge for bags at the same average prices as the shops that have already been charging, the percentage reduction in bag consumption in the former shops is the same as the actual percentage reduction in bag consumption in the latter shops.

$$Q_{p=0.5}^{A\_adjusted\ total} = Q_{p=0.5}^{A\_paid} + Q_{p=0.5}^{A\_free\ to\ paid}$$

Therefore, by taking the imperfect enforcement into account, we can finally construct the null hypothesis of the validity test under the circumstance of perfect enforcement: the *ex-post* adjusted actual total bag consumption is equal to the *ex-ante* predicted total bag consumption at the same 0.5 yuan price.

Hypothesis: ***H0:*** $Q_{p=0.5}^{A\_adjusted\ total} = Q_{p=0.5}^{P\_total}$

Statistical tests will be performed for the hypothesis at each of the 0.3 and 0.5 yuan prices, respectively. It is worth noting that the *ex-post* adjusted actual total bag consumption used in the hypothesis includes the component *ex-post* actual free to paid-for bag consumption ($Q_p^{A\_free\ to\ paid}$) that is a product of the subjects' actual total bag consumption per week multiplying two fractions[16], which could be a noisy measurement. We therefore conduct multivariate tests with different types of controls of the regulation enforcement to circumvent difficulties associated with the statistical tests.

2.3. Experimental procedures

We want to control for the possibility that customers who are in different cities or areas and who typically shop at different shops and at different times of day are systematically different. We therefore conducted two parallel surveys in two cities, Beijing and Guiyang. While Beijing is the capital and one of the most developed metropolitan areas in China, Guiyang is a medium-sized

[16] That is, the *ex-post* actual free to paid-for bag consumption is a fraction of the *ex-post* actual free bag consumption that is a fraction of the *ex-post* actual total bag consumption. Due to the impossibility of accurately forecasting the *ex-post* policy enforcement situation, this is the best measurement we can find given the complexity of the *ex-post* enforcement situation.

city located in one of the most underdeveloped provinces. We conducted surveys in the two most frequently visited types of shops, i.e., supermarkets and open markets. Consumers shopping at supermarkets are generally considered to have a higher income and standard of living than those shopping in open markets. Three main residential areas in each city were chosen, and the surveys were conducted in one large supermarket and one large open market in each area. Furthermore, we conducted the surveys on both weekdays and weekends/public holidays, and at three times of day, i.e., morning, noon/early afternoon, and late afternoon/early evening. As presented in Table 1, we attempted to distribute our observations evenly across the dimensions in order to obtain representative and comparable samples.

<Table 1 to be here>

The sampling procedure of interviews was carried out as follows: Every third shopper that exited the shop[17] was approached by the enumerators and asked if she would like to participate in a survey that would last a few minutes. If the selected consumer refused to participate, the enumerator approached the very next shopper. If this person agreed to participate, then the enumerator completed the survey and then proceeded to the next "third" shopper. We ended up with 3,074 interviewed respondents[18]. The most commonly stated reason for refusing to participate was lack of time. We believe that the sample selection bias (if any) can be cancelled out by the use of the between-survey comparisons.

2.4. Multivariate testing: econometric method

In order to test the validity of consumers' predicted consumption as compared to their actual revealed consumption while controlling for other influential factors, we use econometric models. In the first type of multivariate test, we estimate a model including both the *ex-ante* and the *ex-post* subjects who faced the same hypothetical or actual prices. Accordingly, the dependent

[17] If more than one person exited at a time, the enumerators always counted them from left to right in order to select the "third" subject.

[18] In total, we asked about four thousand customers to obtain the 3074 respondents. Moreover, we discard 18 observations considered as outliers since these respondents consumed an extremely high number of new plastic bags per week.

variable refers to the combination of both the *ex-ante* predicted total number of new plastic bags used per week at certain hypothetical prices ($\boldsymbol{Q_p^{P\_total}}$) and the *ex-post* self-reported actual total number of new plastic bags used per week ($\boldsymbol{Q_p^{A\_total}}$) at the same but real prices. It is worth noting that $\boldsymbol{Q_p^{P\_total}}$ is continuous since it is a fraction of a consumer's *ex-ante* actual total bag consumption per week. The dummy variable "actual price" is included to identify whether or not the subjects faced actual prices. Since a proportion of subjects did not using new plastic bags, we apply a Tobit model (Wooldridge, 2002).

$$\boldsymbol{Q^* = X\beta + \varepsilon, \quad Q = max\ (0, Q^*)},$$

where the dependent variable Q^* denotes the combination of the predicted and actual total bag consumption per week at the same hypothetical or real prices,[19] and the independent variable vector $\boldsymbol{X}$ has several components, i.e., $\boldsymbol{X} = (\boldsymbol{X_0, X_i, X_j, X_m, X_n, X_r})$. The independent variable $\boldsymbol{X_i}$ refers to the key dummy variable "actual price," while the others act as controls in the multivariate tests: $\boldsymbol{X_j}$ denotes consumers' self-reported percentage of paid-for plastic bags out of their total bag consumption[20], which is capturing the enforcement of the regulation; $\boldsymbol{X_m}$ expresses the variables regarding consumers' cognition of the policy and of not using plastic bags provided by shops; $\boldsymbol{X_n}$ refers to the socioeconomic variables of the respondents and their families; and $\boldsymbol{X_r}$ denotes variables used to control bag use behavior shifts due to regional discrepancy, market type difference, weekday/weekend, and time of day. We take the first element $\boldsymbol{X_0}$ to be unity. We will explain all the variables in detail in the next section.

In the second type of multivariate test, we use another adjustment approach to consider the imperfect regulation enforcement: We replace the *ex-post* actual total number of new plastic bags

[19] However, we only observe Q^* when Q^* is equal to or greater than zero. Therefore, Q is used to refer to the observed number of new plastic bags used per week.
[20] As mentioned, the percentage of paid-for bags is given to be 100% in the hypothetical scenario for all the subjects participating in the *ex-ante* survey.

used per week ($\boldsymbol{Q_p^{A\_total}}$) with the *ex-post* adjusted actual total number of new plastic bags used per week ($\boldsymbol{Q_p^{A\_adjusted\ total}}$) as a part of the dependent variable. Therefore, we insert the control of the imperfect regulation enforcement directly into the dependent variable. We still keep the predicted total number of new plastic bags used per week at the same hypothetical prices ($\boldsymbol{Q_p^{P\_total}}$) in the dependent variable. We then estimate a similar Tobit model except that we do not contain the regulation enforcement variable in the model since we have corrected the imperfect enforcement in the dependent variable.

In both tests, we control for other factors that could affect subjects' plastic bag consumption. The coefficients of the "actual price" dummy variables indicate the extra effect of the actual price on the number of plastic bags consumed, as compared to the effect of the same hypothetical price. If the impact of actual prices on consumption is the same as that of hypothetical prices, i.e., if consumers at a real price actually consume what they predicted they would consume at the same hypothetical price in the *ex-ante* SP survey, then the coefficient of the variable should not be significantly different from zero; otherwise, the coefficient should be significantly positive (negative) if consumers underestimate (overestimate) their actual consumption of plastic bags after the regulation. The same models are applied for the 0.3 and 0.5 yuan prices.

3. The data

3.1. Descriptive statistics of characteristics

The descriptive statistics of potentially influential factors are presented in Table 2, sorted by different sub-groups of the sample. Column [1] shows the information for the 1,025 subjects from the *ex-ante* survey who faced the hypothetical prices 0.3 and 0.5 yuan. The figures in Columns [2] and [3] reflect the information for the 1,595 and 337 subjects from the *ex-post* survey who faced the average actual prices 0.3 or 0.5 yuan, respectively. Column [4] summarizes the statistics for all observations from both surveys.

Following implementation, only slightly more than 40 percent of the bags are paid for, which

indicates an unsatisfying imperfect enforcement of the regulation. All the other variables vary much less dramatically across different groups of the sample. The proportion of subjects who knew about the regulation increased from 89% before the implementation to more than 98% after the implementation, and the perceived inconvenience of not using plastic bags also slightly increased. However, the subjects' understanding of the regulation's environmental purpose, their supportive attitude toward the regulation, their perceived effectiveness of the regulation, and their perceived seriousness of the environmental problem go down from *ex-ante* to *ex-post* the implementation. The *ex-ante* subjects' average understanding of the indissolubility of plastic bags is worse than the *ex-post* ones' who faced the 0.3 yuan actual price yet is better than the *ex-post* ones' who faced the 0.5 yuan actual price.

Regarding subjects' and their families' socioeconomic characteristics, the mean age of all subjects is 41 years and about 44% of the subjects are male. Around 10% of the subjects work in sales or run their own business, nearly 20% are registered as rural residents, and one-fifth are Communist Party members[21]. The average years of schooling and monthly income in the sample are 12.7 years and 2,200 Chinese yuan respectively, while the average family size is nearly three persons. The mean of most variables shifts from the *ex-ante* sub-sample to the two *ex-post* sub-samples. More exactly, the proportions of males, businessmen, rural residents, years of schooling, and family size increase, while the mean age and the proportion of party members decrease. The *ex-ante* subjects' average monthly income is higher than the *ex-post* ones' who faced the 0.3 yuan actual price yet is lower than the *ex-post* ones' who faced the 0.5 yuan actual price.

As shown in the last two columns in Table 2, the differences in the mean of many variables between the sub-samples in Columns [1] and [2] and between the sub-samples in Columns [1] and [3] are significant in terms of t-tests, proportional tests, and Wilcoxon-Mann-Whitley tests[22], respectively. The small standard error of the variables generated by the large sample may

[21] Since nearly 70% of the party members were urban residents as late as in 2008 (Organization Department of the Central Committee of the Communist Party of China, 2009) and the urban population is smaller than the rural population, this urban survey data shows a larger fraction of party members than the fraction of party members in the whole Chinese population.

[22] Variables with ranked data are tested by Wilcoxon-Mann-Whitney tests.

contribute to the significance of the differences. These differences between the sub-samples suggest a need for applying econometric analysis to control for these variables in order to achieve clearer comparisons.

<Table 2 to be here>

3.2. Predicted reactions to hypothetical prices

In the valuation part of the *ex-ante* survey, there were a total of 11 response patterns, and none of the total 1,039 subjects fell into the two inconsistent response patterns. Only 14 out of the 1,039 subjects made the inconsistent choices that they would consume more plastic bags at a higher bag price, or *vice versa*.[23] In this study, we report the results based on the remaining 1,025 consistent subjects. Only two out of the 1,025 subjects do not use plastic bags at all. Table 3 shows the three most common reaction patterns. Together, they account for more than 82% of the total subjects. All the three reaction patterns indicate a quantitatively large reduction in bag consumption given perfect enforcement of the regulation.

<Table 3 to be here>

In the *ex-ante* survey, the hypothetical price started at 0.5 yuan and then the price of 0.3 and/or 1 yuan was given depending on the answer given. Consequently, all 1,025 subjects responded to 0.5 yuan, 955 subjects responded to 0.3 yuan, and only 633 responded to 1 yuan. By using the deduction rules introduced in Section 2.1, we can complete the choices for all 1,025 subjects at the 0.3 yuan price. However, we can only complete the choices for 989 subjects at the 1 yuan price. In theory, it is impossible to complement the remaining 36 subjects' choices at the 1 yuan price since these subjects chose "reduce use" at the 0.5 yuan price and "the same use" at the 0.3 yuan price. In the remaining analysis, we will use this completed dataset with 1025, 1025, and 989 observations at the 0.5, 0.3, and 1 yuan price, respectively.

Table 4 reports the frequency and cumulative percent of subjects choosing certain contingent

[23] The tiny fraction of inconsistent responses demonstrates the seriousness of subjects' answers to the questions in the questionnaire.

behaviors. The data indicates a clear trend that subjects believe they would indeed cut down more on plastic bag consumption the higher the price: as the price increases from zero to 0.3, 0.5, and 1 yuan, an increasing number of consumers choose to either reduce their bag consumption more or stop using plastic bags. The proportion of subjects who stated they would stop using bags increases to 27.4%, 34.7%, and 64.1%, at 0.3, 0.5, and 1 yuan, respectively, while the proportions of subjects who stated they would stick to the same use are 10.7%, 6.8%, and 3.1%, at 0.3, 0.5, and 1 yuan, respectively. Consequently, given perfect enforcement of the regulation in the *ex-ante* hypothetical scenario, the percentage reduction in total bag consumption can be calculated as 63.2%, 70.5% and 88.3% at 0.3, 0.5, and 1 yuan, respectively.

<Table 4 to be here>

Before the regulation, we collected consumers' actual total bag consumption at zero price ($\boldsymbol{Q_{p=0}^{A\_total}}$). Figure 2 shows the distribution of the number of plastic bags used per week from the *ex-ante* survey when the bags were still free. Based on this information, we can estimate the predicted total bag consumption by using the predicted reduction.

<Figure 2 to be here>

3.3. Predicted consumption vs. actual consumption

In the *ex-post* survey, the number of subjects who do not use plastic bags is 188 out of the total 2,035 subjects[24], reflecting that the regulation results in a considerable proportion of consumers not using plastic bags at all. Due to the highly competitive retail trade environment in China, shops adjusted their prices of plastic bags downwards. The actual price of a new plastic bag turns out to vary from 0.2 to 0.6 yuan depending on region, residential area, and type of shop, and also on the size and quality of the bags. In the supermarkets and open markets where the surveys were conducted, 99% of the reported bag prices ranged from 0.3 to 0.5 yuan. Looking at all shops in

[24] We conducted the *ex-post* survey with a larger sample size because each subject was only able to face one average actual price after regulation implementation. In the *ex-ante* survey, subjects could state hypothetical consumption at several prices.

the two survey cities, the most common average prices are also around 0.3 or 0.5 yuan, but very rarely close to 1 yuan. Therefore, only the cases of the 0.3 and 0.5 yuan prices were investigated in the *ex-post* survey. Figure 3 shows the distribution of the number of plastic bags used per week from the *ex-post* survey when shops charged for the bags.

<Figure 3 to be here>

Table 5 shows the statistics of the predicted and actual weekly plastic bag consumption from the *ex-ante* and *ex-post* surveys. Before the regulation, the mean actual total consumption of free new bags is about 21 per week. When the hypothetical price is increased from zero to 0.3, 0.5, and 1 yuan, subjects predicted that their mean total bag consumption would shrink from 21 bags per week to 7.8, 6.4, and 2.8 bags per week respectively, which describes an obvious reduction tendency induced by the regulation. After the regulation, the mean actual total consumption turns out to be 11.4 and 7.8 bags per week corresponding to the 0.3 and 0.5 yuan average prices, respectively. The actual reactions to certain prices seem to be less dramatic than the *ex-ante* survey subjects thought they would be. This is because the direct comparison ignores the imperfect enforcement. Nevertheless, this comparison serves as a conservative benchmark since a consumer's actual total bag consumption under perfect enforcement cannot be larger than her actual total bag consumption under imperfect enforcement. On the other hand, if we take subjects' percentage of paid-for bags into consideration, the mean consumed number of paid-for new bags per week turns out to be only 4.1 and 3.4 bags at the 0.3 and 0.5 yuan prices, respectively. It is clear that the remaining 7.2 and 4.4 new bags per week obtained for free still account for a major part of the actual total bag consumption after the regulation. If we ignore the free bag consumption and only compare the consumption of paid-for new bags with the predicted consumption of new bags, this acts as the opposite boundary of a consumer's least total bag consumption in reality after the regulation. By utilizing subjects' percentage of actual reduction in bag consumption in shops that have charged for bags, we can convert the number of bags obtained for free into the number of paid-for bags as shown in Section 2.2. Finally, the adjusted

actual total number of new bags consumed per week turns out to be, on average, 9.0 and 6.2 bags respectively. The figures in the last column represent the proportion of zero-bag users in each case.

<Table 5 to be here>

4. Results

4.1. Statistical tests

Table 6 reports the results from statistical tests of the hypothesis shown in Section 2.2 for both the 0.3 and the 0.5 yuan price. For each hypothesis, we conduct a t-test for mean differences as well as a Wilcoxon rank-sum test of equality of distributions for actual and predicted number of bags consumed per week at the same prices. Furthermore, we perform a proportional test of the hypothesis of equal shares of zero-bag users and perform t-tests and rank-sum tests for actual and predicted number of bags consumed per week conditional on excluding the zero-bag users.

<Table 6 to be here>

The results show that we can reject the null hypothesis that the actual total bag consumption is equal to the predicted total bag consumption at the 0.3 yuan price, while the difference is fairly small if taking the total bag reduction into consideration.[25] In the 0.3 yuan case, the mean actual total bag consumption is significantly higher than the mean predicted bag consumption, and this is largely explained by the large difference in the proportion of subjects not using plastic bags at all. The proportion of subjects not using plastic bags is significantly lower in the real market setting than in the hypothetical scenario for both prices. If the zero-bag users are removed, the difference in the number of plastic bags consumed turns out to be smaller and insignificant in terms of a t-test, yet remains significant in terms of a rank-sum test. Consequently, at the 0.3 yuan price, the major reason for the bag consumption difference is the larger share of zero-bag users in the hypothetical scenario. That is, a considerable fraction of the subjects stated that they would completely stop using plastic bags if all shops began enforcing the regulation as stated in the

[25] The mean adjusted actual total bag reduction per week is approximately 11.966 (= 20.937 - 8.971); thus, the over-prediction in bag reduction equals around 9.5% (≈ 1.141 / 11.966).

hypothetical scenario of the *ex-ante* survey. Yet, under the *ex-post* real circumstance of imperfect enforcement, the fraction of subjects who actually stop consuming bags is significantly smaller than the fraction of subjects stating no bag consumption in the *ex-ante* survey.

For the 0.5 yuan case, however, the mean adjusted actual total bag consumption and the mean predicted total bag consumption are essentially the same. The proportion of subjects not using plastic bags is still significantly lower when they were faced with a real market situation than when they were faced with a hypothetical scenario. Interestingly, if we take out the zero-bag users, the difference for the 0.5 yuan case turns out to be larger and significant in terms of both a t-test and a rank-sum test. That is because if we remove the zero-bag users in this case, the mean adjusted actual total bag consumption becomes even lower than the mean predicted total bag consumption.

In line with the findings of Shogren *et al*. (1999), the predicted bag consumption is closer to the actual bag consumption at the higher price of 0.5 yuan than at the lower price of 0.3 yuan.[26] There are two factors that could explain this. First, under the higher price of 0.5 yuan, subjects are likely to take the price more seriously than under the lower price of 0.3 yuan when making predictions. Second, 0.3 yuan is the second price given, and is therefore less likely to be taken as seriously as the first one when predicted.[27]

The results from the statistical tests demonstrate that consumers predicted their future bag consumption reasonably well, although there was a small bias of under-prediction of bag consumption for the lower price. However, the results above may not be reliable since they do not control for other influential factors that vary across the two surveys. This should be kept in mind when viewing the above statistical test results. In order to make clearer comparisons between the stated and the revealed bag consumption behaviors, econometric analysis is needed to control for factors that may potentially affect plastic bag consumption.

[26] We perform a t-test for the two differences in mean bag consumption at the 0.3 and 0.5 yuan prices in Table 6, and find that the difference between the two differences is significant from zero.
[27] Since we did not randomize the order of the hypothetical prices, it is not possible to test the "order effect."

4.2. Econometric analysis

In the econometric analysis, multivariate tests are used to estimate the possible difference between predicted and actual consumption while controlling for other influential factors. The coefficient of the dummy "actual price" indicates the potential discrepancy. We proceed to compute the marginal effects on the expected number of new bags per week based on the regression results of Tobit models with and without controlling for the regulation enforcement. Table 7 reports marginal effects for the regressions of the first type of tests for the 0.3 and 0.5 yuan prices.[28] For simplicity, Table 7 does not include the estimated parameters of the control dummies that control for time of day and location of conducting the survey.

<Table 7 to be here>

In Columns [1] and [3] in Table 7, the regression models do not include the enforcement variable to control for the crucial influential factor of regulation enforcement in the regressions. Not surprisingly, despite controlling for other factors, the marginal effect of the actual price dummy reflects that people consume 2 and 1.5 more bags at the price of 0.3 and 0.5 yuan, respectively, when they face the actual prices as compared to when they face the hypothetical ones. Columns [2] and [4] report the multivariate test results generated by including the "percentage of paid-for bags" variable to capture the variation in the actual enforcement of the regulation. After correcting for the influence of the bags still obtained for free, the marginal effects of actual price dummy variables now turn out to be insignificant at both prices, showing that the fraction of bags obtained for free essentially has explanatory power on the number of new bags used per week. The models, which control for the degree of regulation enforcement and other factors, suggest that the effects of paying the actual prices on consumers' actual bag consumption do not differ from the effects of paying the same hypothetical prices on their predicted bag consumption. So, we cannot reject the hypothesis of equal predicted and actual bag

[28] We use the post-estimation command in STATA to calculate the variance inflation factor (VIF) for the counterpart OLS models, and do not find any evidence of multicollinearity problems.

consumption at the same hypothetical and actual prices. In other words, the *ex-ante* contingent behavior valuation provides accurate estimates of citizens' actual consumption behavior at both 0.3 and 0.5 yuan. Moreover, still-free provision of plastic bags in some shops and especially in some open markets is the key explanation for the underestimation of consumption, which is found in the multivariate tests without control for enforcement.

A substantial number of other factors are shown to significantly influence plastic bag consumption at both prices. Almost all the other influential variables stay the same in terms of direction, magnitude, and significance across the different specifications of the models. Since the main interest of the paper is to test the consumers' prediction ability by using the SP survey method and since including other variables is mainly for control purpose rather than interpretation purposes, we will not provide a detailed discussion of the impacts of other variables.[29] Additionally, although we have tried to add interaction variables, i.e., various socioeconomic characteristics and treatment dummies interacted with the actual price dummy, respectively, we do not find any particular sub-groups of consumers with persistently better or worse prediction ability than others across prices.[30]

The results of the second type of tests, with the adjusted actual bag consumption as a part of the dependent variable, are reported in Table A1 in the appendix. The results in these models are similar to those from models in the first type of tests discussed above. The coefficients of the "actual price" dummies are not significantly different from zero. Again, controlling for degree of regulation enforcement and other influential factors, we cannot reject the hypothesis of equal predicted and actual consumption of plastic bags at the two hypothetical and actual prices.

5. Discussion and conclusion

A fundamental question for researchers working with SP elicitation methods is whether stated

[29] A detailed analysis of the influential variables and the impact of the regulation is provided by He (2009).
[30] We perform likelihood ratio tests for the null of joint insignificance of the interaction variables in the models, and we cannot reject the null hypothesis. Therefore, interaction variables are not included in the models presented in this paper.

values accurately correspond to consumer behavior in real-world situations. In this paper, by conducting a large-scale survey using consumers in a real market setting, we investigate the possible bias between consumers' shifts in stated and actual consumption of a private good following implementation of an environmental regulation. Our results suggest that, regarding an everyday private good, estimates from a SP survey method are reasonably accurate predictors of actual consumer behavior in a real setting. While our findings cannot confirm external validity of all SP survey techniques, they do shed some light on the idea that pre-policy evaluation prediction provides a close approximation of the actual effects in a real setting.

As far as we know, nearly all previous studies on the validity of SP estimates have been conducted in western countries. However, the developing country context may influence the accuracy of predictions of SP estimates in one way or another. In this case, the fact that Chinese consumers may care less about the environmental harmfulness of plastic bags[31] may contribute to the accurate prediction of their plastic bag consumption. That is, as compared to consumers in developed countries, Chinese consumers may have less incentive to behavior pro-environmentally in the *ex-ante* SP survey regarding the hypothetical scenario.

There are additional important lessons to learn: First, in line with the findings in List and Gallet (2001), the private good nature and the respondents' familiarity with the bags may contribute to the accurate prediction based on our SP technique. Second, regulation enforcement plays a crucial role in determining the validity of our SP prediction since the actual enforcement differed largely from that in the hypothetical scenario in the *ex-ante* survey. Third, given 0.5 yuan is the best prediction of the expected price of a regular plastic bag, we mainly focused on this price and set it as the initial hypothetical price in the *ex-ante* SP survey. In the fiercely competitive Chinese retail trade sector, unfortunately, a substantial fraction of shops adjusted their bag prices downwards from the initial 0.5 yuan to prices below 0.5 yuan shortly after the regulation went into effect. The study would have benefited from a design allowing us to take the

[31] For example, only half of the subjects in our survey understand that indissolubility of plastic bags is the main environmental harmfulness of the bags.

unexpected price adjustment into consideration, e.g., randomizing the appearance order of prices in the *ex-ante* SP survey.

The findings of this paper provide evidence for the reliability of SP estimates predicting policy effects on consumer behavior in the context of everyday private goods. Whether or not our findings can be extended to other types of goods and policies is an empirical question that hopefully can be answered by future research.

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Table 1: The time and spatial distribution of the observations in both surveys

Survey period	Beijing		Guiyang		All regions and shops
	supermarket	open market	supermarket	open market	
07:30-11:00	227	202	276	285	990
12:00-15:00	195	194	349	272	1010
17:30-20:00	202	190	276	406	1074
All periods	624	586	901	963	3074

Notes: The three periods are the main shopping hours of the shops

Table 2. Definitions and descriptive statistics of variables used in the analysis

Variable	Description	*Ex-ante*	*Ex-post*		All subjects pooled	P-value of tests between Columns [1] and [2]	P-value of tests between Columns [1] and [3]
		Hypo. price of 0.3 and 0.5 yuan	Actual price of 0.3 yuan	Actual price of 0.5 yuan			
		[1]	[2]	[3]	[4]		
Actual price	= 1 if subject faces the actual price	0.000	1.000	1.000	0.653	0.000[b]	0.000[b]
Percentage of paid-for bags	= percentage of all consumed bags that are paid-for bags	100.000	42.533	46.914	62.952	0.000[a]	0.000[a]
Know regulation	= 1 if subject knows about the regulation before participating in survey	0.890	0.987	0.958	0.950	0.000[b]	0.000[b]
Understanding of regulation's purpose	= subject's perception of the regulation purpose on a 1-5 scale, where 1 is to help shops earn money from citizens and 5 is to reduce environmental pollution	4.721	4.172	4.050	4.349	0.000[c]	0.000[c]
Supportive attitude	= subject's level of support of the regulation on a 1-5 scale, where 1 is does not at all support and 5 is strongly support	4.463	4.045	4.142	4.201	0.000[c]	0.000[c]
Inconvenience of not using plastic bags	= subject's perception of the inconvenience level of not using plastic bags on a 1-5 scale, where 1 is not inconvenient at all and 5 is very inconvenient	2.739	2.972	3.119	2.908	0.000[c]	0.000[c]
Perceived effectiveness	= subject's perception of effectiveness of the regulation on a 1-5 scale, where 1 is no use at all and 5 is very effective	3.550	3.245	3.326	3.360	0.000[c]	0.001[c]
Understanding plastic bag's indissolubility	= 1 if subject's perception of biggest problem caused by plastic bags is indissolubility of the bags	0.529	0.544	0.469	0.530	0.459[b]	0.056[b]
Perceived seriousness of environmental problem	= subject's perception of seriousness of environmental problem faced by China on a 1-5 scale, where 1 is no problem at all and 5 is very serious problem	4.365	4.214	4.211	4.266	0.000[c]	0.014[c]

Table 2. (continued)

Variable	Description	*Ex-ante*	*Ex-post*		All subjects pooled	P-value of tests between Columns [1] and [2]	P-value of tests between Columns [1] and [3]
		Hypo. price of 0.3 and 0.5 yuan	Actual price of 0.3 yuan	Actual price of 0.5 yuan			
		[1]	[2]	[3]	[4]		
Age	= age of subject (years)	42.929	40.534	38.599	41.143	0.000[a]	0.000[a]
Male	= 1 if subject is a male	0.418	0.456	0.442	0.441	0.054[b]	0.428[b]
Businessman	= 1 if subject works in sales or has own business	0.090	0.097	0.110	0.096	0.561[b]	0.276[b]
Rural register	= 1 if subject belongs to the rural register system	0.178	0.197	0.223	0.193	0.218[b]	0.067[b]
Education Years	= subject's number of years of schooling	12.386	12.845	12.985	12.702	0.000[a]	0.004[a]
Monthly income	= subject's net monthly income divided by 1000	2.182	2.133	2.555	2.198	0.450[a]	0.001[a]
Party member	= 1 if subject is a communist party member	0.227	0.176	0.226	0.200	0.001[b]	0.946[b]
Family size	= number of family members living together in subject's household	2.866	2.948	3.095	2.936	0.133[a]	0.008[a]
No. of Obs.		1025	1595	337	2957	-	-

Notes: 1. [a] indicates it is from t test; [b] indicates it is from the proportional test; [c] indicates it is from Wilcoxon-Mann-Whitley test; 2. The currency used in the survey is Chinese Yuan Renminbi. At the time of the survey, 6.98 Chinese Yuan Renminbi = 1 USD (2008-05) and 6.85 Chinese Yuan Renminbi = 1 USD (2008-11).

Table 3: The share of respondents with different reaction patterns

Reaction pattern	0.5 yuan	0.3 yuan	1 yuan	Frequency (No. of Obs.)	Percent (%)
1	the same use	n.a.	the same use	31	3.0%
2	the same use	n.a.	reduce use	30	2.9%
3	the same use	n.a.	stop use	9	0.9%
4	reduce use	the same use	n.a.	36	3.5%
5	reduce use	reduce use	the same use	0	0.0%
6	reduce use	reduce use	reduce use	294	28.7%
7	reduce use	reduce use	stop use	269	26.2%
8	reduce use	stop use	n.a.	0	0.0%
9	stop use	the same use	n.a.	4	0.4%
10	stop use	reduce use	n.a.	71	6.9%
11	stop use	stop use	n.a.	281	27.4%
No. of Obs. directly facing the price	1025	955	633		

Notes: 1. Patterns 5 and 8 are the inconsistent patterns. 2. "n.a." means the question was not asked to the subjects directly. 3. The currency used in the survey is Chinese Yuan Renminbi. At the time of the *ex-ante* survey, 6.98 Chinese Yuan Renminbi = 1 USD (2008-05)

Table 4. The shares of respondents with different reaction patterns after deduction processing*

	0.3 yuan		0.5 yuan		1 yuan	
Responses	Frequency of Obs.	Cumulative percent	Frequency of Obs.	Cumulative percent	Frequency of Obs.	Cumulative percent
The same use	110	10.7%	70	6.8%	31	3.1%
Reduce use 0-20%	19	12.6%	12	8.0%	8	3.9%
Reduce use 20-40%	102	22.5%	63	14.1%	11	5.1%
Reduce use 40-60%	234	45.4%	216	35.2%	52	10.3%
Reduce use 60-80%	168	61.8%	191	53.9%	92	19.6%
Reduce use 80-100%	111	72.6%	117	65.3%	161	35.9%
Stop use	281	100.0%	356	100.0%	634	100.0%
Total No. of Obs. at each price	1025		1025		989	

Notes: 1. * Deduction processing means that many responses at the non-answered prices are complemented by utilizing two deduction rules mentioned in Section 2.1; 2. The currency used in the survey is Chinese Yuan Renminbi. At the time of the *ex-ante* survey, 6.98 Chinese Yuan Renminbi = 1 USD (2008-05)

Table 5. Descriptive statistics of the number of new bags per week

	Number of new plastic bags per week	Obs.	Mean	Std. Dev	Proportion of zero-bag users
Actual and predicted bag consumption obtained from the *ex-ante* survey	$Q_{p=0}^{A\_total}$	1025	20.937	18.304	0.20%
	$Q_{p=0.3}^{P\_total}$	1025	7.829	11.496	27.61%
	$Q_{p=0.5}^{P\_total}$	1025	6.392	10.768	34.93%
	$Q_{p=1}^{P\_total}$	989	2.759	8.662	64.31%
Actual bag consumption obtained from the *ex-post* survey	$Q_{p=0.3}^{A\_total}$	1595	11.362	14.913	7.77%
	$Q_{p=0.3}^{A\_paid}$	1595	4.125	6.959	13.73%
	$Q_{p=0.3}^{A\_free}$	1595	7.237	11.477	13.67%
	$Q_{p=0.3}^{A\_adjusted\ total}$	1595	8.971	12.868	10.09%
	$Q_{p=0.5}^{A\_total}$	337	7.810	11.933	14.54%
	$Q_{p=0.5}^{A\_paid}$	337	3.415	6.056	22.55%
	$Q_{p=0.5}^{A\_free}$	337	4.396	9.073	24.63%
	$Q_{p=0.5}^{A\_adjusted\ total}$	337	6.239	10.456	18.99%

Note: $Q_p^{P\_total}$ denotes the predicted total bag consumption at price *p*; $Q_p^{A\_total}$ denotes the actual total bag consumption at price *p*; $Q_p^{A\_paid}$ denotes the actual paid-for bag consumption at price *p*; $Q_p^{A\_free}$ denotes the actual free obtained bag consumption at price *p*; $Q_p^{A\_adjusted\ total}$ denotes the adjusted actual total bag consumption at price *p*.

Table 6. The results of statistical tests

	Hypothesis
Null hypothesis (For 0.3 yuan case)	$\boldsymbol{Q_{p=0.3}^{A\_adjusted\ total} = Q_{p=0.3}^{P\_total}}$
Difference in mean consumption	1.141
t-test (p-value)	0.018
Rank-sum test (p-value)	0.000
No. of obs: Q^A / Q^P	1595/1025
Difference in proportion of subjects with zero bag consumption	-17.52%
Proportional test (p-value)	0.000
No. of obs: zero Q^A / zero Q^P	161/283
Difference in mean consumption if above 0	-0.838
t-test (p-value)	0.141
Rank-sum test (p-value)	0.000
No. of obs: non-zero Q^A / non-zero Q^P	1434/742
Null hypothesis (For 0.5 yuan case)	$\boldsymbol{Q_{p=0.5}^{A\_adjusted\ total} = Q_{p=0.5}^{P\_total}}$
Difference in mean consumption	-0.153
t-test (p-value)	0.817
Rank-sum test (p-value)	0.067
No. of obs: Q^A / Q^P	337/1025
Difference in proportion of subjects with zero bag consumption	-15.94%
Proportional test (p-value)	0.000
No. of obs: zero Q^A / zero Q^P	64/358
Difference in mean consumption if above 0	-2.121
t-test (p-value)	0.010
Rank-sum test (p-value)	0.000
No. of obs: non-zero Q^A / non-zero Q^P	273/667

Note: $Q_p^{P\_total}$ denotes the predicted total bag consumption at price *p*; $Q_p^{A\_adjusted\ total}$ denotes the adjusted actual total bag consumption at price *p*.

Table 7. Regression results regarding the validity of the prediction for both prices

Dependent variable	Number of new plastic bags per week			
Price	When price is 0.3 yuan		When price is 0.5 yuan	
Model specification	[1] Tobit Model 1	[2] Tobit Model 2	[3] Tobit Model 3	[4] Tobit Model 4
	Mar. Eff.	Mar. Eff.	Mar. Eff.	Mar. Eff.
Actual price	2.041 (4.49)***	-0.084 (0.13)	1.517 (2.44)***	1.137 (1.16)
Percentage of paid-for bags	-	-0.038 (4.47)***	-	-0.007 (0.49)
Know regulation	1.104 (1.17)	1.180 (1.26)	0.027 (0.03)	0.036 (0.04)
Understanding of regulation's purpose	-0.131 (0.50)	-0.208 (0.79)	0.219 (0.68)	0.214 (0.66)
Supportive attitude	-0.777 (2.89)***	-0.738 (2.75)***	-0.351 (-1.12)	-0.349 (1.12)
Inconvenience of not using plastic bags	0.495 (2.86)***	0.538 (3.11)***	0.760 (3.84)***	0.762 (3.85)***
Perceived effectiveness	-0.378 (1.69)***	-0.308 (1.38)	-0.345 (-1.33)	-0.344 (1.32)
Understanding of plastic bag's indissolubility	-0.357 (0.82)	-0.408 (0.94)	-0.181 (-0.36)	-0.176 (0.35)
Perceived seriousness of environmental problem	-0.094 (0.35)	-0.147 (0.54)	-0.307 (-1.01)	-0.314 (1.03)
Age	-0.048 (3.06)***	-0.059 (3.74)***	-0.043 (-2.26)***	-0.043 (2.29)***
Male	1.334 (3.10)***	1.399 (3.25)***	1.662 (3.28)***	1.678 (3.31)***
Businessman	3.346 (4.01)***	3.356 (4.04)***	2.419 (2.45)***	2.440 (2.47)***
Rural register	0.133 (0.22)	0.067 (0.11)	1.195 (1.61)	1.184 (1.60)
Education years	-0.288 (3.55)***	-0.297 (3.67)***	-0.117 (-1.23)	-0.114 (1.19)
Monthly income	0.551 (3.88)***	0.579 (4.09)***	0.358 (2.32)***	0.359 (2.32)***
Party member	0.193 (0.35)	0.285 (0.51)	1.068 (1.69)***	1.064 (1.68)***
Family size	0.332 (2.15)***	0.359 (2.33)***	0.200 (1.10)	0.203 (1.12)
Dummies for time when survey was conducted	*Yes*	*Yes*	*Yes*	*Yes*
Dummies for shops where survey was conducted	*Yes*	*Yes*	*Yes*	*Yes*
No. of Obs	2620	2620	1362	1362
Pseudo R-square	0.029	0.030	0.018	0.018
Prob > chi2	0.000	0.000	0.000	0.000

Note: 1. Absolute value of z statistics in parentheses; 2.* significance at 10%; ** significance at 5%; *** significance at 1%.

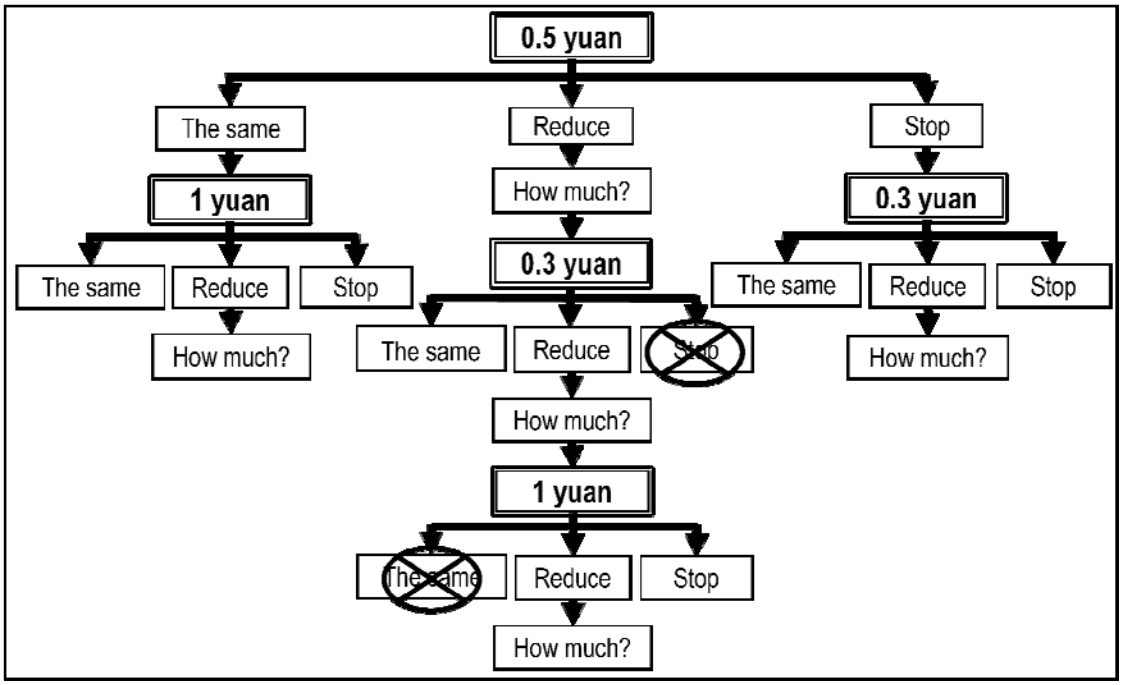

Figure 1. The valuation question structure in the *ex-ante* survey questionnaire

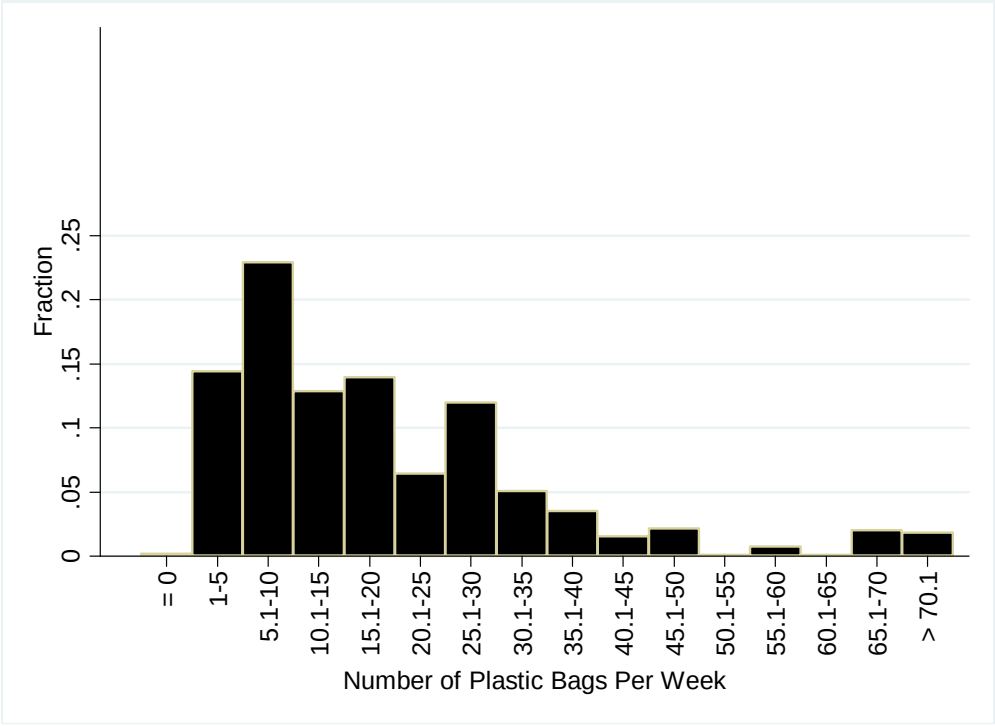

Figure 2. Histogram of number of plastic bags per week before the regulation

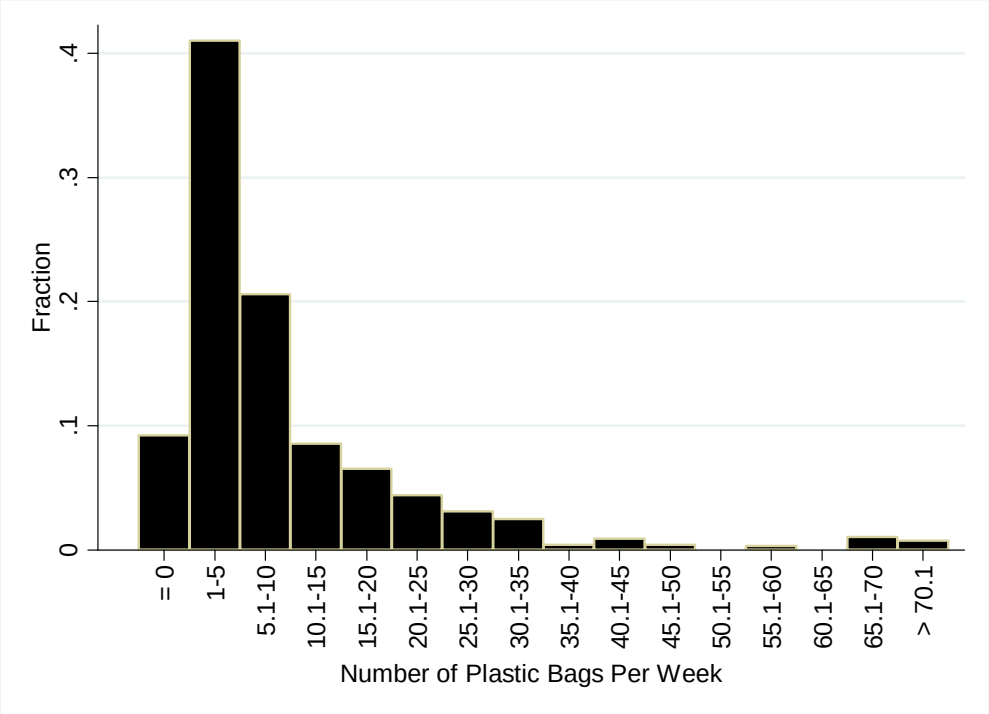

Figure 3. Histogram of number of plastic bags per week after the regulation

Appendix 1: Results of alternative specification

Table A1. Regression results regarding the validity of the prediction for both prices

Dependent variable	Adjusted number of new plastic bags per week	
Price	When price is 0.3 yuan	When price is 0.5 yuan
Model specification	[1] Tobit Model 1	[3] Tobit Model 3
	Mar. Eff.	Mar. Eff.
Actual price	0.196 (0.47)	0.078 (0.14)
Percentage of paid-for bags	-	-
Know regulation	0.976 (1.16)	-0.095 (0.11)
Understanding of regulation's purpose	-0.177 (0.75)	0.078 (0.25)
Supportive attitude	-0.598 (2.48)**	-0.135 (0.45)
Inconvenience of not using plastic bags	0.510 (3.29)***	0.775 (4.05)***
Perceived effectiveness	-0.318 (1.59)	-0.281 (1.12)
Understanding of plastic bag's indissolubility	-0.639 (1.64)	-0.055 (0.11)
Perceived seriousness of environmental problem	-0.138 (0.56)	-0.394 (1.35)
Age	-0.063 (4.47)***	-0.047 (2.57)***
Male	1.478 (3.82)***	1.497 (3.06)***
Businessman	3.144 (4.17)***	2.643 (2.73)***
Rural register	0.180 (0.33)	0.741 (1.05)
Education years	-0.244 (3.36)***	-0.078 (0.85)
Monthly income	0.510 (4.02)***	0.343 (2.30)***
Party member	0.347 (0.69)	0.945 (1.55)
Family size	0.263 (1.90)*	0.213 (1.22)
Dummies for time when survey was conducted	Yes	Yes
Dummies for shops where survey was conducted	Yes	Yes
No. of Obs	2620	1362
Pseudo R-square	0.026	0.016
Prob > chi2	0.000	0.000

Note: 1. Absolute value of z statistics in parentheses; 2.* significance at 10%; ** significance at 5%; *** significance at 1%.

Appendix 2. Relevant questions asked in the ex-ante and ex-post surveys

Part 1. Questions in the ex-ante survey

For collecting $Q_{p=0}^{A\_total}$

1. How many new plastic shopping bags on average do you* think you use from various shops in one week? _____bag(s)

For calculating $Q_{p=0.3}^{P\_total}$, $Q_{p=0.5}^{P\_total}$, $Q_{p=1}^{P\_total}$

1. If the price of one new plastic shopping bag in all shops turns to be 0.5 yuan after implementation of this policy, what will you do?

   ☐ Keep buying and using the same number of new plastic shopping bags as before (Go to question 5)

   ☐ Keep buying and using new plastic shopping bags, but fewer than before

   ☐ Stop buying and using new plastic shopping bags altogether (Go to question 3)

2. In percent, how many fewer new plastic shopping bags will you buy and use in various shops when shopping?

   ☐ 0-20% ☐ 20-40% ☐ 40-60% ☐ 60-80% ☐ 80-100%

3. If the price of one new plastic shopping bag in all shops turns to be 0.3 yuan instead, what will you do?

   ☐ Keep buying and using the same number of new plastic shopping bags as before (Go to next part)

   ☐ Keep buying and using new plastic shopping bags, but fewer than before

* The second person pronoun "you" has two different words for its singular and plural forms in Chinese. The "yous" used in the Chinese questionnaire are all strictly limited to the singular form.

☐ Stop buying and using new plastic shopping bags altogether (Go to next part)

4. In percent, how many fewer new plastic shopping bags will you buy and use in various shops when shopping?

☐ 0-20% ☐ 20-40% ☐ 40-60% ☐ 60-80% ☐ 80-100%

(If they answered question 3, then go to next part)

5. If the price of one new plastic shopping bag in all shops turns to be 1 yuan instead, what will you do?

☐ Keep buying and using the same number of new plastic shopping bags as before (Go to next part)

☐ Keep buying and using new plastic shopping bags, but fewer than before

☐ Stop buying and using new plastic shopping bags altogether (Go to next part)

6. In percent, how many fewer new plastic shopping bags will you buy and use in various shops when shopping?

☐ 0-20% ☐ 20-40% ☐ 40-60% ☐ 60-80% ☐ 80-100%

Part 2. Questions in the ex-post survey

For collecting average prices faced by subjects and $Q_{p=0.3}^{A\_total}$, $Q_{p=0.5}^{A\_total}$

1. How many new plastic shopping bags on average do you think you use from various shops in one week now? _____bag (s)

2. On average, which of the following prices is closest to the average price that you currently pay for one new plastic shopping bag in the supermarkets or open markets that you usually visit?

☐ 3 Jiao ☐ 5 Jiao ☐ provided free ☐ I don't know

For calculating $Q_{p=0.3}^{A\_paid}$, $Q_{p=0.3}^{A\_free}$, $Q_{p=0.5}^{A\_paid}$, $Q_{p=0.5}^{A\_free}$

1. Since the 1st of June, according to policy, most supermarkets have begun charging for new plastic shopping bags, but many other shops such as open markets or shops along streets have not applied this new regulation. On average, what percentage of the new plastic shopping bags you get now are provided by the shops with a charge and what percentage of the new shopping bags you get now are free of charge?

Paid	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Free	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	0%
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

For calculating $Q_{p=0.3}^{A\_adjusted\ total}$, $Q_{p=0.5}^{A\_adjusted\ total}$

1. Now that the supermarkets or open markets have begun charging 3 Jiao/5 Jiao as the average price for one new plastic shopping bag, what do you actually do when shopping?

☐ Keep buying and using the same number of new plastic shopping bags as before charging (Go to next part)

- ☐ Keep buying and using new plastic shopping bags, but fewer than before charging
- ☐ Stop buying and using new plastic shopping bags altogether (Go to next part)

2. In percent, how many fewer new plastic shopping bags do you use in the shops that charge for them?

☐ 0-20% ☐ 20-40% ☐ 40-60% ☐ 60-80% ☐ 80-100%