CONSUMER RESPONSES TO INCENTIVES TO REDUCE PLASTIC BAG USE: EVIDENCE FROM A FIELD EXPERIMENT IN URBAN INDIA

Kanupriya Gupta and Rohini Somanathan

Delhi School of Economics

Delhi 110007

Email: kanupriya.gupta@gmail.com

and

rohini.somanathan@gmail.com

November 2011

Abstract

In this paper we test for appropriate policies that could help control the use of plastic bags in Delhi. In January 2009, the Government of Delhi introduced a wide-ranging ban on the use of plastic bags in market places. Our results showed a dilution in the efficacy of the ban within a year, with widespread lack of enforcement. About 94% of the consumers continue to use plastic bags in blatant violation of rules. This motivated us to examine the effects of other possible price and non-price instruments possibly requiring less monitoring and enforcement in order to control/reduce the use of plastic bags. We tested the effectiveness of these policies through field experiments in the semi-organized retail sector. The policy treatments included (i) provision of information to consumers, (ii) a cash-back scheme contingent on use of non-plastic bags and (iii) provision of substitutes for plastic bags. The results indicate that cumulatively these interventions increase the proportion of consumers who bring their own bags from 4.6% in the baseline to 17.7% post treatment. The number of consumers who would only use plastic bags came down on average from 80.8% to 57.1%. Hence, our study concludes that in developing countries with little enforcement capacity, a blanket ban may not be the best possible solution. Instead, low cost information interventions, availability of substitutes to plastic bags, and subsidies (taxes) on the use of reusable bags (plastic bags) could constitute an important policy-mix.

Key Words: Plastic Bag Usage; Ban on Plastic Bag Usage; Solid Waste and Policy Instruments; Field Experiment; Consumer Behavior; Delhi, India.

Table of Contents

CONSUMER RESPONSES TO INCENTIVES TO REDUCE PLASTIC BAG USE: EVIDENCE FROM A FIELD EXPERIMENT IN URBAN INDIA

1. Introduction

In many countries including India, plastic bags have largely replaced the use of re-usable bags and containers in shopping. In India, the share of plastic waste in total solid waste has thus risen from 0.6% in 1996 to 9.2% in 2005 (World Bank, 2008). Over 50% of this waste comprises used plastic bags and packaging (TERI, 2002).

The environmental externality of solid waste associated with plastic bag consumption illustrates the classic tragedy of the commons. While individual consumers derive the benefit of convenience from the use of plastic bags, the whole society has to bear the collective cost of their disposal. However, there is inadequate recognition of the potential costs of plastic litter in many parts of the world, with the problem especially grave in developing countries. Although the traditional externality problem would always remain in plastic bag usage, the effectiveness of various policy instruments that privatize the costs and thereby internalize the externality to some extent remains untested.

Research has adequately established the public costs of plastic bag usage. They are environmentally unfriendly in the extreme, take hundreds of years to degrade, and fill up landfills. Plastic litter can also lead to clogged drains resulting in sanitation and sewage problems, and to soil degradation, which hampers trees growth. In addition, animals have been known to often ingest plastic bags while its indiscriminate disposal by incineration pollutes the air and releases toxic substances (Dikang and Visser, 2010). The Mumbai floods in India in which about a thousand people died were partly the result of plastic bags clogging the drains (*The Economist*, 2009). In 2002, Bangladesh banned the use of plastic shopping bags for the same reasons (Spivey, 2003). Plastic bags are also responsible for using up oil, a scarce natural resource.

These concerns have caused governments across the world, including many states in India, to introduce legislation to limit the use of plastic bags. They have used a variety of regulatory instruments for this purpose. These include the mandatory pricing of plastic bags, explicit levies on each bag, taxes at manufacturing level, discounts on use of own bags, awareness campaigns, command and control approaches and, in some cases, a total ban on the use of plastic bags.

Evidence on the effectiveness of such policies is mixed. While plastic bag retail levies in Ireland have resulted in a dramatic fall in the demand for plastic bags, and an environmental levy at the point of manufacturing in Denmark has been similarly effective, experiences with complete ban yield mixed results. (Convery *et al.,* 2007). While a complete ban on the use of plastic bags in San Francisco and in the Indian state of Himachal Pradesh have been largely effective, it seems not to have worked in the case of Bangladesh, particularly in the long run (BBC, 2003; BEN, 2008).

Most research on solid waste problems has focused on developed countries: for example, the study by Fullerton and Kinnaman (1996) in Virginia, Houvten and Morris (1999) in Georgia, and Covery *et al* (2007*),* in Ireland. Our study addresses the problem of plastic litter in the context of a large city, Delhi, in the fast-growing developing country of India where the problem has exacerbated with rapid economic growth. The research highlights the issues of monitoring and enforcement in the context of regulation, a pertinent issue in developing countries. The other issue that we incorporate into our experiments is the willingness to pay for cleaner products. In terms of methods, our study tests instruments that could control environmental externality through experiments in actual markets as opposed to a lab experiment or a non-market-based field experiment. [1]

The study focuses on markets in Delhi, the capital of India. Delhi is an ideal case to study the issues related to plastic bags usage because Delhi contributes around 5% of the packaging waste produced in the country although it represents only about 1.5% of the population of India.[2] The main reason for such a disproportionate share has been a near uncontrolled growth in the use of thin plastic bags. However, only recently has there been a new surge of political and administrative will to curtail plastic litter. In August 2008, the Delhi High Court directed the state to raise the minimum thickness of plastic bags from 20 to 40 microns.[3] Five months later, on 7th January 2009, it ordered a complete ban on the use of all plastic bags within market areas. However, our results show that the ban was not effective in changing consumer behavior towards own bag use. This was due to weak enforcement of the law particularly weaker enforcement of penalties.

The lack of effectiveness of the ban motivated us to set up a field experiment in an actual market setting in order to test various price and non-price instruments aimed at controlling the use of plastic bags. The three interventions that we experimented with are (i) provision of information, (ii) cash-back scheme, and (iii) provision of substitutes for plastic bags. The objectives of the study were:

- To test and compare the effectiveness of a portfolio of options to limit the use of plastic bags; and

---

[1] In recent times, field experiments have begun to play an important role in evaluating various policy instruments. The field experiment studies implementation and evaluation by comparing the control group with different treatment groups of an intervention specifically designed to test a hypothesis (Duflo, 2006). It is important to note that we base our field experiment a on real market setting where consumers are faced with actual budget constraints and a real menu of goods from which they make their choices.

[2] We estimate the proportion of packaging waste in Delhi using numbers from the TERI (The Energy Research Institute) Report 2002 submitted to the Department of Environment, Delhi, and the Central Pollution Control Board website.

[3] Micron is the parameter that measures the thickness of the plastic bags. Higher the microns size, more the thickness of the plastic bag and hence more reusable it is.

- To compare how the use of own bags differs across various socio-economic characteristics.

Our results show that the interventions had a significant effect on reducing plastic bag use. Importantly, the low cost information intervention that involved putting up banners aimed at creating awareness on the use of alternative bags also turned out to be a significant determinant of the reduction in plastic bag use. This shows that the lack of environmental awareness in developing countries might be a constraining factor leading to choices that are environmentally unfriendly. The study leads to the conclusion that in developing countries with little enforcement capacity, a blanket ban may not be the best possible solution. Instead, a combination of policies might be required to create an incentive-based system for the consumer and the retailer, which could influence behavior significantly.

The paper is organized as follows. Section 2 briefly describes the structure of the Indian retail sector and the regulatory framework that has been put in place by central and state governments to control plastic litter. Section 3 summarizes findings from existing research on plastic bag use across different countries. Section 4 outlines a model of consumer behavior that formalizes the effect of the interventions. Section 5 summarizes the experimental design. Section 6 analyses survey results by presenting summary statistics and econometric results. Section 7 concludes with policy implications.

2. The Retail Sector and Plastic Bag Regulations in India

2.1 The Retail Sector

We classify Indian retail activity into three sectors for the purpose of studying incentives for consumers and retailers to use plastic bags. Of the three sectors, organized corporate retailing is now the fastest growing segment. Supermarket chains such as Spencers, Reliance Fresh, Food Bazaar and Fair Price have proliferated in many neighborhoods around Delhi. In addition to modern supermarkets, this sector comprises the government-managed *Kendriya Bhandar* neighborhood stores and *Mother Dairy* Fruit and Vegetable outlets.

Before the ban on plastic bags, most supermarkets in Delhi provided plastic bags free of charge to the consumers. Although the government-operated *Kendriya Bhandar* stores and Mother Dairy outlets were mandated not to use non-biodegradable plastic bags, in face of competition they switched to a system of providing plastic bags for a fee of one rupee per bag. The Mother Dairy outlets often disregarded this rule ostensibly due to competition from other stores (In this case there was an outlet specific ban that was ineffective).[4] After the ban on plastic bag use came into effect, most organized retailers,

[4] 'No polybags: Mother Dairy outlets forget their resolve', *Express News*, December 22, 1998. Our own survey of these outlets suggests that outlets that are surrounded by other vendors are the most likely to provide free plastic bags (Gupta and Somanathan, 2009).

including government-managed stores, have started providing synthetic woven bags at a price ranging from INR 3 to INR 5. However, this has not stopped some organized neighborhood stores from time and again violating the ban by providing plastic bags free in the face of weak enforcement of the law.

The second type of store is mostly small stand-alone stores, typically owned by a single proprietor and usually located in demarcated market centers. Despite the ban being in place, almost all these stores still provide plastic bags free of charge. The thickness of these bags varied significantly with the type of product sold. While small grocery shops and fruit and vegetable stalls use the largest number of bags, in most cases, these bags are thin single use plastic bags below 20-micron in thickness.[5]

The third sector is completely unregulated. It consists of mobile vendors and weekly markets or *haats* with temporary stalls selling fruits, vegetables, spices and a variety of other goods. These weekly markets usually service many Delhi slums, as well as some middle-class neighborhoods. Even after the blanket ban came into effect, vendors continue to use plastic bags that are ultra-thin and usually colored that often litter the streets once the market closes. Although most of these temporary stalls are not licensed, they continue to exist possibly due to corruption because they bribe officials. It is to be expected that regulations would be most difficult to enforce and compliance most difficult to monitor among this group of traders.

2.2 Plastic Bag Regulation in India

The Plastic Manufacture, Sale and Usage Rules, 1999, as amended in 2003 under the Environment (Protection) Act of 1986, regulates plastic bag use in India. The Rules prohibit the manufacture, stocking, distribution, or sale of carry bags made of virgin or recycled plastic less than 20 x 30 centimeters in size and 20 microns in thickness. The Rules also disallow the use of recycled plastic bags and containers for storing, carrying, dispensing or packaging of food items. Further, the Rules require units manufacturing plastic bags to register with the respective State Pollution Control Board (SPCB) or Pollution Control Committee (PCC) prior to the commencement of production.

The Plastic Waste (Management and Handling) Rules, 2011, which would replace the earlier Recycled Plastics Manufacture and Usage Rules, 2003, is the latest drive by the Government of India to limit plastic waste in the country. The new rules have raised the minimum thickness of plastic bags to 40 microns and require recycled carry bags made from compostable plastics to conform to specific BIS (Bureau of Indian Standards). Importantly, the Rules ban the use of plastic sachets for storing, packing or selling *gutkha*

[5] Interestingly, despite the supposed violations of the ban, vendors in these shops expressed unhappiness over the cost of plastic bags. Several shop owners claimed that they would welcome enforcement and coordinated action that would limit their use, but were reluctant to change their behavior independently in the absence of such enforcement and monitoring for the fear of losing clients.

(a crushed preparation of betel nut with tobacco), tobacco and *pan masala* (betel nuts).[6] One of the major provisions under the new Rules is the explicit recognition of the role played by waste pickers. The new rules require the municipal authority to constructively engage with waste pickers, agencies, or groups working in waste management. Another important policy recommendation is that no plastic carry bags be made available free of cost to consumers and that the municipal authority be given the power to determine the minimum price for plastic bags. However, the explicit pricing rule is diluted in effect because it does not clearly specify the modalities for the execution of the policy.

Some states have introduced incremental regulations toward the control of plastic bags. Himachal Pradesh, for example, banned bags made of non-biodegradable material of thickness less than 70 microns and size less than 18 X 12 inches in 2003. Violations carry fines of up to INR 100,000 or seven years in jail.[7] Similarly, the states of Maharashtra, Punjab, Kerala, Meghalaya and Goa have also prescribed norms regarding the thickness of plastic bags varying between 30 and 50 microns. The Government of West Bengal has banned the manufacture, use, storage and sale of plastic bags of thickness below 40 microns and size lower than 16 X 12 inches. The governments of Gujarat, Orissa and Goa have banned the use of plastic bags in certain religious and tourist areas such as Ambaji, Dakor and Somnath in Gujarat, the municipal area of Puri and Konark in Orissa, and the beaches in Goa.

More recently, Chandigarh in 2008, Rajasthan in 2010 and Haryana in 2011 have imposed a complete ban on plastic bag use. Faced with a ban, shops in these states have responded mainly in two ways. The sellers of high-value goods such as garments and electronics have started providing their customers fiber-cloth bags free of charge. Those selling lower value goods such as grocery stores have started a deposit-refund system where customers deposit some amount for a cloth bag, which is refunded when they return the cloth bag. Some shops are also offering 1% cash subsidies (on the value of purchases) for consumers using their own bags.

The Delhi High Court in August 2008 directed the state to raise the minimum thickness of plastic carrier bags from 20 to 40 microns. Somewhat surprisingly, the Delhi State government not only passed legislation to this effect fairly quickly but, in January 2009, ordered a complete ban on the use of all plastic bags within market areas. *De jure*, anyone found guilty of breaking the ban faces a maximum penalty of one hundred thousand rupees, or five years' imprisonment, or both.

---

[6] The ban on plastic sachets has shut down *gutkha* factories in Karnataka, Kanpur, etc., until they find a cheap and acceptable packaging alternative. This ban would not only have the desired effect of reduced litter and cleaner environment, it would also reduce the incidence of oral cancer, which is increasing at an alarming rate in India. The results of a comprehensive study by the National Institute of Public Health (NIPH) indicates that 86 percent of oral cancer cases in the world occur in India and chewing tobacco was the leading cause of such cancers in 90 percent of the cases. The study also revealed that 24 percent of school-going children are addicted to chewing *gutka* and *pan masala* (RCTFI 2011).

[7] Anecdotal evidence suggests that the ban has been effective (BBC news 2003). However there is no recent research on the effectiveness of the ban in Himachal Pradesh.

3. The National and International Experience: Regulations and Their Impact

The use of plastic bags in retailing became widespread in supermarkets in the United States during the late 1970s. They spread to Europe in the following decade and to developing countries in the 1990s. Conservative estimates suggest that, today, people use between 500 billion to 1 trillion plastic bags worldwide and about a million every minute (Clapp and Swanston, 2009).

The plastic shopping bags are increasingly seen as more of an environmental hazard than a modern day convenience. Consequently, since the early 1990s, various regulatory policies have emerged to control the use of plastic shopping bags around the world. Two principal approaches have been used to deal with the littering and waste management problems caused by the large volume of plastic bags used in the consumer retail sector. While the first approach aims at reducing the use of plastic bags through consumer incentives such as levies on plastic bags, explicit pricing, and occasionally outright bans on plastic bag use, the second approach aims at more effective collection and recycling of plastic bags.

Denmark was the first country to introduce mandatory levies on plastic bag manufacturers in 1994. The policy was perceived as largely successful since it reduced plastic bag use by 66% (Akullian, 2006). In 2002, Ireland instituted a tax on bags. However, unlike Denmark, Ireland introduced a levy of 15 Euro cents on the plastic shopping bags provided to consumers at the point of sale. According to Convery *et al.* (2007), the estimated decline in demand for plastic bags was roughly 90% over the following year.[8] More recently, several other European and Middle-eastern countries (France, Paris, Belgium and Israel) have introduced regulations or encouraged voluntary initiatives towards limiting the use of plastic shopping bags. The Australian and British governments too have recommended that supermarkets explicitly price plastic bags or face legislation if their use does not decline significantly. In Portugal, a study that compares consumer behavior in supermarkets which have instituted a nominal charge of 2 cents per each shopping bag with consumer behavior in others that do not, has found that consumers use far fewer bags and utilize them to capacity when there is an explicit levy on their use (Luis and Spinola, 2010).

In the case of the United States and Canada, several states and/or cities are considering taxing or banning plastic bag use. In New York and Toronto, for instance, fees have been imposed on the use of plastic shopping bags, of 6 cents and 5 cents, with effect from November 2008 and June 2009 respectively. The legislators have earmarked the funds collected from the levy to facilitate a move towards a new product bag

[8] In Convery et al., the researchers surveyed the households selected for the study over the telephone, which carries a treatment bias when it comes to estimating effects since the treated are aware that they are in an experiment (Harrison and List, 2004). On the contrary, our study is based on real market transactions and therefore carries relatively less bias of the sort outlined above.

development fund. Other North American cities such as San Francisco (2007), Oakland (2010) and Mexico City (2010) have imposed a ban on plastic bag use. According to Akullian *et al.* (2006), in Rhode Island, USA, customers receive a 3-cent retailer-funded rebate for each bag a customer brings to the store. However, the authors argue that the incentive structure of the amendment is poorly designed and does not meet the needs of the plastic bag problem in Rhode Island where the total social cost of a plastic bag is estimated to be over 11 cents. They instead propose that the government impose an 11-cent Pigouvian tax on the use of plastic bags in order to effect a significant internalization of the externality.

The South African experience with plastic bag regulation combines levies with thickness restrictions similar to those that have been legislated in India. Beginning in September 2002, the regulations in place require plastic shopping bags to be at least 30 microns thick while consumers are charged 46 cents for each plastic bag used, which includes an environmental levy of 2 cents per plastic bag. Following this legislation, plastic bag sales went down by 60-90%. Although usage increased significantly in the following year when the price came down to 17 cents per bag, it has remained 20-80% below the pre-legislation level (Hassan *et al.,* 2007).

Botswana passed a plastic bag tax in the form of an environmental levy on retailers with effect from 2007 to curb plastic bag demand. Interestingly, the legislation did not force retailers to charge for plastic bags, which they however did voluntarily at different prices. Dikgang and Visser (2010), who assessed the environmental effectiveness of the plastic bag legislation in Botswana, found that, within 18 months, overall plastic bag use fell by 50% compared to pre-levy consumption. During this period, the overall price of plastic bags also increased by 31%. The partial success of the Botswana levy was therefore due to the constantly high price of the bags.

In East Africa, Rwanda passed a law banning plastic bags in 2004. The success of the ban on plastic bags is a visible example of the commitment of the Rwandan leadership to environmental issues and their willingness to address such issues (UNEP, 2010). The tiny African country's success in becoming plastic-bag free has been praised in many quarters.

Among Asian countries, both Taiwan and China have introduced regulations on plastic bag use during the last few years. In both cases, the national government has required retailers to explicitly price plastic bags. These laws took effect in Taiwan in 2003 and in China in 2008. In the case of China, a study that recorded the use of plastic bags before and after the policy through exit surveys of consumers as they left retail outlets found that the policy resulted in a 49% decline in new plastic bag use and a substantial increase in the number of times old bags were re-used (He, 2010). However, another study by Xing (2009) showed that the ban in China was not as effective among small retailers. In the case of Taiwan, researchers have found that the benefits of the plastic bag policy went beyond a reduction in plastic bag use. The greater environmental awareness created by the policy has resulted in an overall reduction in the amount of all types of solid waste generated by households (Yan and Innes, 2007).

Other developing economies of Asia such as Bangladesh and Bhutan too have introduced plastic bag policies banning single-use plastic bags completely. However, as in other developing countries, the issue of effective enforcement remains (BEN 2008). Both these countries therefore have failed to sustain the initial decline in the use of plastic bags that followed the legislation. More recently, the city of Pokhara in Nepal banned plastic bag use in 2010. In India, too, various states such as Chandigarh (in October 2008), Delhi (in January, 2009) and Rajasthan (in 2010) have instituted bans on plastic bag use. However, as in the case of the other South Asian countries referred to above, enforcement remains the challenge although the plastic bag ban in Shimla and the 70-micron norm in Himachal Pradesh in India seem to be effective. Among the explanations given for the success are the demographic features of these areas and the impact of local environmental groups.

Plastic waste generation is not the only problem that developing countries face with regard to plastic use. Waste management is another given the growing amount of waste generation in the face of urbanization. The international experience suggests that the introduction of unit pricing in many countries has resulted in successful solid waste management (SWM) systems. Households in many developing countries, including India, do not pay for waste that is generated *by the bag* and the SWM system therefore does not adhere to the *polluter pays* principle. However, evidence suggests the overall efficacy of unit pricing in influencing consumer incentives. Moreover, such pricing could provide municipalities with needed financial resources to improve waste management.[9] For example, Houvten and Morris (1999) examine the implications of a unit pricing demonstration project in Georgia for the year 1994, which required residents to pay by the unit for waste disposal services. Rather than pay a fixed monthly fee for collection, half of the residents in the project opted to pay a fee per reusable trash can while the other half paid for each non-reusable trash bag collected. Data from the sample of households covered indicated that the programs significantly reduced waste set-outs. The bag program caused larger reductions (36%) than the subscription can program (14%). Rough estimates for the program indicate savings for the residents as well as social welfare increases.

Another related study by Fullerton and Kinnaman (1996) used original data gathered from individual households to estimate responses to the implementation of a price per bag of garbage in Virginia. They found the incremental benefit of unit pricing to be small because, although the number of bags from the households decreased, there was no reduction in the actual weight of their garbage. It is also possible that while households increased the amount of recycling, they might have resorted to illegal dumping. Thus the reduction in the weight of garbage was only 10 percent.

The discussion above shows the wide array of measures adopted by countries around the world to control solid waste in general and plastic bag usage in particular. Drawing

[9] The World Bank source book for policy makers, *Improving Municipal Solid Waste Management in India*, Chapter 2, provides several examples of successful unit pricing in major world cities.

from the portfolio of options, we therefore chose three instruments that target the different factors leading to excessive use of plastic bags. In the next section we explain our experimental design, which assesses the efficacy of different instruments in controlling plastic bag usage.

4. The Experimental Design

4.1 The Study Area and Sampling Strategy

The sampling frame of this study is a retail consumer market in Delhi and the National Capital Region of Delhi (NCR). Our sampling strategy was to randomly select 4 neighborhoods in Delhi that are covered by the ban and 1 in NCR (Ghaziabad) that does not fall within the capital's boundaries and is therefore not within the area covered by the ban.

After initial sampling, we identified three market areas within the neighborhoods and randomly selected 12 fruit and vegetable shops in each market. In all, there were 180 fruit and vegetable and grocery shops in the sample (See Figure 1). We chose fruit and vegetable and grocery shops following the results from our earlier study, which showed that these two categories of shops use plastic bags the most (Gupta and Somanathan, 2009). Moreover, these shops tend to use ultra thin bags with very small micron sizes.

Among the three neighborhood markets in each zone, we chose two as our treatment markets while one remained a control market throughout the experiment. We visited each market once a week.

4.2 The Survey Design and the Interventions

The experiment involved surveys in 3 stages. We first conducted a two-week baseline survey to record transactions in each shop and the different types of bags that consumers used. After the baseline survey, we introduced three types of interventions: information, cash-back scheme, and availability of reusable bags. In each treatment market, we introduced these interventions **sequentially** and **squeezingly** for nine weeks in three phases of three weeks each.[10]

In the first phase of intervention we introduced the information treatment for three weeks in the two treatment markets of each zone where we provided information about the environmental effects of using plastic bags. The first week involved campaigning and persuasion and the next two weeks involved survey and monitoring in the morning and evening respectively. We followed this strategy in all the phases of the experiment. A

[10] The term "squeezingly" refers to the practice of applying each add-on intervention in a fewer number of shops (see details in the text).

group of enumerators involved in the project undertook campaigning and persuasion on the demerits of using plastic bags dressed in T-Shirts showing a cow voicing the slogan "Go Green, Go Reusable" and "Say no to Plastic Bags". They explained to consumers in the market how the use of plastic bags was hurting the environment and attempted to motivate them to change from plastic bags to reusable bags.

We used two different kinds of information treatment, that is, negative information (showing the harmful impacts of plastic bag use) and positive information (showing the positive impacts of cutting down on plastic bag use). The objective was to test the right kind of information to which consumers would respond. Hence, in each neighborhood two of the markets experienced a different information treatment (one negative and the other positive) while the third area acted as a control group. Note that in each treatment market, we provided information in only 9 shops out of the12 shops, leaving 3 shops untreated in order to capture the spillover effects.[11] Out of the 180 shops, the enumerators therefore provided information to only 90 shops.

After two weeks of information treatment, we started with the second phase of intervention where, we introduced cash-back schemes (in addition to information treatment) in 6 out of the 9 information shops in each treatment market where a consumer who was not using a retailer-provided plastic bag would receive 1% or 2% of the value of his or her purchase as cash back. The shops with exclusive information treatment would help us in analyzing the impact of the information treatment for the longer period. Similarly, two of the markets in each neighborhood experienced different cash-back treatments (1% and 2% respectively) while the third area acted as a control group. Out of 180 shops, 60 shops therefore adopted the information and cash-back schemes.

After two weeks of this treatment, in the third phase of intervention, we introduced alternatives to plastic bags, i.e., reusable cloth bags (in addition to information and the cash-back scheme) in 3 out of the 6 information and cash-back shops in the two treatment markets while the third acted as a control. The shops sold these cloth bags to the consumers at the cost price of INR 15 per bag. However, we gave cash transfers of INR 3 per bag as an incentive to the shops that participated in the cloth bag treatment.

Out of 180 shops, 30 shops therefore provided information, cash-back scheme and cloth bag scheme. The shops with exclusive information and cash-back treatment would help us analyze the impact of the cash-back treatment for the longer period. We give the diagrammatic representation of the sample design and data collection strategy in Figures 2 and 3.

Finally, five weeks after the intervention, we conducted a two-week follow-up survey in which we visited the shops to find out if the behavioral changes observed during the treatment period had persisted.

---

[11] These shops are the untreated shops in the treatment market, which would assist in capturing the role of social interactions in switching from plastic bags to reusable bags. We consider this aspect in a separate working paper (Gupta and Somanathan, 2011).

The design of the experiment as laid out above might seem complex but the rationale behind it is simple. Firstly, in our earlier study (Gupta and Somanathan, 2009), we had found that the three treatments, to a large extent, were complementary in nature. While posters would address the lack of information, cash-back incentives would correct the externality problem while the availability of cloth bags would solve the problem of suitable substitutes. We hypothesized that the compound effect would be much greater than the individual effects. Secondly, if we provided only the cash-back treatment, the consumer would not have the opportunity to pick up the embedded information on the demerits of plastic bag use that we convey in the first treatment. Therefore, in order to disentangle the effects of information, it is logical to combine the second treatment with some explicit information. Since the non-availability of alternatives could negatively impact the cash-back scheme, combining the latter treatment with the availability of cloth bags would help augment the effects of the cash-back scheme.

Figure 3 gives a clear picture of how the application of the squeezing technique leads to a fewer number of shops with each added intervention. There are three reasons for this. Firstly, at the beginning, we left 3 shops untreated in each treatment market in order to examine the role of social effects in the tendency of consumers to bring reusable bags.[12] Secondly, this design would help us look at interventions for the longer period of time. Thirdly, it would help us disentangle the impacts of individual interventions from combined interventions in the best possible manner given the average values over the longer period of time.

Our sampling technique explained above is a clustered randomization where we randomize clusters of people or social units instead of individuals. In such cases, researchers apply interventions at the group (or shop) level but measure outcomes at the individual level. Cluster sampling violates the simple random sampling assumption of the independence of observations. Hence, there would be some loss of power due to clustered randomization. We therefore need to account for intra-class correlation (ICC) to measure sample size. We used our earlier study (Gupta and Somanathan, 2009) to estimate ICC. We calculated ICC to be 0.05 and then used it to calculate the design effect in order to arrive at the adjusted sample size assuming the cluster size to be 180 shops. The adjusted sample size after taking into account the design effect is 1217 observations based on the 1% level of significance and 0.99 power for each group separately. Since we have 9 different types of groups--i.e., baseline, two information treatments, two cash-back treatments, cloth bags, spill shops, control group and follow up--we would need approximately 10953 observations (1217x9).

During the period of 10 survey weeks, we collected data on 20,197 unique observations. This is a pooled data set on different consumers where the power calculations suggested above show that the sample size was sufficient for the power of the study. In the survey, we recorded transaction details and customer characteristics that

[12] We consider the role of social effects in a separate paper (Gupta and Somanathan, 2011).

included information on the shop type, the number of different types of shopping bags used (i.e., whether paper, plastic or reusable [cloth/jute]), demographic characteristics of the consumer, the value of the purchase and the type of products purchased. We also asked the consumers about the likely price at which they would switch away from plastic bags, their willingness to participate in cleanliness drives, and what they would do with plastic bags after taking them home. It is noteworthy that the focus group for our analysis is consumers using only own bags (that is, not a mix involving plastic bags) since this is a class of consumers who benefit from all the treatments, i.e., information, cash-back and cloth bags.

5. Results and Discussion

5.1 Summary Statistics

The study drew its sample of 20,197 consumers from one of the three types of retail sectors: the small stand-alone shops, typically owned by a single proprietor, and located in different parts of Delhi and NCR region.[13] These shops provide plastic bags with no explicit charge or adopt a policy of implicit pricing.

Since sellers have small margins in the owner-managed stores, there are likely to be important cost implications for the use of plastic bags for sellers. We found that the type of bag that was most commonly in use in these shops was the single-use thin plastic bag below an average thickness of 20 microns and that its use was quite high, with an average 32 kilograms per month per shop. The results showed that the shops did not usually follow the state government ban on the use of plastic bags. In fact, the proportion of consumers using plastic bags in Delhi (at 93.8%) was not very different from the proportion of consumers using plastic bags in Ghaziabad (at 96.7%) where there was no ban on the use of plastic bags. There could be two possible reasons for such high usage. Firstly, in a situation of no actual penalties (*de facto* v *de jure*), the shop owners resorted to the use of the cheapest bags.[14] Secondly, most users were unaware of the legal and social cost dimensions to plastic bag use in the absence of adequate and accurate information on the subject.

The experimental interventions that we introduced showed some behavioral change in the consumers who moved from plastic bags to own bag use. Figure 4 shows that there was a general upward trend towards own bag use as we introduced different interventions. Interventions resulted in an increase of more than three times in the proportion of consumers switching to own bag use--from an average of 5% during the baseline survey to 17.8% in the eighth week of the interventions. The proportion of

[13] We detail the types of retail sector in section 2.1.

[14] In addition to low prices, the other reason for the high use of plastic bags is easy availability. These single-use thin plastic bags are easily available at the doorstep of sellers, which cuts down the transaction cost of shop owners.

consumers bringing their own bags to control shops, on the other hand, remained almost consistent throughout the intervention period and corresponds to baseline numbers. Figures 4 and 5 show the impact of differential interventions on own bag use.

As Figure 4 shows, each intervention significantly increased the proportion of people bringing their own bag over time. The information treatments showed a rise in the proportion of consumers using their own bag from 6.6% in week 3 to 8.6% in week 4. The introduction of a cash-back scheme in addition to information led to a cumulative impact on the use of own bags with the proportion of consumers bringing own bags increasing from 7.8% to 11.1% during week 5. The introduction of cloth bags during week 7 similarly increased the use of own bags from 14.9% to 16%, which further increased to 17.8% during week 8.

Figure 5 shows the average marginal impact across different types of interventions. The information treatment increased own bag use from 4.5% in the baseline to 7.7%. The relative proportion of own bag use in the control shop was 3.6%. Moreover, positive information appeared to have more impact than negative information, which suggests that consumers were psychologically more receptive to information with a positive message. This shows that persuasion and the right kind of information play an important role in spurring desired behavior (Mullainathan, Schwartzstein and Shleifer, 2006).

The addition of the cash-back scheme to the information treatment increased the number of consumers using own bag by about 5.5%. The cloth bag alternative increased own bag usage by 4.5%. As expected, the 2% cash-back scheme exerted more influence than the 1% cash-back scheme. Although the study considered subsidies offered by retailers, it may still provide conservative estimates of the price elasticity of demand for plastic bag use by assuming the cash-back benefit on bringing reusable bags as an indirect tax on the use of plastic bags.

Figure 6 presents the demand curve for plastic bags based on these figures. When the explicit price of plastic bags was zero, the demand for plastic bags was 94%. The explicit pricing of plastic bags at INR 0.80 decreases the demand for plastic bags to 87%. The demand for plastic bags further decreases to 84% when the price increases by INR 0.50 to INR 1.30.[15] Hence, explicit pricing/taxing of plastic bags has an impact on consumer behavior towards low plastic bag usage.[16]

We further conjectured that these interventions complement each other in determining the outcomes". To reiterate, each of the interventions addresses a different problem. So, while posters could solve the information problem, taxes could resort to pricing to solve the externality problem and cloth bags could solve problem of the availability of

[15] We calculate INR 0.80 and INR 1.30 using the 1% cash-back and 2% cash-back respectively of the average value of purchase.

[16] Gupta and Somanathan (2008) show that explicit pricing of plastic bags in some organized grocery and fruit and vegetable stores of Delhi has a significant impact on consumer behavior towards own bag use.

substitutes. In terms of efficacy, the results indicate that the cash-back scheme was the most effective, followed by cloth bag and information.

It is noteworthy that there is a class of consumers who switched to own bag but used it in combination with plastic bags. Table 1 displays the type of bags used by consumers for shopping before and after the interventions. The results indicate that the share of consumers bringing only their own bags increased from 4.6% in the baseline to 17.7% after the cumulative effect of all the interventions. At the same time, the use of plastic bags went down from 80.8% in the baseline to 57.1% after interventions. These consumers receive the benefits of information, cash-back schemes and availability of cloth bags.

However, the proportion of consumers using own bags as well as plastic bags has also increased significantly from 12.3% in the baseline to 22.8% after interventions. This class of consumers likely changed their behavior towards own bags and minimized the use of plastic bags due to the information treatment, limiting their use of plastic bags for soft and wet items like sweets, milk products, and fruits like grapes, berries, etc. (see Table 1).

We now look at the follow-up results after we discontinued the interventions. Own bag use decreased to 6.2% but remained above the baseline levels. Plastic bag use increased but remains below the baseline level. However, the consumers who combined own bag use with plastic bags did not change their behavior much implying that changes in behavior due to the information treatment prevails while changes in behavior due to cash and other incentives may revert to earlier patterns.

We further found that consumer behavior differs significantly with respect to the use of plastic bags (and/or own bags) based on shop type and attributes. In the sample of 180 shops, 70% were fruit and vegetable shops and 30% were grocery shops. The average value of purchase per plastic bag by the consumer was INR 40. Alternatively, consumers use more plastic bags per rupee in the case of fruits and vegetables (at INR 30) than grocery shops (at INR 67).

Figure 7 show that a significantly higher proportion of consumers brings own bag for grocery shopping than for fruit and vegetable shopping in the control shops and intervention shops. The proportion of consumers bringing own bag is much higher in the intervention shops with 4.9% in the fruit and vegetable shops and 20.8% in grocery shops. This shows that consumers used more reusable bags for grocery items but found the plastic bags indispensable for fruits and vegetables, especially soft and small vegetables and wet purchases like cottage cheese, cut pumpkin, etc.

Further, we found women to be more receptive to interventions compared to their male counterparts. Even in the control shops, women used own bags more than males. The pattern continued in the intervention shops but at higher proportions, with about 11.9% of the females and 9.7% of the males using reusable bags. Figure 8 shows that intervention had the maximum impact on the non-working-age population in the treatment shops. The highest proportion of individuals getting their own bags was in age

groups less than 20 years and more than 60 years. This suggests that the younger generation and senior citizens might be either more environmentally conscious or more receptive to messages about the environment.

Among occupations, it is the non-earning category--students, housewives and the retired--who showed the maximum impact due to interventions. This complements the results given for the age attribute. In the case of the income category, it is again the non-earning category that showed the maximum influence from the interventions and switched to own bag use confirming earlier results. The results are predictable since students might be more environmentally sensitive due to recent environmental education campaigns conducted in schools. In the case of housewives, what enables them to steer away from plastic is possibly the price-incentive since they are known to be more price-sensitive due to constraints of fixed budgets and because their shopping involves fewer unplanned trips. As discussed earlier, older people may find it easier or may like to use re-usable bags because they could recall a time when such bags were the norm.

We also interviewed consumers on Knowledge, Attitude and Perceptions (KAP) questions such as whether they would participate in a voluntary program to clean their neighborhood. About 78% of the consumers agreed while 10% were indecisive and the rest said 'no'. About 89% of the consumers confessed to a propensity to switch to own bags if they see others bringing them which signals some peer effect.[17] The results for the question on plastic bag reuse suggest that 47% of people throw plastic bags away after use. The most common way to reuse plastic bags is to dispose garbage (at 42%) followed by storing (at 5%). About 1% of the consumers got rid of used plastic bags by burning them. These consumers may not know about the poisonous gases that these plastic bags emit when incinerated.

One of the important findings of the survey is related to the willingness to pay for the use of plastic bags. Figure 9 shows the preference for plastic bags at different prices based on the willingness to pay question.[18] The results show that 82% of the consumers would switch from plastic bag use to own bag use if they were charged explicitly for the plastic bag. 71% of consumers showed willingness to switch to reusable bags at INR 1 per plastic bag while another 9% of the consumers expressed a willingness to switch at INR 2 per plastic bag. However, the demand curve derived from the contingent valuation on willingness to pay for plastic bags is more elastic than the demand curve based on the actual behavior of the consumers recorded during the survey (see Figure 6). The discrepancy could be due to two reasons: one, that actual behavior may take time to adjust so that the two might get closer in the long run and, two, due to bias involved in the contingent valuation study (Cummings and Taylor, 1999).

---

[17] A detailed discussion on the role of social interactions in plastic bag use can be found in the forthcoming work of Gupta and Somanathan (2011).

[18] Note that the willingness to pay in the present context relates to a hypothetical situation. Thus, it is subject to the hypothetical bias known to be prevalent in choice experiments. One could gauge the extent of the hypothetical bias only by tallying it with actual intervention.

5.2 Econometric Analysis

The summary statistics outlined above indicate that the different policies/interventions applied have an effect on plastic bag use and on consumer attitudes and behavior towards reusable bags. In this section, we test econometrically the effect of policies or interventions on plastic bag use after controlling for relevant retailer and consumer characteristics. We would also like to see how consumer choice with regard to own bag use depends on the socio-economic characteristics of the consumer.

We model consumer choice of re-usable bag as a function of general characteristics such as the consumers' age, gender, income, education, distance traveled to the market, mode of transport, and day of the week on which he or she shopped (See Table 2 for a description of the variables). We also consider environmental preference variables such as what a consumer does with plastic bags after taking them home, etc., and an indicator variable that equals 1 if a particular intervention was active in the shop. We postulate that customers maximize a latent variable (for example, net utility from choosing a reusable bag) over the choice of bags. However, what we observed in the data is the binary variable, that is, whether or not the consumer chooses a reusable bag.

Thus, we express the regression models for using reusable bags as

$$R_{ijt} = \alpha + \sum_{m=1}^{M} \beta_m I_{mijt} + \sum_{k=1}^{K} \gamma_k X_{kijt} + e_{ijt} \qquad (1)$$

$$R_{ijt} = \alpha + \sum_{m=1}^{M} \beta_m I_{mijt} + \sum_{k=1}^{K} \gamma_k X_{kijt} + f_j + e_{ijt} \qquad (2)$$

where in both the equations above R_{ijt} is the binary variable that equals 1 if consumer i is using a reusable bag in shop j in time period t and equals zero otherwise. I_{ijt} is the indicator variable that equals 1 if intervention type m is active in shop j where consumer i shopped in time period t. X_{kijt} is the k number of characteristics of consumer i going to shop j in time period t and f_i is shop fixed effect in Equation 2.

There are several ways in which equation 1 can be estimated, viz., a linear probability model, a probit model or a logit model. The linear probability model has the problem that estimated probabilities can turn out to be greater than 1 or less than 0 which can be found in the results in many cases. Hence, we prefer a logit or probit where the two differ with regard to the assumption on the distribution of the error term e_{ijt}. Assuming that normality yields the probit model and logistic distribution results in a logit model, in this paper we have estimated equation 1 using a probit model.

The coefficient β like other coefficients in a probit regression does not have a clear interpretation because they relate to the effect on the latent variable. A function of β, the marginal effect measures the effects of intervention on the probability of using reusable bag becoming equal to 1. In the case of the continuous variable, the marginal effect

relates to unit (marginal) changes in the explanatory variable everything else remaining constant. In the case of discrete variables such as the indicator variable for intervention, the marginal effect is defined as the change in the probability of using reusable bags with certainty from a change in state from no intervention to intervention. X_{kijt} is the k number of explanatory variables of the general characteristics of the consumer and e_{ijt} is the error term. The vector $X_{kijt\_}$ includes the day (taking value 1 if weekends and 0 if weekdays), shoptype (taking value 1 if grocery and 0 if fruits and vegetables), gender (taking value 1 if female and 0 if male), age, zone, education, income (taking value 1 if non-earning and 0 if earning), distance traveled to the market, mode of transport and if consumers reuse plastic bags taken home. Table 2 presents the description and summary statistics of the explanatory variables. Table 3 shows the results for the model.

The variables of interest are the intervention variables, which appear to be significant at the 1% level of significance. In the face of intervention, the effect on the probability of using a reusable bag would be 0.02, 0.06 and 0.11 for posters, posters and cash-back, and posters, cash-back and cloth bags respectively in Model 1 of Table 3. Importantly, a low cost intervention such as posters in isolation also appears to be quite effective. This suggests that lack of information might be a critical factor in determining bag choice. In Model 2, we have considered two types of information treatments and two types of cash-back schemes that we have experimented with in the field and, again, we find that positive intervention is more effective while negative information has an insignificant impact on the consumers bringing their own bag. This shows the importance of the type of information used in changing consumer attitudes towards desired behavior.[19]

Further, we find that consumers are more likely to bring own bag for grocery shopping than for fruit and vegetable shopping. With grocery shopping, the marginal effect on the probability of using reusable bags would be 0.13. Consumers are also more likely to bring own bag when they walk to the market than when they have to use other modes of transport. This may be because plastic bags available in the market are generally single-use thin shopping bags and hence get ragged more easily. Moreover, the results indicate that longer the distance between their residence and the market, the more likelihood there is of consumers bringing own bag to market. An increase in the distance to the market by 1 km increases the probability of bringing own bags by 0.001 units.

Women are more likely to bring reusable bags than men with the probability of bringing own bag increasing by 0.01 percentage points in the case of women. Further, consumers use more reusable bags during weekdays. This might be due to the fact that customers do more planned shopping during weekdays relative to the weekend. It is also possible that women shop more during weekdays relative to men. Therefore, on weekdays the marginal effect on the probability of using reusable bags would be 0.01. The results also show that the younger generation in the age group of 0-20 years and

[19] Our field experiment confirms that persuasion through advertisements works to change attitudes as advocated in literature (Mullainathan, Schwartzstein and Shleifer, 2006). Jalan and Somanathan (2008) have shown the importance of role information in determining the demand for water quality.

senior citizens in the age group of more than 60 years are more likely to change their behavior when it comes to using own bag. This result conforms to the income category results above. We therefore find that it is the non-earning category (housewives, students and the retired) that is more likely to bring own bag compared to the income-earning group. Consumers who are more educated also significantly increase the probability of bringing own bag by 0.02 percentage points.

We also find consumers living in South Delhi more likely to bring reusable bags. This could be due to the fact that South Delhi residents are more environmentally conscious than consumers living in other parts of Delhi. Interestingly, consumers who are more likely to reuse plastic bags for purposes like garbage, storing, and returning bags to shops, etc., are also more likely to bring reusable bags for shopping. It is clear that this class of consumers is more environmentally friendly.

Since consumer preference for bringing own bag for grocery shopping is significantly higher than for fruit and vegetable shopping, it would be interesting to assess whether the effects of the interventions varied across different types of shops. For this, we need to interact intervention-type with shop-type. For the purpose of keeping regression results clean, we have done regressions for each shop type, that is, grocery and fruit and vegetable shops, separately in Table 4. The main difference in the results is the significance and the impact of information type. We found that both positive and negative information has an impact on grocery shoppers while only positive information impacted on fruit and vegetable shoppers. Also the marginal impacts of all treatments are quite high in the case of grocery shopping compared to fruit and vegetable shopping.

In order to account for unobserved shop-specific heterogeneity that could bias our results, we include shop-fixed effects in the regression (see equation 2), which would also act as a robustness check for our earlier results. We present the results in Table 5. Our variables of interest in the regression are again intervention dummies. We find the fixed effect estimates comparable to the earlier results indicating robustness of the results discussed earlier.

5.3 Cost-Benefit Analysis of Reduction in Plastic Bag Consumption

The choice between alternative interventions for the purpose of reducing plastic bag consumption requires an analysis of the true costs and benefits of their implementation. Our study reveals that cumulatively the interventions reduce the use of plastic bags in favor of own bags. The combined effect of the interventions on plastic bag use was a reduction from 79.1% in the baseline to 65.8% post-treatment. Considering that ours was a small-scale intervention over a short period of time, this signifies a significant reduction. At the same time, two issues remain. The first relates to the external validity of this field experiment in terms of a reduction in plastic bag usage under non-experimental conditions. We would argue that this concern is mitigated (although *not* eliminated) because the experiment was implemented in actual markets. The second issue relates to the long-term sustainability of the effects of such interventions. To the extent that we implemented these interventions without any command and control systems, we would argue that they can be self-sustained. These factors would determine

the costs and benefits of the policies employed where benefits are proxied by the magnitude of reduction in plastic bag usage (suitably normalized) and costs are weighed in terms of the expenditure required to implement the programs.

The reduction in the use of plastic bags is however only a means towards achieving improvements in environmental quality. A comprehensive analysis would require waste management data for the purpose of estimating the environmental externalities of plastic bag consumption. We could then map the change in plastic bag consumption into improvements in environment and thus estimate the true social benefit from a reduction in plastic bags use.

A comparison of the different interventions deployed shows that some interventions are relatively low cost, such as the information campaigns aimed at explaining the externalities of bag consumption and encouraging the use of reusable shopping bags. We spent on average INR 1.5 in our experiment on information per plastic bag use avoided[20] where a plastic bag on average cost INR 2.[21] Therefore, based on our survey, the information campaigns were beneficial even in terms of saving the private cost of a plastic bag to the consumer concerned. The cost would likely be much less per plastic bag avoided when information would be disseminated on a larger scale than ours, thereby reducing even more the cost of posters. However, the information program only takes care of information externality by *encouraging* consumers to recycle their bags rather than motivating a more dramatic behavioral change through cash incentives.

Our alternative policy instrument of cash-back schemes would create a system of economic incentives to change consumer behavior. It was a store-funded rebate where shop owners agreed to provide a cash-back of 1% and 2% on the value of purchase to consumers who brought their own bag. No store agreed to a cash-back of more than 2% revealing their break-even cost at this point. In our experiment, we spent about INR 2.95 on the cash-back scheme posters per plastic bag avoided.[22] However, when the policy is actually in force, we estimate the cost involved in reducing per plastic bag use to be much less. Since it is logical to assume that the cash-back scheme would carry some implicit information about the ill-effects of plastic bag use, a minimum level of explicit information combined with the cash-back scheme would be reasonable to make the incentive scheme more effective.

The effectiveness of the cash-back scheme could be constrained by the non-availability of alternatives. Hence, our third policy alternative of making cloth bags available to consumers further strengthens the cumulative effect of plastic bag avoidance by providing the consumers with substitutes to plastic bags. In our experiment, we sold bags

---

[20] This includes the cost of posters displaying information about the impacts of plastic bag use.

[21] According to Akulian (2006), conservative calculations of the social cost of litter, CO2 emissions from bag production, land filling, and improper recycling of plastic bags reveal that each 1 cent plastic bag used at a retail outfit in Rhode Island costs over 10.5 cents for society as a whole.

[22] This includes the cost of stickers announcing the cash-back scheme and the monitoring cost.

to consumers at the cost price of INR 15 per bag. However, we did provide incentives of INR 3 per bag to shop owners who participated in our experiment. Thus, in total, we spent about INR 2.91 on the cloth bag scheme per plastic bag avoided.[23]

Although a full cost-benefit analysis is beyond the scope of the paper, the interventions discussed above show that the cost of interventions as a fraction of reductions in the use of plastic bags tends to be small. A proper cost-benefit analysis of the reduction in plastic bag consumption requires estimating the social cost of plastic bag consumption and the actual costs of alternative instruments, which would involve working with government officials. This is a fertile area for future research.

6. Concluding Remarks and Policy Implications

Plastic waste is a pressing issue, especially in the big cities of India like Delhi. With the problem aggravating by the day, the Government of Delhi in January 2009 ordered a complete ban on the use of all plastic bags within market areas. This paper provides systematic evidence that the ban has been largely ineffective based on surveys across many different markets. The ineffectiveness of a stringent policy such as a ban prompted us to look at more incentive-compatible policies for both consumers and retailers. We aimed at knowing whether there could be other polices instead of a ban, or other polices that could supplement the ban, in limiting plastic bag use. Towards this, we studied the feasibility and effectiveness of alternative policies in regulating plastic bag use in Delhi.

We implemented a mix of instruments to control the use of plastic bags hypothesizing that each one of them potentially addresses a different problem at hand. The results, with this mix of policies, show that our self-designed intervention played a significant role in altering consumer behavior towards bringing their own bag in lieu of the plastic bag from the retailer. In terms of efficacy, the cash-back scheme (at 5.5%) played a relatively more significant role than cloth bag and information through posters/banners, at 4.5% and 3.5% respectively, in changing consumer behavior towards reducing plastic bag usage.

A more detailed econometric analysis preserved these results. The additive nature of the effects points towards complementarities in these interventions in determining the outcomes. As discussed above, each of the interventions addresses different problems. For example, while posters could have mitigated information problems, subsidies (i.e., taxes) address the issue of pricing for the externality problem (akin to a Pigouvian tax) and the provision of alternative bags solves the problem of a low-cost substitution for the plastic bag. Therefore, cumulatively, these interventions increase the proportion of consumers bringing their own bags from 4.6% to 17.8%. On the other hand, plastic bags (only) usage on average came down from 79.1% to 65.8%.

A comparison with studies conducted in other countries where similar interventions were introduced, such as Ireland where plastic bag use came down by 90% (Convery,

[23] This includes cash transfers made to shop owners per bag.

2007) or China where it came down by 49% (Haoran, 2010), may suggest that the reduction in plastic bag use in our study as a result of the intervention is small but it is possible that the gap might go down over a period of time.

The study makes available several policy implications. First, for the ban to be effective, it should be enforced with credible information about the penalties both for shop owners and consumers. However, this is clearly lacking in the policies relating to the ban espoused by the Delhi government although imposing penalties on offenders (consumers or retailers) is vital for sending a signal to the users about the costs of violation. Secondly, a blanket ban may not be the best possible solution under weak institutional enforcement. Hence, we propose a combination of standards and right incentives, depending on the kind of retail activity, to bring down the use of plastic bags. Thirdly, information highlighting the environmental impacts of plastic bag usage can influence consumer behavior significantly. As seen in our study, relatively low cost interventions can change consumer attitudes towards reusable bags. Fourthly, subsidies either in cash or in kind (in the form of reusable bags) and explicit pricing could lead to lower plastic bag use.

Although not considered in our study, it would also be important to see to what extent the peer groups influence consumer behavior in switching from plastic bags to reusable bags. Historically, social interactions have played a significant role in correcting individual behavior for environmental externality problems. Hence, we expect norms and peer group effects to have an important effect on plastic bag usage as well.

Our findings on changes in plastic bag usage due to alternative policy interventions would be strengthened by a proper cost-benefit analysis of the reduction in plastic bag consumption, which requires estimating the social cost of plastic bag consumption and the actual costs of alternative instruments. This is undoubtedly fertile ground for future research.

Acknowledgements

This study was carried out under the supervision of my PhD advisor Rohini Somanathan, Delhi School of Economics, and SANDEE advisor Subhrendu Pattanayak. My heartfelt thanks go to both of them for their ideas, support and encouragement. The South Asian Network for Development and Environmental Economics (SANDEE) funded this study. I have received useful comments from several SANDEE advisors and participants of SANDEE biannual Research and Training Workshops in Kathmandu and Sri Lanka. Comments from Mani Nepal and an anonymous referee were very useful in improving the quality of this research. The SANDEE secretariat provided grant-related logistical help and travel support to attend biannual meetings. The students of the College of Arts at Delhi University designed the posters and women of neighboring villages stitched re-usable bags that were used in the experiment conducted in Delhi and the national capital region of Delhi. We collected our survey data with the help of selected third-year students of economics from Delhi University. My thanks to all of them.

References

Akullian, A., Caroline Karp, Kemen Austin, and Drew Durbin (2006), 'Plastic bag externalities and policy in Rhode Island', *Brown Policy Review Paper,* Available at: http://seattlebagtax.org/referencedpdfs/en-akullianetal.pdf [Accessed on: 1st December, 2008.

BBC News (2003), 'Indian state outlaws plastic bags', Available at: http://news.bbc.co.uk/2/hi/south_asia/3132387.stm, 7th August [Accessed on: 20 December, 2008].

Business Standard (2007), 'Future group plans 1500 fair price shops', Available at: http://www.business-standard.com/india/storypage.php?autono=293903, 9th August, [Accessed on: 19 January 2009].

Cummings, Ronald and Laura O. Taylor (1999), 'Unbiased value estimated for environmental goods: a cheap talk design for contingent valuation method', *The American Economic Review* **89(3):** 649-665.

Convery, F., Simon McDonnell and Susana Ferreira (2007), 'The most popular tax in Europe? lessons from the Irish plastic bags levy', *Environmental and Resource Economics* **38**: 1-11.

Dikgang, Johane and Martine Visser (2010), 'Behavioral response to plastic bag legislation in Botswana', *Environment for Development,* Discussion Paper Series, Resources for the Future, Washington DC, 10-13.

Duflo, Esther (2006), 'Field experiments in Development Economics', in Richard Blundell, Whitney Newey, and Torsten Persson, *Advances in Economics and Econometrics: Theory and Applications,* Ninth World Congress, Cambridge University Press, Vol II, 322-348

The Economist (2009),'India's urban environment: heavy baggage', January 29th, available at http://www.economist.com/node/13041382. [Accessed on: 19 December, 2008]

Express News Service (1998), 'No polybags: Mother Dairy outlets forget their resolve', December 22nd, available at: http://www.indianexpress.com/story.php?storyId=69397 [Accessed on: 19 December, 2008].

Express India (2008), 'Plastic bags banned, blamed for Maha floods', August 27, available at: http://www.expressindia.com/news/fullstory.php?newsid=53482 [Accessed on: 19 December, 2008].

Gupta, Kanupriya and Rohini Somanathan (2009), 'Regulatory policies to limit the use of plastic bags in Delhi', Report of a study commissioned by the Department of Environment, Government of Delhi, India.

Gupta, Kanupriya and Rohini Somanathan (2011), 'Peer group effects in environment friendly behavior: the case of reusable bags', Working Paper from the Study Funded by South Asian Network of Environmental and Developmental Economics, Forthcoming.

Harrison, Glenn W. and John A. List (2004), 'Field experiments', *Journal of Economic Literature* **XLII:** 1009-1055.

Haoran, He (2010), 'The effects of an environmental policy on consumers: lessons from the Chinese plastic bag regulation', Working Paper No. 453, University of Gothenburg, Sweden.

Jalan, Jyotsana and E. Somanathan (2008), 'The importance of being informed: experimental evidence on demand for environmental quality', *Journal of Development Economics* **87**: 14-28.

Killian, Sheila (2005), 'Revenue services and environmental taxes: a comparative study of the Irish and South African approaches to a levy on plastic bags', in A. Calvieri (ed.), *Critical Issues in Environmental Taxation III, Richmond Law and Tax* **26**: 491-507

Manski, Charles (1993), 'Identification of endogenous social effects: the reflection problem', *The Review of Economic Studies* **60(3)**: 531-542.

Mullainathan, Sendhil, Joshua Schwartzstein and Andrei Shleifer (2006), 'Coarse thinking and persuasion', NBER Working Paper No. 12720, Available at: http://www.nber.org/papers/w12720, [Accessed on: 19 December, 2008].

Naryan, Priya (2001), 'Analyzing plastic waste management in India: case study of polybags and pet bottles', M.Sc. Thesis Submitted to the University of Lund, Sweden.

Reeson, Andrew (2008), 'Institutions, motivations and public goods: theory, evidence and implementation for environmental policy', Socio-Economics and the Environment in Discussion (SEED) Working Paper Series, 2008-01, CSIRO Sustainable Ecosystems, Australia.

Spivy, Angela (2003), 'Plastic bags-prolific problems,' *Environmental Health Perspectives'* **111(4):** 208.

The Energy Research Institute (2002), 'Plastic waste management for Delhi', Report Submitted to Department of Environment, Government of Delhi, India.

Yang, Hai-lan and Robert Innes (2006), 'Economic incentives and residential waste management in Taiwan: an empirical investigation', Environmental *and Resource Economics* **3**7: 489-519.

UNEP (2006), 'Policy instruments for the management of plastic bags in Nairobi', Report prepared by Kenya National Cleaner Production Centre, Nairobi.

World Bank Institute (2008), *Improving Municipal Solid Waste Management in India: A Source-book for Policy Makers and Practitioners,* Washington, D.C.: World Bank.

Young, Peyton (forthcoming), ‘Innovation diffusion in heterogeneous populations: contagion, social influence and social learning’, *American Economic Review* **99(5):** 1899-1924.

Figures

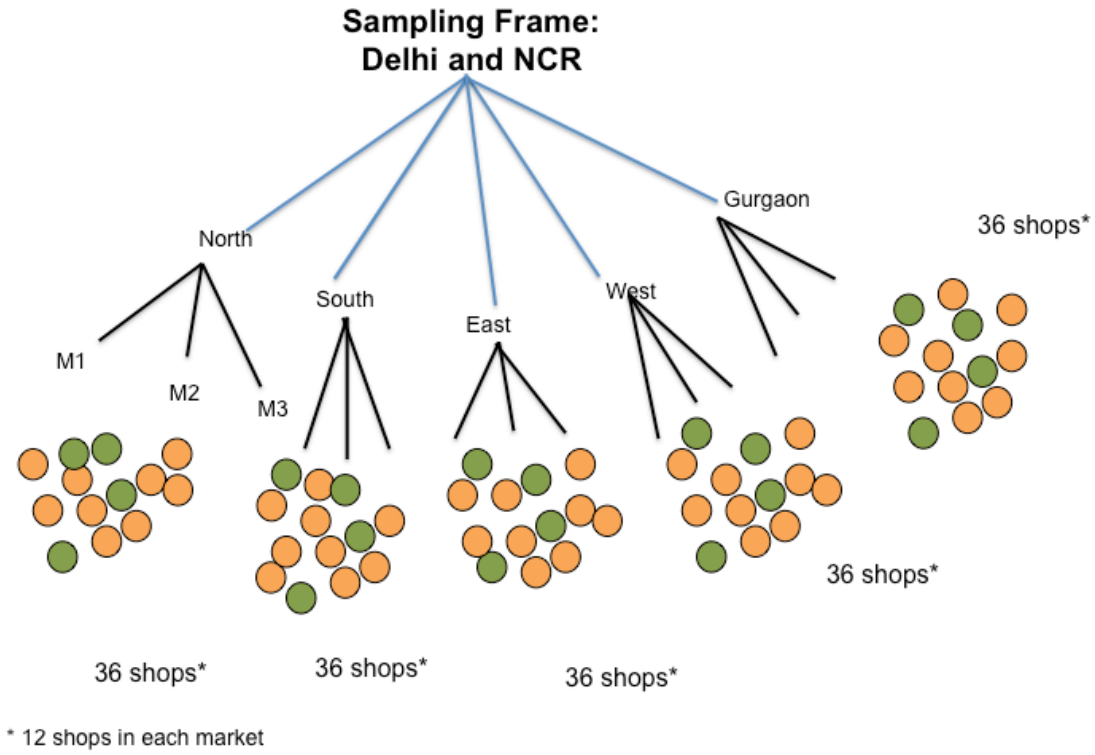


Figure 1: Sampling Strategy

Figure2: The Experimental Design

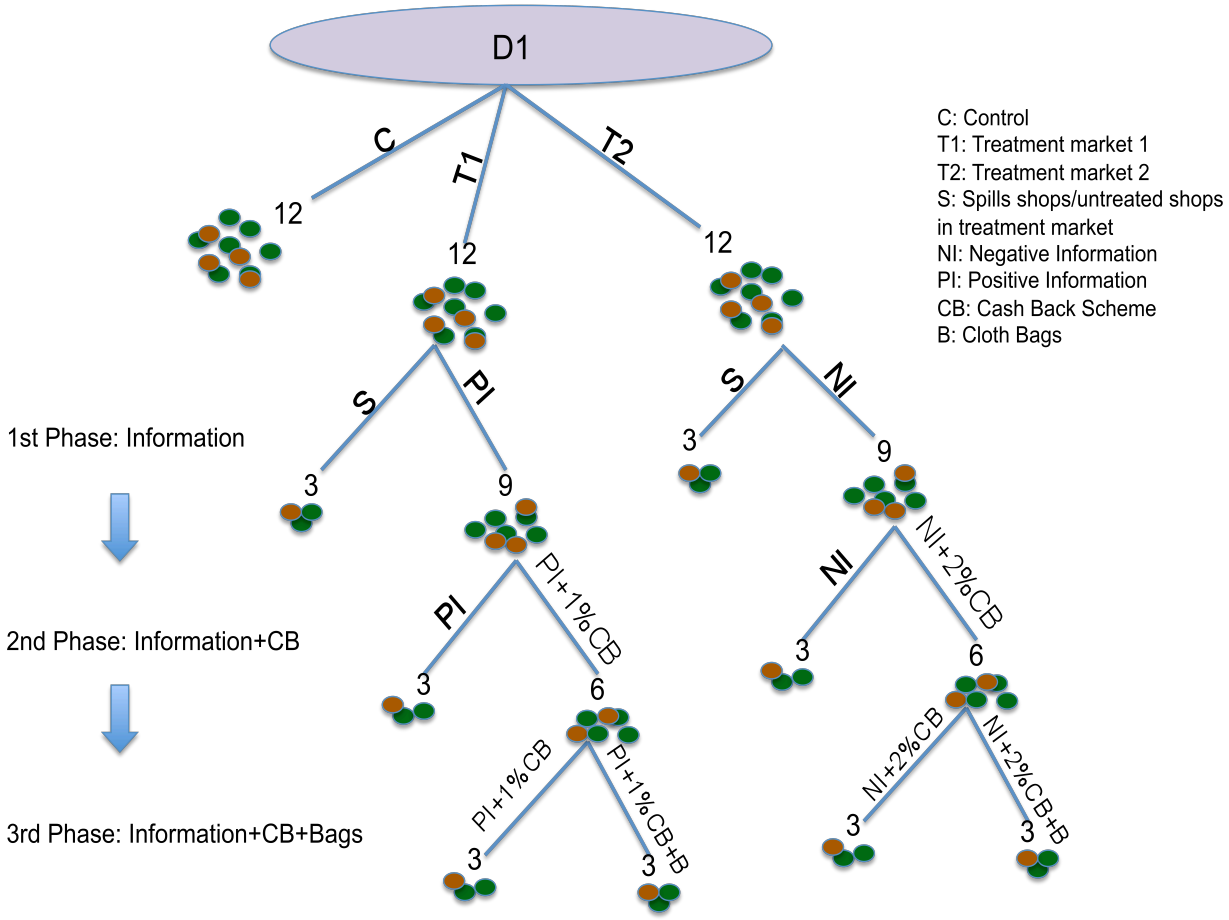
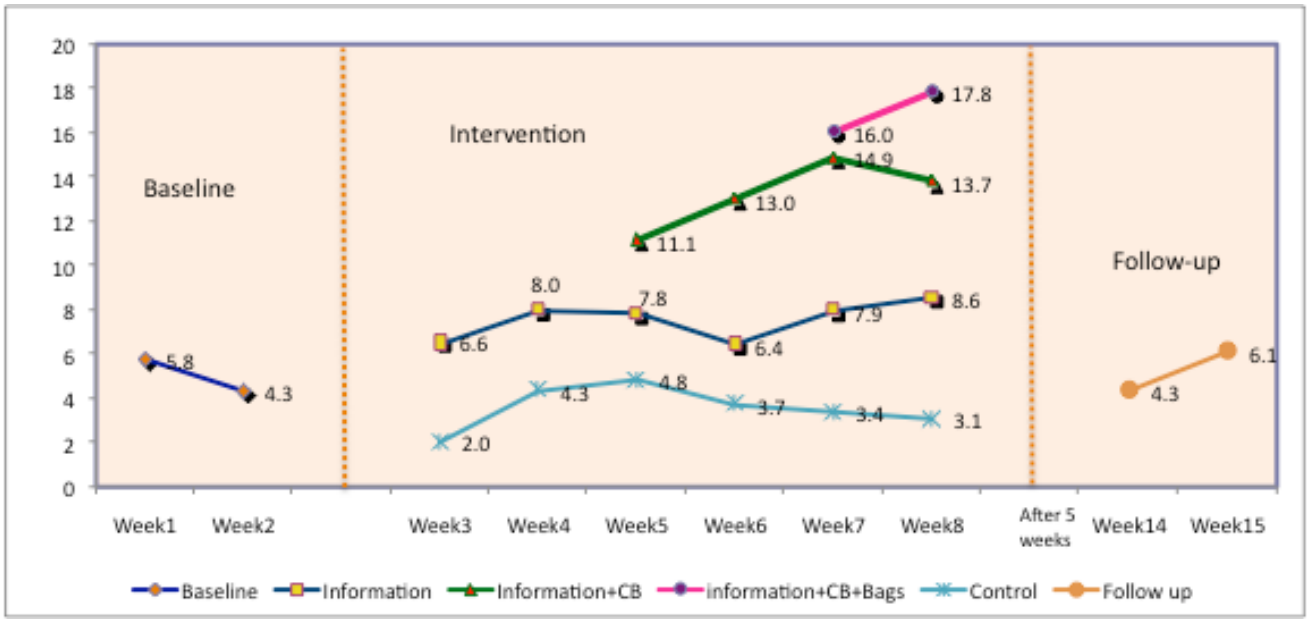
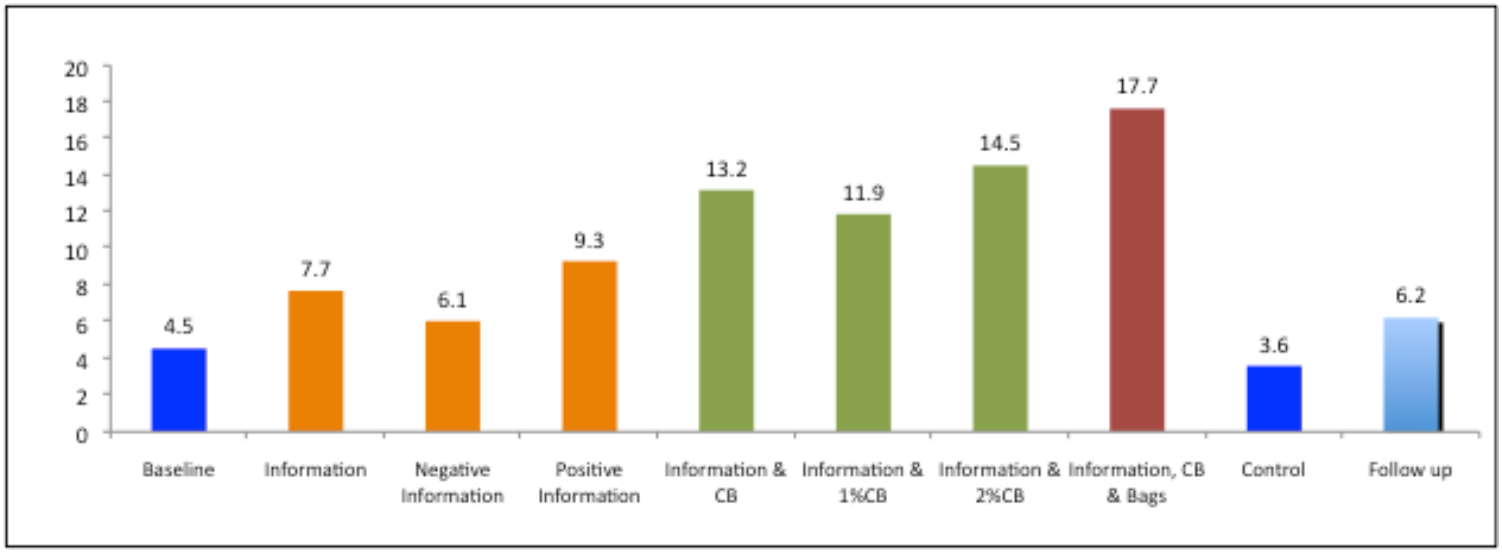


Figure3: The Field Experiment: Sequential and Squeezing Intervention



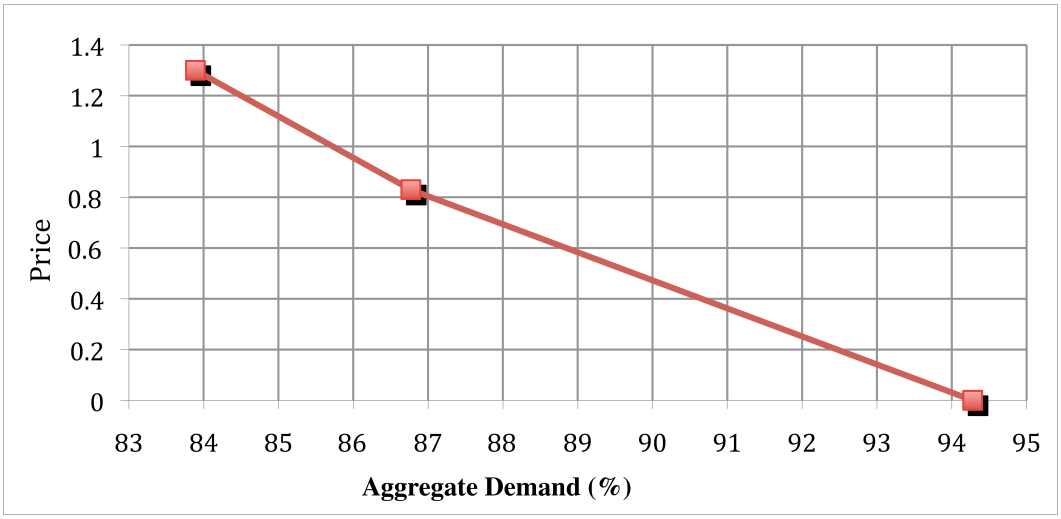
Source: Survey data from Delhi-NCR
Note: Values are two week moving averages

Figure 4: Impact of Differential Interventions on Own Bag Usage Over Time



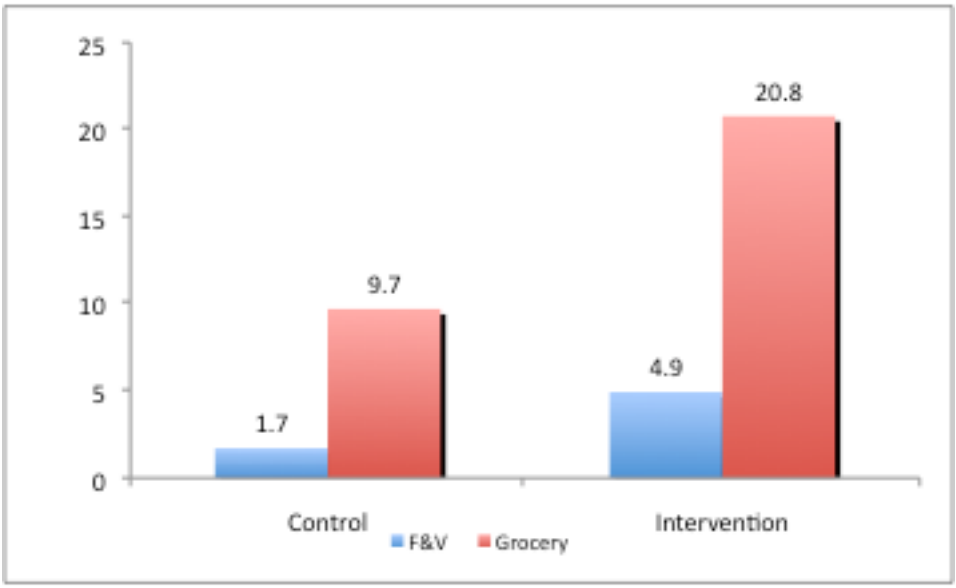
Source: Survey data from Delhi-NCR

Figure 5: Average Impact of Differential Interventions on Own Bag Usage



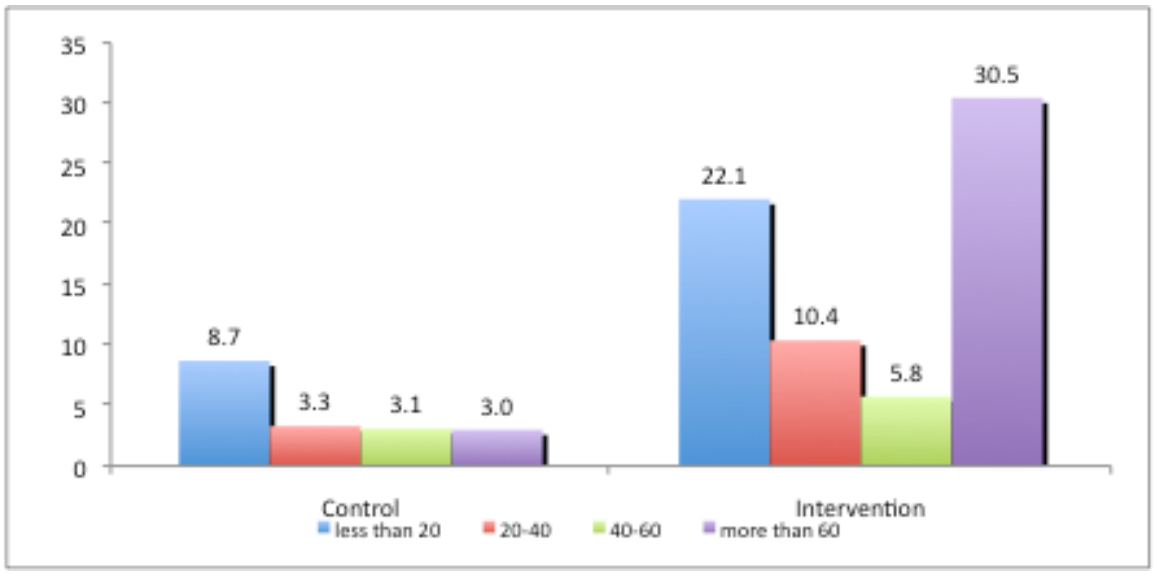
Source: Survey data from Delhi-NCR

Figure 6: Elasticity of Demand for Plastic Bags



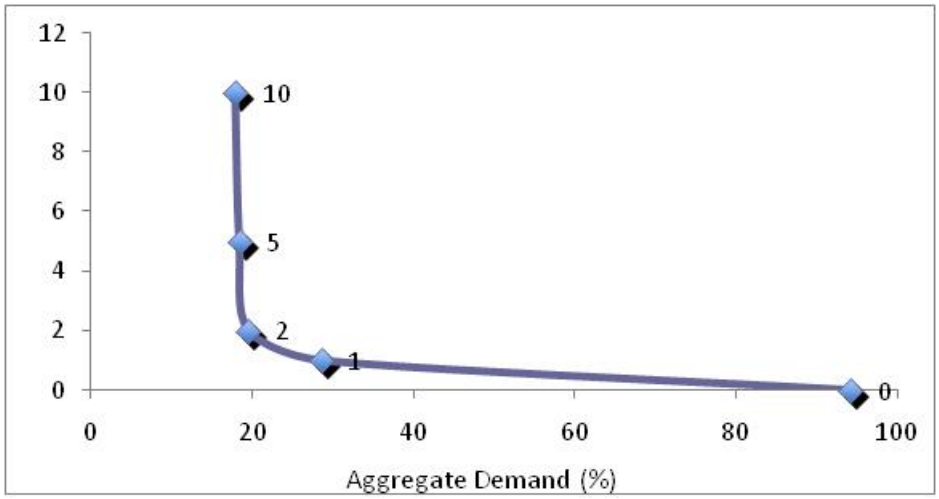
Source: Survey data from Delhi-NCR

Figure 7: Proportions of Consumers Bringing Their Own Bag by Shop Type



Source: Survey data from Delhi-NCR

Figure 8: Proportions of Consumers Bringing Their Own Bag by Age



Source: Survey data from Delhi-NCR

Figure 9: Revealed Percentage of Demand for Plastic Bags at Different Prices

Tables

Table 1: Percentage of Consumers by Types of Bags Used in Baseline, Control, Interventions and Follow-up

	Baseline	Control	Information	Information and Cashback	Information, Cashback and Cloth Bag	Follow up
Plastic Bag Only	80.8	79.1	70.7 (8.2)***	61.2 (14.7)***	57.1 (12.9)***	71.8 (7.6)***
Paper Bag Only	1.0	0.2	0.5 (-2.2)**	1.3 (-5.3)	0.0 (1.2)	0.5 (2.3)***
Own Bag Only (Plastic)	0.5	0.1	0.8 (-4.5)***	1.3 (-6.1)***	0.7 (-3.4)***	0.4 (-2.7)***
Own Bag Only (Non-plastic)#	4.1	3.5	7.0 (-6.7)***	11.9 (-12.5)***	17.0 (-14.6)***	5.9 (-5.1)***
Plastic & Own	12.3	15.6	19.7 (-4.5)***	22.9 (-6.9)***	22.8 (-4.8)***	20.0 (-5.2)***
Mixed	1.3	1.6	1.3 (1.1)	1.5 (0.3)	2.5 (-1.7)**	1.5 (0.36)

Source: Survey data from Delhi-NCR

Notes

1. # includes no bag used
2. Values in parenthesis is the z statistic for the proportion difference test between the control and the interventions for each type of bag used by the consumer.

*** significance at 1% level, ** significance at 5% level and * significance at 10% level.

Table 2: Description, Mean and Standard Deviation of Explanatory Variables

Variable	Description	Mean	Standard Deviation	Min	Max
Information	Dummy variable indicating the presence of information treatment.	0.16	0.37	0	1
Information & Cashback	Dummy variable indicating the presence of information and cash-back treatment.	0.10	0.30	0	1
Information, Cashback & Cloth Bags	Dummy variable indicating the presence of information, cash-back and cloth bags treatment.	0.04	0.19	0	1
Weekend	Dummy variable taking value 1 for the weekend (Saturday and Sunday) and 0 for weekdays (Monday to Friday)	0.27	0.44	0	1
Grocery	Dummy variable for the shop type taking value 1 for grocery shop and 0 for fruits and vegetables shop.	0.30	0.46	0	1
Soft F&V	Number of soft fruits and vegetables purchased by the consumer	0.44	0.65	0	5
Wet Items	Number of wet items purchased by the consumer like dairy products, cut fruits and vegetables.	0.07	0.28	0	3
Unpacked Grocery	Number of unpacked grocery items purchased by the consumer.	0.16	0.50	0	5
Female	Dummy variable taking value 1 for the consumer being female and 0 for males.	1.47	0.49	1	2
Age	Dummy variable for the age of the consumer.	2.29	0.66	1	4
Zone	Dummy variable indicating the zone of the sampling frame.	2.96	1.41	1	5
Education	Dummy variable indicating education of the consumer	5.16	1.37	2	7
Income	Dummy variable indicating income category of the consumer taking value 1 if the consumer is earning and 0 for non-earning.	0.46	0.49	0	1
Distance to the Market	Distance from the residence of the consumer to the market (in km)	1.73	3.57	0	50
Transport	Dummy variable indicating mode of transport used by the consumer to reach the market.	1.40	0.61	1	3
Plastic Bag Reuse	Dummy variable indicating what the consumers do with plastic shopping bags after taking home.	0.65	0.48	0	1

Source: Survey data from Delhi-NCR

Table 3: Analysis of Own Bag Use Using Probit Model

Dependent Variable: Consumer Brings Own Bag		
	Model 1	Model 2
	Marginal Effects (with Robust Standard Errors)	
Information	0.02***	-
Negative Information	-	0.01
Positive Information	-	0.03***
Information & Cash back	0.06***	-
Information & 1% Cash back	-	0.05***
Information & 2% Cash back	-	0.09***
Information, Cash-back & Cloth Bags[1]	0.11***	0.11***
Weekend	-0.01**	-0.01**
Grocery	0.13***	0.13***
Soft F&V	-0.02***	-0.02***
Wet Items	-0.03***	-0.03***
Unpacked Grocery	-0.07***	-0.07***
Female	0.01***	0.01***
Age: less than 20yrs [2]	0.06***	0.06***
Age: 20-40yrs	0.02***	0.01***
Age: more than 60yrs	0.10***	0.10***
Zone: North [3]	-0.02***	-0.02***
Zone: East	-0.01*	-0.01*
Zone: West	-0.001	0.0001
Zone: Ghaziabad	-0.02***	-0.02***
Education: Middle [4]	-0.0001	0.0007
Education: Class 10	0.01	0.01
Education: Class12	0.01	0.01
Education: Graduates and above	0.02**	0.02**
Income: Non-earning	0.01**	0.01**
Distance to the Market	0.001***	0.001***
Transport: Walked [5]	0.01*	0.01*
Transport: Public(Small)	0.01	0.01
Transport: Public(Big)	0.01	0.01
Plastic Bag Reuse	0.01*	0.01*
Observations	14,994	14,994

Source: Survey data from Delhi-NCR

*** significance at 1% level, ** significance at 5% level and * significance at 10% level

1. Omitted category: No intervention
2. Omitted category: 40-60 years
3. Omitted category: South zone
4. Omitted category: Primary class
5. Omitted category: Private transport

Table 4: Analysis of Own Bag Use using Probit Model by Shop Type

	Dependent Variable: Consumer Brings Own Bag in the Grocery Shops		Dependent Variable: Consumer Brings Own Bag in the Fruits and Vegetable Shops	
	Model 1	Model 2	Model 3	Model 4
	Marginal Effects (with Robust Standard Errors)			
Information	0.06***	-	0.01	-
Negative Information	-	0.04**	-	-0.00
Positive Information	-	0.09***	-	0.01**
Information & Cash back	0.12***	-	0.04***	-
Information & 1% Cash back	-	0.12***	-	0.02**
Information & 2% Cash back	-	0.14***	-	0.07***
Information, Cash-back & Cloth Bags[1]	0.19***	0.19***	0.08***	0.08***
Weekend	-0.003	-0.005	-0.01***	-0.01***
Grocery				
Soft F&V	-	-	-0.01***	-0.01***
Wet Items	-0.08***	-0.08***	-0.002	-0.002
Unpacked Grocery	-0.13***	-0.13***	-	-
Female	-0.004	-0.005	0.02***	0.02***
Age: less than 20yrs [2]	0.14***	0.14***	0.03***	0.03***
Age: 20-40yrs	0.05***	0.06***	0.002	0.002
Age: more than 60yrs	0.24***	0.24***	0.06***	0.06***
Zone: North [3]	-0.06***	-0.06***	0.002	0.003
Zone: East	-0.03**	-0.03**	0.003	0.003
Zone: West	0.02	0.02	0.003	0.003
Zone: Ghaziabad	-0.08***	-0.08***	0.01**	0.01**
Education: Middle [4]	0.02	0.02	-0.01	-0.01
Education: Class 10	0.04*	0.04*	-0.001	-0.001
Education: Class12	0.05**	0.05**	-0.003	-0.003
Education: Graduates and above	0.05**	0.05**	0.003	0.003
Income: Non-earning	0.02	0.01	0.01*	0.01**
Distance to the Market	0.004***	0.004***	0.001**	0.001**
Transport: Walked [5]	0.02	0.01	0.003	0.003
Transport: Public (Small)	0.08**	0.08**	-0.003	-0.004
Transport: Public (Big)	0.05*	0.05*	-0.01	-0.01
Plastic Bag Reuse	0.01	0.004	0.004	0.004
Observations	4,409	4,409	10,585	10,585

Source: Survey data from Delhi-NCR

*** significance at 1% level, ** significance at 5% level and * significance at 10% level

1. Omitted category: No intervention
2. Omitted category: 40-60 years
3. Omitted category: South zone
4. Omitted category: Primary class
5. Omitted category: Private transport

Table 5: Analysis of Own Bag Use Using Shop Fixed Effects Model

Dependent Variable: Consumer Brings Own Bag		
	Model 1	Model 2
	Coefficients (with robust standard errors)	
Information	0.02**	-
Negative Information	-	0.01
Positive Information	-	0.03***
Information & Cash-back	0.06***	-
Information & 1% Cash-back	-	0.05***
Information & 2% Cash-back	-	0.08***
Information, Cash-back & Cloth Bags[1]	0.11***	0.11***
Weekend	-0.01**	-0.01**
Soft F&V	-0.01***	-0.01***
Wet Items	-0.06***	-0.06***
Unpacked Grocery	-0.09***	-0.09***
Female	0.02***	0.02***
Age: less than 20yrs [2]	0.06***	0.06***
Age: 20-40yrs	0.01***	0.01***
Age: more than 60yrs	0.10***	0.10***
Zone: West [3]	0.07***	0.07***
Education: Middle [4]	0.003	0.003
Education: Class 10	0.01	0.01
Education: Class12	0.02	0.02
Education: Graduates and above	0.02*	0.02**
Income: Non-earning	0.01**	0.01*
Distance to the Market	0.002***	0.002***
Transport: Walked [5]	0.001	0.001
Transport: Public (Small)	0.02	0.02
Transport: Public (Big)	0.01	0.01
Plastic Bag Reuse	0.004	0.004
Constant	0.01	0.01
Observations	14,994	14,994

Source: Survey data from Delhi-NCR

*** significance at 1% level, ** significance at 5% level and * significance at 10% level

1. Omitted category: No intervention
2. Omitted category: 40-60 years
3. Omitted category: South zone
4. Omitted category: Primary class
5. Omitted category: Private transport