

Working Paper No. 111-16

Plastic Bag Ban in Nepal: Enforcement and Effectiveness

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Published by the South Asian Network for Development and Environmental Economics (SANDEE)
PO Box 8975, EPC 1056, Kathmandu, Nepal.
Tel: 977-1-5003222 Fax: 977-1-5003299

SANDEE research reports are the output of research projects supported by the South Asian Network for Development and Environmental Economics. The reports have been peer reviewed and edited. A summary of the findings of SANDEE reports are also available as SANDEE Policy Briefs.

National Library of Nepal Catalogue Service:

Bishal Bharadwaj

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(SANDEE Working Papers, ISSN 1893-1891; WP 111–16)

ISBN: 978-9937-596-35-0

Keywords

Plastic bag ban

Enforcement

Effectiveness

Municipalities of Nepal

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August 2016

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The South Asian Network for Development and Environmental Economics

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SANDEE is financially supported by the International Development Research Center (IDRC), The Swedish International Development Cooperation Agency (SIDA), the World Bank and the Norwegian Agency for Development Cooperation (NORAD). The opinions expressed in this paper are the author's and do not necessarily represent those of SANDEE's donors.

The Working Paper series is based on research funded by SANDEE and supported with technical assistance from network members, SANDEE staff and advisors.

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Abstract

The rampant use of plastic bags in Nepal has led to growing concern in recent years regarding the impact of discarded plastic bags on the environment. Though a number of different control measures are being implemented to curb the release of this type of waste into the environment, policy makers are uncertain about their effectiveness. From 2010, some Nepalese municipalities have banned plastic bags but the effectiveness of this ban is not even. We investigate how the different levels of subjective expectation of fine of the bans affect plastic bag use. Survey information on retailers and consumers from 14 municipalities in Nepal show that the partial ban does not help to reduce plastic bags use, a finding that highlights the ineffectiveness of the National Plastic Bag Reduction and Regulation Directives 2011 that aim to enforce a selective ban on black plastic bags less than 20 microns thick. Our results indicate that a strict enforcement, subjective expectation of fine, of a complete ban on plastic bag use will reduce the number of plastic bags used by consumers by around 95% and the weight of plastic bags used by retailers by almost 100% as compared to a poorly enforced complete ban, a partial ban, or no ban. Ensuring the highest level of subjective expectation of fine in the 191 municipalities of Nepal will help stop 1250 million single-use plastic bags from entering the environment every year.

Keywords

Plastic bag ban; enforcement; effectiveness; Municipalities of Nepal

JEL Classification: Q580

Plastic Bag Ban in Nepal: Enforcement and Effectiveness

1. Introduction

The widely used single-use plastic bag is a major source of non-degradable solid waste across South Asia. In the absence of proper management, plastic waste pollutes the soil, and gets deposited in water sources (Baker, 2010). It reduces the scenic beauty of the landscape and clogs drainage, which might result in urban flooding (Spivy, 2003). When plastic is burnt, it pollutes the air and, when buried in a landfill site, it remains for a long time.

Realizing the potential negative impacts of plastic bags, many countries are using command and control as well as market-based approaches to reduce their usage. Studies suggest that the effectiveness of these various interventions are context-specific and depend very much on how they are implemented (He, 2010; NOLAN- ITU Pty. Ltd., 2002; AECOM, 2010). For example, despite a ban on the production, distribution and usage of plastic bags in Bangladesh and parts of India, violations of this regulation are common (Gupta, 2011).

Plastic bag charges and bans are not uniformly positive. Though plastic bag bans affect consumer behavior (OEA, 2011) reducing the use of such bags, it has some negative implications like job losses (BHI, 2011), substitution costs (Sapphos Environmental Inc., 2010), and increased use of reusable plastic bags (Waters, 2015).

In Nepal, plastic bags have been identified as a cheap and convenient replacement for paper bags since the early 1990s. Retailers do not charge separately for plastic bags, thus discouraging consumers from carrying their own bags. As a result, the contribution of plastics to Nepal's solid waste stream is increasing (Manandhar, 2012). While the contribution was a little over 8% in 2008, it had gone up to 11% by 2012 (SWMTSC, 2008; 2012).

The government of Nepal started to regulate the use of plastic bags by enforcing the Plastic Bag Reduction and Regulation Directive of 2011.¹ This Directive restricts both the use and the production of plastic bags that are less than 20 microns thick. At the local level, several municipalities have also been regulating the use of plastics bags, using a variety of approaches for the past few years. Out of Nepal's 58 municipalities², ten municipalities have been implementing a complete ban while six are implementing a partial ban based on color and thickness. However, the effectiveness of the bans varies significantly across the municipalities. This study investigates the impact of the variations in subject expectation of fine, a measure of enforcement, on the behavior of both retailers and consumers via consumer and retailer surveys in 56 sites of 14 municipalities. As the plastic bag ban is not completely random across the municipalities, we use city police per capita, an instrumental variable to enforcement, subjective expectation of fine, as an identification strategy. Our results indicate that a strict enforcement of a complete ban on plastic bag use will reduce the number of plastic bags used by consumers by around 95% and the weight of plastic bags used by retailers by almost 100% as compared to a poorly enforced complete ban, a partial ban, or no ban. Ensuring the highest level of subjective expectation of fine in the 191 municipalities of Nepal will help stop 1250 million single-use plastic bags from entering the environment every year.

¹ The Directive was amended in 2014 lifting the minimum allowable thickness to 40 micron.

² There were 58 municipalities when the survey was conducted. In 2014, the number of municipalities increased to 191.

2. Plastic Bag Regulations in Nepal

2.1 National level ban

The history of plastic bag bans in Nepal goes back to 1998 when Hetauda Municipality first declared a ban on plastic bags. The effectiveness of this plastic bag ban gradually faded with time and had almost reached oblivion by 2005. However, from 2010, other municipalities in Nepal have started banning plastic bags. These decisions were backed by two laws: the first being the Nepal Local Self Governance Act 1999 and Regulation 2000 by which local bodies were granted the right to ban goods and activities that damage the environment; the second being the Plastic Bag Regulation and Control Directive 2011, which prohibits the production, import, sale, distribution and use of plastic bags that are less than 20 micron in thickness (MOEST, 2011). The Kathmandu Metropolitan City was among to declare a ban on plastic bags in April 2013. But the ban resulted in a stay order by the Supreme Court of Nepal on ban implementation consequent to a writ application filed by the Plastic Material Production Association. Though the Court decided in favor of the Kathmandu Metropolitan City, a year or so later, the ban remained unimplemented. In April 2015, following a Parliament Environment Committee direction to ban plastic bags, the Government of Nepal reimposed the ban.

2.2 Municipality-level ban and its enforcement:

In 2010, Ilam Municipality implemented a complete ban of plastic bags that was followed by other municipalities. However, as mentioned before, the 2013 complete ban on bags by the Kathmandu Metropolitan City was temporarily suspended when the Nepal Supreme Court issued a stay order in favor of the country's association of plastic bag producers. Baglung Municipality in 2011 decided to ban black plastic bags, which are believed to be more harmful to the environment than plastic bags of other colors and some other municipalities followed suit. The diverse approaches used by the municipalities on reducing the use of plastic bags would serve as test cases for the implementation of a partial or a complete ban on plastic bags of all colors. Not all municipalities are enforcing the bans that they have put in place. Among reasons reported during focus group discussions for such weak- or non-enforcement include weak cooperation from the retailer associations; a lack of resources; changes in priorities of the municipalities; and lack of cooperation from civil society.³

The typical procedure required to set up and implement a plastic bag ban takes months. It includes: a) approval from the relevant municipal council; b) discussions with relevant stakeholders; c) an awareness-raising campaign; d) the formation of a coordination team; e) a public appeal (which takes place a few weeks before the declaration of the ban); f) the ban declaration (which involves a public gathering); g) intensive monitoring of the ban, which lasts for several weeks; h) a gradual reduction in the level of monitoring; and i) occasional monitoring. Municipalities mobilize the city police to monitor the violation of the plastic bag ban though each of these measures for implementation incurs a cost to the municipalities. In the context of Nepal, implementing a typical ban costs around a million Nepalese rupees (USD 10,000) in 2014.⁴ The determinants of costs are the size of the municipality, population, types of business, and retailer density.

The preparatory activities that take place before the bans are put in place differ between municipalities. While some have resorted to buying back plastic bags from retailers, others give retailers a grace period to use their stock. In the initial days of the ban, monitoring is intense and done by a committee, represented by different stakeholders like the retailer's association, environmentalists, and municipal officials, to persuade, raise awareness and ensure smooth implementation. After it has been in place for a while, it is handed over to the city police for monitoring targeted areas where the incidence of offences is high.

³ From discussions with executive officers and/or relevant municipal staff.

⁴ Based on interviews with concerned officials from municipalities enforcing the plastic bag ban.

2.3. Factors affecting ban compliance

Compliance by consumer: Compliance with the plastic bag ban is determined by many factors including the level of enforcement (Lane & Potter, 2007; Ravara, *et al.*, 2013; Bhate & Lawler, 1997), however compliance is complex to predict (Efron, 1997). Consumers normally look for cost-free bags that they can conveniently use. As a result, during the initial days of a ban, consumers often forget to bring their own bags (Zen, *et al.*, 2013). A consumer who is aware of the ban and its consequences is more likely to use a reusable bag (Winter & May, 2001; Alm, *et al.*, 2009). Individual characteristics like education, age, and attitude are also associated with compliance (Becker, 1968; Barnes, *et al.*, 2011; Winter & May, 2001; Convery, *et al.*, 2007; He, 2010; Ravara, *et al.*, 2013; Zhang, *et al.*, 2007). Convenience is also influenced by cultural factors and individual choice (Burns & De Vere, 1982). Some consumers have a habit of using reusable bags. For instance, women in Nepal generally carry reusable bags with them. A wide range of literature, including Becker (1968) and Winter and May (2001), discusses how motivation determines compliance.

Compliance by retailer: Retailer compliance with a plastic bag ban is different from consumer compliance, both in terms of cost and the threat of being caught. Retailers' associations are linked in many ways with their local municipalities and are also normally involved in the decision to introduce a ban. A plastic bag ban can bring a double bonus to retailers: it helps to reduce the cost of buying plastic bags while allowing a retailer to earn profits by selling reusable bags. In addition, the intensity and effectiveness of enforcement activities also depend on municipality characteristics such as area, population, revenue and literacy rates. The bigger the municipal area and larger its population, the greater is the effort that is required to maintain the threat of fine (Tyran & Feld, 2006). The poverty rate is inversely related with plastic bag use, as consumption tends to be lower with increased poverty. In contrast, the literacy rate is positively related with awareness on plastic bag harm to the environment.

3. Theoretical Framework

Plastic bag bans affect consumer behavior (OEA, 2011). Sustainable compliance with a plastic bag ban involves two different behavioral changes. First, giving up plastic bag use and, second, adoption of reusable bags (Taylor & Villas-Boas, 2015). A municipality would use various enforcement activities to ensure compliance (Egbue & Long, 2012).

We define Enforcement = Probability of being caught (p) * amount of municipality fine (f),

Where the probability of being caught is a subjective judgment on the part of the consumer/retailer which is elicited from the survey whereas the fines are decided by the municipalities in Nepalese Rupees⁵. Subjective self-reported measures of enforcement can strongly predict the level of actual enforcement (Burby & Paterson, 1993). To assess this, a five-point Likert-type scale has been used in various studies (Burby & Paterson, 1993; Rooij, *et al.*, 2013). The consumer's/retailer's sense of the probability of being caught is largely determined by municipal enforcement activities such as awareness-raising campaigns and monitoring by city police (Laurian, 2003).

The enforcement that takes place under different ban scenarios has different targets. The enforcement of partial bans is focused on the thickness and color of bags, whereas, in a complete ban, it covers all types of single use plastic bags. Subjective expected fine equals zero if a municipality fails to implement its ban or if it does not impose a fine on violators. The municipality implementation strategy is designed to create awareness on, participation in, and preparation for plastic bag ban so that all stakeholders are made adequately cognizant of the ban. It is noteworthy that intense monitoring during the initial days contributes to a fear among potential violators of being caught and fined, so that occasional monitoring there after would be adequate to maintain the ban⁶. The enforcement is explained as subject expectation of fine for consumer/retailer.

⁵ 1 US\$ is equivalent to NRs 95 during survey period.

⁶ Based on the focus group discussion with complete ban municipalities.

A ban will not be effective or will fall short of full enforcement unless consumers are offered an alternative to plastic bags. Plastic bags offer a convenient way to carry goods and they are something for which retailers do not in general charge separately. In addition, plastic bags have an advantage over paper bags when it comes to carrying wet goods such as meat and milk, where the substitutes are costly to afford or inconvenient to use. It is therefore clear that the threat of being caught alone might not coerce a user to carry a reusable bag.

As fines are several times higher than the cost of a reusable bag, and using a plastic bag, usually, does not have any tangible and direct benefit over a reusable bag, consumers should choose a reusable bag as long as the subjective perception of being fined exists. Thus, a large fraction of consumers would comply even at a low level of subjective expectation of fine (Taylor & Villas-Boas, 2015). This is in line with what Groot and Schuitema (2012) say about the widespread acceptance and popularity of policy that targets low cost behavior in United Kingdom. However, if the fine is very small (i.e., around the cost of a reusable bag) or that the probability of being fined is low, then the consumers may pay the fine if caught and carry on using a plastic bag, as in the case of parents who cannot be deterred, due to the small amount of the fine, from arriving late to pick up their children from child care centers (Gneezy & Rustichini, 2000).

4. Methods

4.1 Data collection

We surveyed 56 clusters of consumers and retailers in 14 municipalities of Nepal. The total sample size was 1,661 for retailers and 1,375 for consumers. We used stratified random sampling to choose the clusters. We grouped the 58 municipalities of Nepal into three categories based on their approach to plastic bag bans. Four municipalities were randomly selected from the 'partial' and 'no ban' categories, six were selected from the 'complete ban' category. We randomly chose three to five clusters from each municipality depending on their population.

We collected data through personal interviews with the retailers. In the given municipalities, we selected roads randomly while all shops along each selected road were surveyed to get the allocated sample size in the given cluster. This approach helped to reduce enumerator biases in selecting one or the other retail store in a given cluster.

We followed the cluster randomization method, similar to Gupta (2011), where the same clusters are used to survey consumers. The cluster includes cross roads, junctions, and shopping locations where we surveyed those consumers who agreed to respond to our questions. Once a consumer had been surveyed, or if he or she refused (which was the case with 20% to 35% of consumers approached), then the enumerator moved to the very next consumer. Most of the consumers who refused to take part in our survey stated "lack of time" as their reason. This statement is similar to the reason stated in He (2010).

Our consumer questionnaire was designed to capture the effect of the enforcement of full and partial municipal plastic bag ban. Consumers' weekly use of single-use bags was recorded and broken down by the type of things the bags were used to carry (e.g., grocery, dairy, meat, vegetables, cloth, medicine, other types of goods, etc.). Respondent were asked if they bought/used a certain type of product or not. If they answered 'yes', they were asked how many times a week they used the product and how they carried it. If they said that they carried the product, they were asked what type of bag they used. This allowed information to be gathered on the number and type of bags used and the things that these bags were used for. A typical interview went along these lines:

- | | |
|--|-------------|
| Q: Do you consume meat? | A: yes. |
| Q: How many times a week? | A: twice. |
| Q: What type of bag do you use, plastic or reusable? | A: plastic. |

The enumerator would note, with regard to the scenario noted above, that the respondent used four bags a week to carry meat as meat vendors use two bags (one for packing and the other for carrying) when a customer buys meat.

Consumers/Retailer were also asked about how likely it was that they would be caught and fined for using a plastic bag if they were living in a municipality with ban enforcement. A typical question followed the following sequence.

Q. Do you know about plastic bag ban? A: Yes/No

Q. Do you know about the fine? A: Yes/No

Q. If you use a plastic bag or violate the plastic bag ban rule (for those who said 'yes' to the above questions), how much do you think that

a. You will be caught? A:sure/very high/high/low/not at all

A survey along municipality was used to collect ban information, amount of fine. Fine in practice was used because some municipalities has described maximum amount of fine that can be charged but office uses acertain amount of fine or cost imposing response during implementation.

4.2 Empirical method

All types of plastic bag bans are meant to reduce the use of plastic bags and to stimulate the use of reusable bags. The types of plastic bag covered by this study include single-use shopping or thin plastic bags. Reusable bags are available in many forms. This study includes reusable bags (made of paper, cloth, jute and other materials) that are widely used as a substitute for single-use plastic bags. Generally, retailers buy reusable bags in bulk and sell them individually. The unit of analysis we used for retailers was 'daily bag use in grams per day' as plastic bags come in different sizes and they purchase by weight. The unit of analysis we used for consumers was 'the number of bags used last week'. The quantity of plastic bags used per day describes the level of offence and the use of reusable bags describes the level of compliance where plastic bags were banned. We used these two types of bags as dependent variables to examine the effect of the subjective expectation of fine of a plastic bag ban.

We use the following model to estimate the effect of the ban on types of bag usage:

Quantity of Bags Used = f (bag ban decision, subjective expectation of fine, and characteristics of individual, household and municipality) (1)

Research indicates that the policy decision, plastic bag ban in our study; and enforcement are not random (Gray & Shadbegian, 2005). For example, municipalities tend to impose a ban where the problem is severe and concentrate enforcement in areas where compliance is low. In order to address this selection issue, we use a city police per capita as instrument variable for subjective expected fine while estimating equation (1).

Local self-governance Act, 1999 authorizes municipalities to recruit and mobilize city police to support enforcement of municipal decision though monitoring and catching the offender. There is a wide variety of activities, from urban infrastructure, solid waste management, maintaining public places, environment management etc., a municipality has to perform. City police, as a part of municipality administration, are majorly mobilized in field monitoring. There is no specification on how many city police a municipality can have. Many of the municipalities have same number of city police they had during establishment. Obviously big and developed cities with greater workload and resources tend to have greater number of city polices. Although city police are mobilized to monitor the violation of ban but none of the municipalities have recruited additional city police for this task. As role of city polices are more focused in monitoring, in very few instance like plastic bag ban only they have authority to fine violators. The effectiveness of the city police depends on how many individuals they have to monitor. Thus, the number of city police per capita represents the level of subjective expectation of fine for municipality decision. City police roaming within a city for monitoring different regulations exerts threat of being caught among target audience. As they are limited on monitoring and backing up execution of official decision, they doesn't have any role in planning and decision making. Several municipalities having city police doesn't have the ban. City police alone are not sufficient but necessary condition of a ban, even municipality with city police has failed to implement the ban. City police doesn't have separate organization rather is a small section in municipality which reduce their direct relationship with municipal dweller. Thus, city police in Nepalese municipalities are not so strong enough to reflect the local

resident's behavior. This relaxes to use city police per capita as an instrument for subjective expectation of fine for success of municipal plastic bag ban.

Selection of variable is important in compliance study (Herzfeld & Jongeneel, 2012). We use percentage of poor households, literacy rate, and percentage of urban wards in the municipalities as covariates. As municipality income was significantly correlated with other municipal variables; grant transferred from central government was used as an income variable. Similar covariates are used for both consumer and retailer equations. In consumer equation, the dependent variable is the number of bags used last week and the shop characteristics are replaced by household characteristics. As the behavior of consumers or retailers is likely to be similar within a municipality, we estimated clustered robust standard errors at the cluster level.⁷

5. Results and Discussion

5.1 Descriptive statistics

Table 1 gives the statistical summary of various subjective expected fine for consumers and retailers. As the level of subjective expected fine is a product of the probability of being caught and the level of fine for violating a ban, an increase in subjective expected fine by a NRs means an increase in 2 point increase in the threat of being caught in a municipality with a fine of NRs 50 ($.02 * NRs50 = NRs1$) or a 5 point increase in the threat of being caught in a municipality with a fine of NRs 20 ($0.05 * NRs20 = NRs1$)⁸. In municipalities where fines are not imposed or the probability of being caught is absent, subjective expected fine is zero. The subjective probabilities of being caught that consumers perceive under a partial and complete ban are around 0.10 and 0.30 respectively. The correlation between fine and probability of being caught for retailer is 0.48 (Figure 1) and consumer 0.12 (Figure 2). Even though 90% of respondents were aware of the harm that plastic bags can do, and despite the fact that around 84% of them were in favor of a plastic bag ban, only 14% of consumers were observed using reusable bags. As 50% of consumers do not carry any bag, and given the low possibility of being caught, it is highly probable that they will violate a plastic bag ban rather than pay for a reusable bag. Fines are higher for consumers under a partial ban (around NRs.116) than they are under a complete ban. The average subjective expectation of fine for consumers under a partial ban is NRs. 7.4, which is less than a quarter of the subjective expected fine for consumers under a complete ban. In surveyed municipalities, there was one policeman per 9,000 residents on average.

The average subjective probability of being caught that retailers face under a partial and complete ban is around 0.59 and 0.41 respectively. Fines for retailers are lower under a partial ban (around NRs 176 per episode of non-compliance) than they are under a complete ban. The subjective expectation of fine for retailers is NRs 150 under a complete ban while it is NRs 120 under a partial ban.

The level of subjective expectation of fine varies between municipalities even when they have similar types of plastic bag bans. For example, even though they have similar bans, the subjective expectation of fine is around NRs 80 for consumers in Ilam whereas it is around NRs 30 in Mechinagar. Despite variations in fines between municipalities, overall subjective expectation of fine are higher under a complete ban than under a partial ban (Table 1).

Subjective expectation of fine also depends on the communication of information about the ban decision and the associated fine. Around 85% of retailers knew about the ban. Among them, 47% had been informed by a municipality campaign or friends and family; 32% had heard about the ban on the radio; 13% had read about it in a newspaper; and 5% had heard about it on television. Around 60% of retailers in areas where partial bans were enforced did not know about the minimum allowable plastic bag thickness. In the case of those that were unaware of the ban in their area, ignorance prevailed on both the threat of detention they faced and the fine they might have

⁷ Cluster are location from where retailer and consumer were surveyed within municipalities. A municipality have 3-5 survey clusters in our sample.

⁸ About 1.5% of the consumers reported that they had been caught for using plastic bags. The subjective probabilities may be different from the rates reported in the survey.

to pay. On the other hand, 68% of consumers who knew about the ban in their area were aware of the fine they would have to pay if they were caught violating the ban.

Supplementary Table: 1 presents the comparative summary statistics of bag use by retailer and consumer in municipalities with different type of ban. On average, a retail shop uses 96 grams of plastic bags and 20 grams of reusable bags a day. Plastic bag use in ‘partial ban’ municipalities is 164 grams per day per retailer. This is 57 grams per day per shop higher than the level of plastic bag use in ‘no ban’ municipalities. In ‘complete ban’ municipalities, the daily use of plastic bags is significantly lower (at about 12 grams per day per shop) than in any of the other scenarios while the use of reusable bags is significantly higher (at about 76 grams per day per shop). The share of plastic bags with respect to total bags used by retailers is also lower (46%) in ‘complete ban’ municipalities than it is in ‘no ban’ municipalities (94%) and ‘partial ban’ municipalities (95%). The use of plastic bags and reusable bags is not uniform among municipalities that have the same type of ban. While plastic bag use by retailers in Ilam and Tansen municipalities is zero, it stands at 83 and 109 grams per day per store for the Gorahi and Bhadrapur municipalities.

The weekly use of plastic bags by consumers reveals a similar pattern to that by retailers. It is the lowest in ‘complete ban’ municipalities and highest in ‘partial ban’ municipalities (Figure 4). A household uses an average of 10 plastic bags and 1.58 reusable bags per week in all municipalities. This is around 2 plastic bags per person per week and around 100 bags per individual per year whereas it ranges between 580 and 700 in the Los Angeles County. (AECOM, 2010). On the other hand, the weekly use of plastic bags is significantly lower in ‘complete ban’ municipalities (at seven bags a week), which is less than half the number used in ‘partial ban’ municipalities. Furthermore, the weekly use of reusable bags by consumers is lower in ‘partial ban’ municipalities and higher in ‘complete ban’ municipalities (Figure 4).

Trips to a market are generally associated with shopping. In our sample, an average household visits the market four times a week for groceries. The frequency with which a consumer is provided with a plastic bag free of charge by a retailer is highest in ‘partial ban’ municipalities (at around 68%) and lowest in ‘complete ban’ municipalities (at around 18%). In ‘complete ban’ municipalities, 38% of respondents pay for their reusable bags whereas in ‘no ban’ municipalities only 3% pay for their bags. Supplementary Table: 2 presents the statistical summary of the variable related to retailer, consumer and municipality.

The municipalities of Nepal are diverse in terms of their socio-economic characteristics, geography and infrastructure. They are also different in terms of the performance of their municipal offices. While poverty rates are highest in ‘no ban’ municipalities and lowest in ‘partial ban’ municipalities, population numbers are highest in ‘partial ban’ municipalities and lowest in ‘complete ban’ municipalities. The municipality’s income, literacy rate and the percentage of plastic in the municipality’s solid waste are highest in ‘partial ban’ municipalities. On the other hand, the percentage of plastic in solid waste is 16% in ‘complete ban’ municipalities, which is lower than that of other types of municipalities.

5.2 Econometric analysis

We examine the effect of partial and complete ban enforcements on plastic bag use by retailers and consumers in order to seek an answer to the question “what makes a ban effective?” Subjective expectation of fine in NRs is used as enforcement measures. Table 2 shows the impact of subjective expectation of fine on the daily use of plastic bags by the retailers while Table 3 shows the corresponding results for the consumers. The estimated result for ban dummy and reusable bag is in Supplementary Table: 3 & Supplementary Table: 4.

Effects of the ban on retailers: The effect of a ban on daily bag use by retailers is estimated (i) using the ordinary least square method with ban dummy (Supplementary Table: 3) Models (A-1 and A-2) and subjective expectation of fine (NRs) (Models B-2 and B-3), and (ii) using a IV method (Model C-1 (First stage); C-2 and C-3). The OLS results show that a partial ban increases the use of plastic bags by retailers by approximately 93 grams but reduces the use of reusable bags by around 60 grams; a complete ban on the other hand does not have any significant effect on the use of either bag type by the retailers. However, the OLS results face two problems: 1) considering the ban

without factoring enforcement does not provide a true picture of the effectiveness of the ban and 2) the plastic bag ban decision is endogenous. To resolve these issues, we use subjective expectation of fine in NRs instead of ban as a determinant of plastic bag use and try to assess how the subjective expected fine of a particular type of ban affects the use of bags by the retailers. Using subjective expectation of fine, we estimated the result B-2 and B-3. This second set of results suggests that increasing subjective expectation of fine by NRs 1 in partial ban increases the use of plastic bags by around a quarter of grams per retailer per day and that it reduces the use of reusable bag by 0.14 gram per retailer per day. In comparison, the complete ban reduces the use of plastic bags by 0.167 grams per retailer per day and increases the use of reusable bags by 0.13 grams per retailer per day. The major constraint to infer the result is endogeneity of subjective expected fine with compliance. To address this issue, we estimate the same model using city police per capita as an instrument. The Angrist-Pischke multivariate test, with F value 101 for retailer is significant at 1 percent, suggesting that the instrument, “city police per capita,” is strong enough to predict subjective expected fine levels. The results are presented in Table 2 Model C-1 shows the first stage regression results, Model C-2 presents the results for plastic bags and Model C-3 (Supplementary Table: 3) presents the results for reusable bags. The results show that partial ban subjective expected fine does not have any significant effect on the use of plastic and reusable bags whereas the subjective expected fine of a complete ban reduces the use of plastic bags and increases the use of reusable bags. In a response to increase in subjective expectation of fine by NRs1 in a complete ban retailers reduce their use of plastic bags by 0.7 grams⁹ per day and increase their use of reusable bags by 0.2 grams per day. If the ban is enforced well, as is the case in the Ilam municipality (where the subjective expectation of fine is around NRs 240, the probability of being caught at 0.48 and a fine of NRs 500 per episode of being caught), the daily use of plastic bags by retailers will come down to zero. The result shows that, in order to have a significant impact, a ban needs to be carefully enforced.

Effect of ban on consumers: The Angrist-Pischke multivariate test is significant at 1 percent with F value 285. The IV results in Models F-2 (Table 3) indicate that subjective expectation of fine in a partial ban does not have a significant effect on the use of plastic bags whereas increasing it in a complete ban reduces the use of plastic bags while increasing the use of reusable bags.

More specifically, a complete ban, restriction on use of all type of single use plastic bag, with the highest level of subjective expected fine currently being practiced, reduces the use of plastic bags by 94% and increases the use of reusable bags by 321% for the retailer. For the consumer, this reduces weekly use of plastic bags by 0.17 pieces per week and increases the use of reusable bags by 0.05 pieces per week. Increased subjective expectation of fine of a complete ban from the lowest to the highest level will reduce the use of plastic bag by 94%. Subjective expectation of fine is highest, around NRs 76, in the Ilam municipality, which is achieved from 0.38 point threat of detention and a fine of NRs200. Ensuring subjective expected fine in a complete ban at NRs 76 will reduce the weekly use of plastic bags by 95% at the household level (in comparison with the level of use in ‘partial ban’ municipalities). Replicating this level of subjective expectation of fine for the 191 municipalities of Nepal stops roughly 1250 million pieces of plastic per year from going into the environment.¹⁰

The difference between OLS and IV coefficient for subjective expectation of fine to retailer daily use of plastic bag and consumer weekly plastic bag use is 0.53 and 0.08 incomplete ban and -0.16 and 0.13 in partial ban. This difference suggests that higher use of plastic bag result in bans hence biasing the OLS coefficient toward zero.

The results show that ban subjective expectation of fine has a similar effect on bag use for both retailers and consumers. The partial ban, which is a sanction on only the color and specific thickness of plastic bags, however, does not help to reduce its use. The overall results suggest that even a complete ban, on its own, is not enough to change consumer behavior. Instead, a successful plastic bag reduction program should prohibit all type of single use plastic bag and create sufficient subjective expected fine, which depends significantly on the subjective

⁹ One bag of 5 kg capacity is around 10 gram, 1 bag of 2 kg capacity with 20 micron thickness is around 6-7 grams, a bag of 2 kg which is less than 20 micron in thickness is around 4-5 grams, a bag of 1 kg capacity which is less than 20 micron in thickness is around 3-4 grams, and a very thin ½ kg capacity bag is equal to 2-3 grams. The numbers are based on an interview with a plastic bag producer.

¹⁰ This estimate does not consider the change in bag use behavior in new municipalities where the level of economic activities may not be as high as that of the older ones.

probability of being caught created using good communication regarding the ban in place; monitoring of ban compliance with the assistance of city police; a suitable fine amount; and strict enforcement of such fines on those found to be violating the ban. The result shows that Nepal plastic bag control and regulation Directive 2011 is ineffective. The directive is similar to municipal partial single use plastic bag ban that prohibits the use of plastic bags less than 20 micron and of specific colors. Around 57% of consumer and 69% of retailer in partial ban stated that compliance to plastic bag ban is hard. Furthermore, retailer have to supply thicker plastic bag free of cost thus increasing their cost. Consumer in partial ban municipalities get stronger bag thus substitute it for reusable bag. Identifying the thickness of plastic bag i.e 20 micron is very hard for retailer, municipality official and city police, creating challenge in enforcing partial ban. In some market plastic bag of 25 micron are being used, which will obviously supply more plastic bag into the environment and is still a single-use.

In theory, an increase in the use of reusable bags should reduce the use of plastic bags, or vice versa. Estimates show that the use of a reusable bag replaces 3.5 plastic bags, which is half the substitution rate observed in Los Angeles (AECOM, 2010). Increasing the strength of reusable bag would increase the substitution rate, thus help environment. However, the partial ban is ineffective in reducing the use of plastic bags. The insignificant effect of enforcement of a partial ban could be attributed to the replacement of the thinner plastic bags by thicker plastic bags by consumers, thus substituting thicker and stronger plastic bags for reusable bags.

6. Conclusions and Policy Recommendations

Our main objective in the study is to examine the effect of plastic bag bans and their enforcement on the use of plastic and reusable bags in the municipalities of Nepal. Our results, using a sample of retailers and consumers from 14 municipalities from across Nepal, where plastic bags are banned at different levels, show that the partial ban is ineffective in reducing the use of plastic bags. On the other hand, the subjective expected fine of a complete ban significantly reduces the use of plastic bags and increases the use of reusable bags by both consumers and retailers.

According to our findings, the partial ban does not make economic sense since it is ineffective in reducing the use of plastic bags. The costs associated with having a ban enforcement in place entails significant pre-operational and promotional expenditure that hovers around a million Nepalese Rupees for a medium city. Added to this amount are enforcement costs that include the cost of mobilizing the city police and communicating the message of ban enforcement to the public on a regular basis.

The results, moreover, suggest that a partial ban without proper subjective expected fine could even have retrogressive effects whereas high subjective expected fine of a complete ban curbs plastic bag use effectively. Thus, it is clear that effectiveness of a plastic bag ban policy depends on the choice of ban enforcement. If a municipality creates subjective expected fine of a complete ban, then the use of plastic bags will come down significantly while simultaneously increasing the use of reusable bags.

When compared with poorly enforced partial bans and no bans, strictly enforced complete bans reduce plastic bag use by retailers by almost 100% and by consumers by 95%. Thus, the strict implementation of complete bans at the current highest level of subjective expectation of fine in the 191 municipalities of Nepal will stop the release of roughly 1250 million plastic bags into the environment each year.

As Nepal Plastic Bag Reduction and Regulation Directive¹¹ recommends partial ban, i.e. ban on plastic bag thinner than 40 micron, our results indicate the need for revising the directive with complete ban of single use plastic bag. In addition, municipalities can use the results of the present study to design plastic bag bans and to develop subjective expected fine and monitoring strategies vis-à-vis such bans. The development of such strategies is important as a number of legal provisions such as the Environment Protection Act 1997, the recent plastic bag ban decision in Kathmandu valley, the Local Self Governance Act 1999 etc. are awaiting enforcement. The study would

¹¹ The recently revised version

also be of help in improving the effectiveness of the policies the government is implementing to curb the use of goods and services that harm the public and the environment.

Other important factors to take into account include the supply and demand of bags and their cost. Thus, future directions for research in this area should entail gaining a better understanding of retailer dynamics and undertaking a detailed cost-benefit analysis that takes into account the damage that bags do to the environment.

Acknowledgement

My special thanks go to my advisor Jean Marie Baland, and SANDEE advisors and associates for their guidance and valuable suggestions. I would like to thank Celine Nauges, Mani Nepal, Priya Shyamsundar and E. Somanathan for their valuable suggestions and critical readings of the paper. I would also like to thank SANDEE for financial support to conduct this research and providing me with training on environmental and resource economics. I am also grateful to Anuradha, Neesha, and Malvika from SANDEE, for their administrative help and Mukti N. Subedi, Ravi Kiran Adhikari, Sailaja Basistha and other friends who helped me in data collection and research activities. Finally, I would like to thank Center for Labor and Social Studies (CLASS-Nepal) for the excellent managerial support they provided to conduct the research.

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Tables

Table 1: Summary statistics of subjective expectation of fine

Variable	Partial ¹ Ban		Complete Ban		Mean Difference
	mean	SD	mean	SD	
Consumer					
Subjective probability of being caught using plastic bag	0.10	21.8	.31	0.312	-0.201***
Fine decided by municipality	120	116.9	92.4	59.7	27.631***
Subjective expectation of fine (NRs) ¹	7.386	21.7	30.6	37	-2.346***
sample size	355		713		
retailer					
Subjective probability of being caught for using plastic bag	0.58	0.39	0.41	0.41	.18***
Fine decided by municipality	170	129	366	149	-196.017***
Individual subjective expectation of fine	121	120	149.5	160	-28.44***
sample size	288		564		

1. Partial ban covers ban on black plastic bag only

2. This is a measure for ban enforcement and is product of probability of being caught and fine.

Table 2: Effect of plastic bag ban and subjective expectation of fine on retailer's bag use

Policy Variable Used	without IV		with IV	
	Daily use of plastic bag Gram/day (Model-B1)	First stage (Model-C1)	Daily use of plastic bag Gram/day (Model-C2)	
Partial Ban [#]	0.24** (0.11)		-0.4 (0.24)	
Complete Ban [#]	-0.17*** (0.05)		-0.70*** (0.17)	
City police / Population		64,418.12*** (19,100.00)		
No of daily transaction	0.71*** (0.23)	0.16 (0.01)	0.77*** (0.24)	
Daily sales income	0.00*** (00)	0.00*** (00)	0.00*** (00)	
uhat			0.59*** 0.18	
Constant	179.69** (83.2)	-295.52*** (61.18)	18.49 (86.64)	
Observations	1,307	1,307	1,307	
R-squared	0.3	0.4	0.32	

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1;
PB, Plastic Bag RB, Reusable Bag

F test of excluded instruments:

F(1, 1274) = 101.76;
Prob > F = 0.000

1. Retailer Variable includes: Age, Sex, own a house, if this is family profession, retailer is registered in municipality, member of FNCCI, member of tol level organization etc.
2. Shop Variable: Type of shop, type of good sold, nature of retail shop, value of goods sold,
3. Municipality Characteristics Includes Performance index, population density, literacy rate, total grant received, % of urban area.

it is the subjective expectation of fine for B1, C1 and C2 models

Table 3: Effect of subjective expectation of fine on weekly use of bags by consumer

Model	Without IV	Using IVREG2	
VARIABLES	No of plastic bag used in a week (Model-E1)	First stage (Model F1)	No of plastic bag used in a week (Model F2)
Partial ban [#]	0.07*** (0.02)		-0.06 (0.06)
Complete ban [#]	-0.09*** (0.02)		-0.17*** (0.04)
City police/population		314,196*** (33,524.00)	
Monthly Income NRs	0.00** (0)	0 (0)	0.00** (0)
No of visit to market	0.65*** (0.18)	0.39* (0.02)	0.63*** (0.18)
Family Size	0.33*** (0.11)	-0.37 (0.24)	0.25** (0.11)
uhat			0.11** (0.04)
Constant	4.13 (8.72)	-18.46 (20.66)	-7.57 (10.45)
Observations	1,340	1,340	1,340
R-squared	0.34	0.42	0.35
F test of excluded instruments:		F(1,1313) = 285.48; Prob > F = 0	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Individual Characteristics Includes (Sex, Education, Age, Marital Status, time spend watching TV)

Household Character includes % of house member is a children, Migrant or not, own house in municipality, % of member employed

Municipality Characteristics Includes Performance index, population density, literacy rate, total grant received from government, % of urban area.

it is the subjective expectation of fine for E1, F1 and F3 models

Figures

Figure 1: Scatter plot retailer probability of being caught plotted against fine (NRs) for retailer

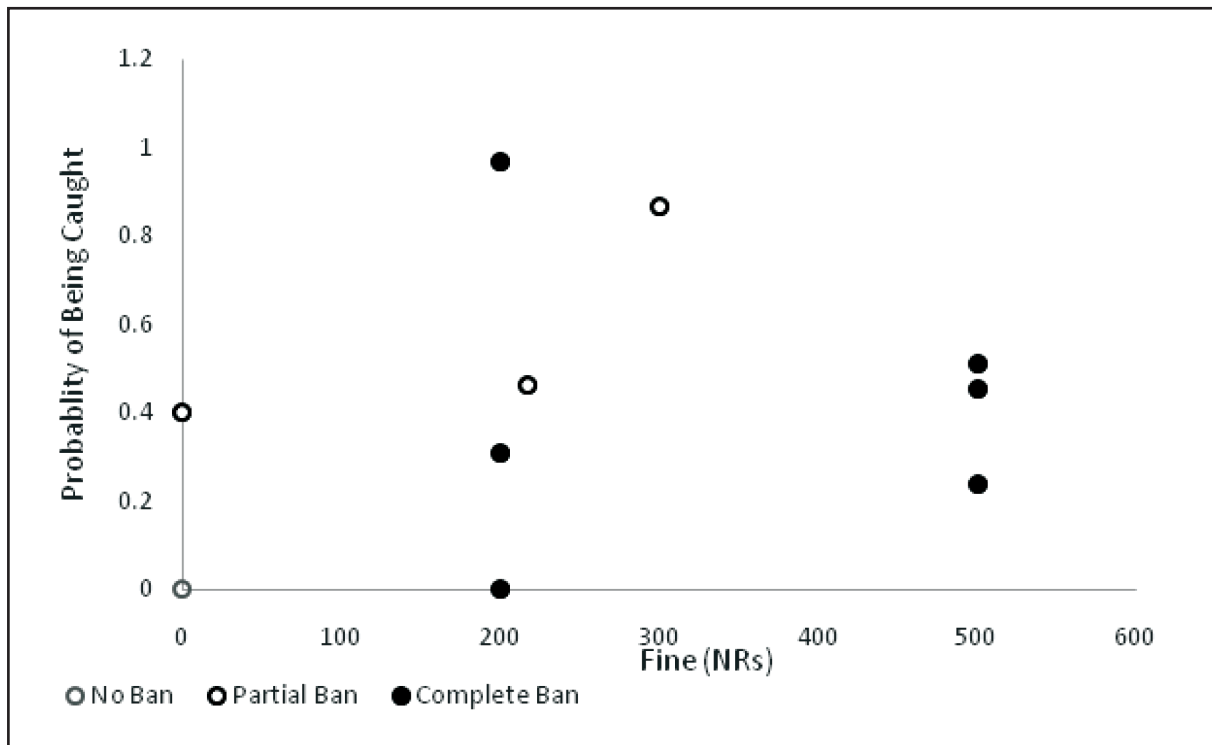


Figure 2: Scatter plot consumers subjective probability of being caught and fine

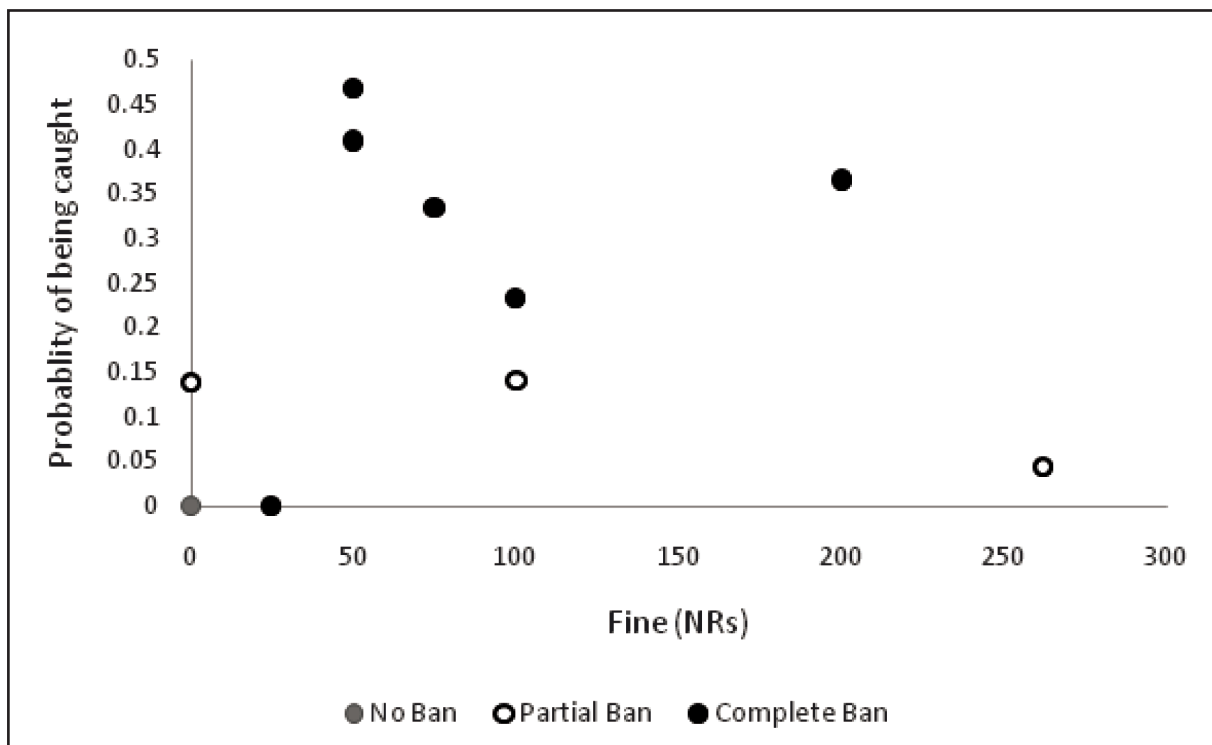


Figure 3: Perception of plastic bag ban compliance

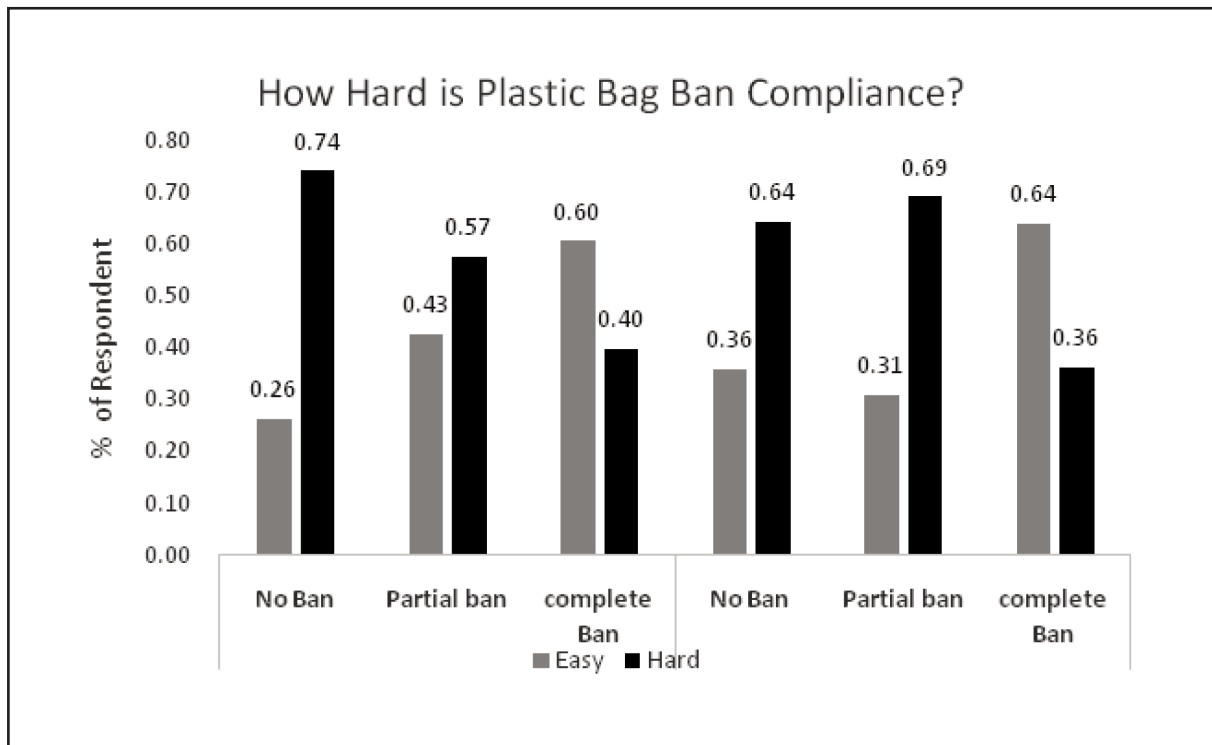
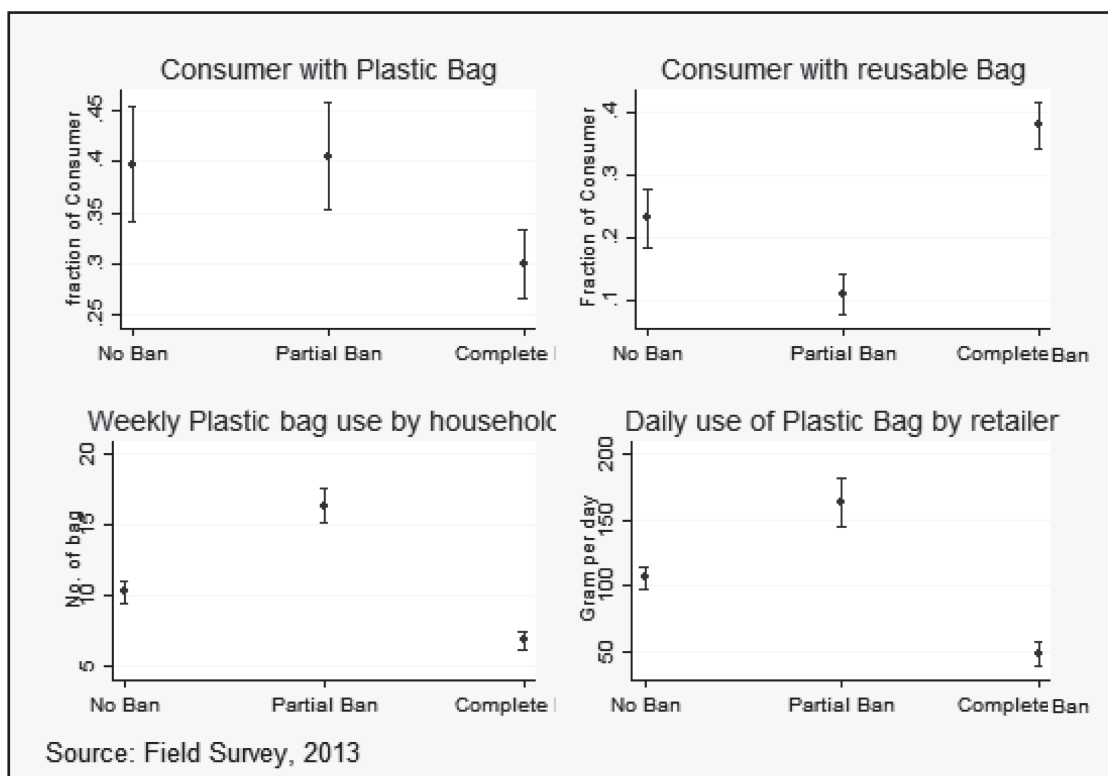


Figure 4: Bag use behavior for consumer and retailer



Upper Panel: percentage of consumer with Left: plastic bag; right: Reusable Bag; Lower Panel is quantitative estimates of number of plastic bag used by a household in a week during survey period (Left) and Daily use of plastic bag by retailer (right).

Appendix

Supplementary Table 1: Comparative statistics of bag use by consumers and retailers

A. Retailer Comparative Summary Statistics						
Ban Type		No Ban	Partial	Complete	Total	
Average Cost	Plastic	220	225	248	227	
	Reusable	331	370	288	300	
Daily Use (gram)	Plastic	107	164	47	97	
	Reusable	6	10	46	20	
	Share of PB	0.94	0.95	0.46	0.79	
Retailer's Daily Expenditure for Bag	Plastic	22.3	33.3	10.7	20.3	
	Reusable	1.7	3.7	13.7	6.1	
Cost of Selling NRs 000 Value	Plastic	6.8	3.1	2.9	4.8	
	Reusable	0.24	0.07	2.47	0.97	
Sample Size		809	288	564	1661	
B. Consumer Comparative Summary Statistics						
Description		No	Partial	Total	Total	
Weekly Use	Plastic Bag	10.30	16.39	6.86	10.1	
	Reusable	1.10	0.52	2.23	1.5	
	Share of PB	0.84	0.96	0.58	0.7	
Weight of Good Carried in a Plastic Bag		913	999	875	923	
Number of Bags Used to Carry Goods of NRs 1000 Value	Plastic bag	6.6	4.1	2.5	3.8	
	Reusable	3	1.3	3.5	2.8	
Sample Size		N	307	355	713	1375

Supplementary Table 2: Summary statistics

Retailer Statistical Summary						
Variable	Unit	Obs.	Mean	SD	Min	Max
Local Resident	Dummy, yes = 1	1352	0.2	0.4	0	1
Education	School Year	1324	10.6	3.8	0	18
Sex	Male = 1	1643	0.7	0.4	0	1
Age	Year	1341	37	11	10	86
Family Profession if retail =1	Dummy	1346	0.9	0.3	0	1
Time Spent Watching TV	Hour a day	1342	2.1	1.5	0	12
Own House in Municipality	Dummy, yes = 1	1352	0.8	0.4	0	1
Member of FNCCI	Dummy, yes = 1	1352	0.6	0.5	0	1
Registered in Municipality	Dummy, yes = 1	1353	0.8	0.4	0	1
Member of TOL	Dummy, yes = 1	1348	0.4	0.5	0	1
Goods Pack Type	Category	1352	1.1	0.9	0	2
Type of Shop	Category	1645	4.6	2.4	1	7
Yesterday's Transaction	Nos	1643	36	43	0	503
Yesterday's Sales Income	NRs' 000	1634	9	14	0	135
Consumer Statistical Summary						
Description	Unit	Obs.	Mean	SD	Min	Max
Age	Year	1373	33	14	12	85
Marital Status	Dummy	1375	0.679	0.467	0	1
Education	School Year	1374	9.8	4.5	0	18
Sex	Male = 1	1375	0.5	0.5	0	1
Migrant	Dummy, yes = 1	1375	1.4	0.5	1	2
Studied Environment Science	Dummy, yes = 1	1375	0.6	0.5	0	1
Time Spent in Watching or Listening to TV/ Radio	Hours a day	1369	2.3	1.5	0	20
Monthly Income	NRs	1360	17792	12805	1000	100000
Member of Tole (urban community)	Dummy, yes = 1	1368	4.0	3.6	1	30
Employed Member	Percent of total	1375	0.3	0.2	0	1
% of Children in Family	% of total	1374	0.3	0.2	0	1
Family Size	Number	1375	5.2	2.0	1	22
Municipality Statistical Summary						
Description	Unit	Obs	Mean	SD	Min	Max
Number of Household	Number	14	19058	20274	3795	68398
Population (2011)	Number	14	79433	81030	17427	264991
Area	Sq Km	14	46	22	11	103
Average Household Size	Number	14	4.3	0.6	3.7	5.82
Sex Ratio	Ratio	14	99	8	85	115
Number of Environmental NGO	Number	14	7.2	7.5	1	27
Revenue Increment Rate	%	14	2.0	1.0	0.86	3.5
Plastic in Solid Waste	%	14	22.1	13.7	10.8	61.71
Total Solid Waste	Gram	14	251	111	107	442
Length of Sewage	Meter	14	2510	3217	25	11361
Literacy Rate (%)	%	14	80	8	63	89
Poverty Rate 2010	%	14	13	8	1	30

Supplementary Table 3: Effect of ban and subjective expectation of fine on retailer's bag use

Policy Variable Used	Ban Dummy		Daily use of reusable bag in gram per retailer		
	PB (A1)	RB (A2)	Without IV	With IV	
VARIABLES			RB(B2)	First stage (C1)	RB (C3)
Partial Ban#	93.21*** (27.16)	-60.68*** (17.19)	-0.14** (0.06)		-0.05 (0.12)
Complete Ban#	-14.05 (28.98)	15.49 (13.98)	0.13*** (0.03)		0.21*** (0.07)
City police / Population				644,181.20*** (129,307.81)	
No of daily transaction	0.65*** (0.24)	0.03 (0.06)	-0.01 (0.05)	0.16 (0.1)	-0.02 (0.05)
Daily sales income	0.00*** (0.0)	0.00*** (0.0)	0.00*** (0.0)	0.00*** (0.0)	0.00** (0.0)
uhat					-0.08 (0.08)
Constant	325.42*** (94.74)	-120.60*** (41.05)	-28.4 (24.76)	-295.52*** (61.18)	-5.47 (26.49)
Observations	1,307	1,307	1,307	1,307	1,307
R-squared	0.32	0.29	0.26	0.4	0.26

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; PB, Plastic Bag RB, Reusable Bag

F test of excluded instruments: F(1, 1274) = 101.76;
Prob > F = 0.000

Controlled for: Retailer Variable includes: Age, Sex, own a house, if this is family profession, retailer is registered in municipality, member of FNCCI, member of tol level organization etc.

Shop Variable: Type of shop, type of good sold, nature of retail shop, value of goods sold.

Municipality Characteristics Includes Performance index, population density, literacy rate, total grant received, % of urban area.

it is the subjective expectation of fine for B2, C1 and C3 models

Supplementary Table 4: Effect of ban and subjective expectation of fine on consumer bag use

Variables	Ban Dummy		Number of reusable bag used by a household in a week		
	OLS		Without IV	With IV	
Model	PB (D1)	RB (D2)	RB(E2)	First stage (F1)	RB (F3)
Partial ban	7.91***	-3.46***	-0.02***		0.01
	2.5	0.73	0.01		0.02
Complete ban	-1.25	-1.44***	0.03***		0.05***
	1.9	0.42	0.01		0.01
City police/population				314,196***	
				33,524.00	
Monthly Income NRs	0.00***	0	0.00	0.00	0.00
	0	0	0	0	0
No of visit to market	0.54***	0.01	0	0.39*	0
	(0.19)	(0.02)	(0.02)	(0.02)	(0.02)
Family Size	0.32***	0.04	0.07***	-0.37	0.09***
	(0.09)	(0.03)	(0.03)	(0.24)	(0.02)
uhat					-0.24
					(-0.24)
Constant	25.34**	-19.88***	-8.82*	-1.85	-6.33
	(10.86)	(3.67)	(4.43)	(3.34)	(3.95)
Observations	1,340	1,340	1,340	1,340	1,340
R-squared	0.36	0.38	0.38	0.42	0.39
F test of excluded instruments:				F(1, 1313) = 285.48; Prob > F = 0	

Robust standard errors in parentheses

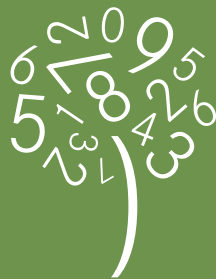
*** p<0.01, ** p<0.05, * p<0.1 PB, Plastic Bag RB, Reusable Bag (Used gram per day)

Individual Characteristics Includes (Sex, Education, Age, Marital Status, time spend watching TV

Household Character includes % of house member is a children, Migrant or not, own house in municipality, % of member employed

Municipality Characteristics Includes Performance index, population density, literacy rate, total grant received, % of urban area.

it is the subjective expectation of fine for E2, F1 and F3 models



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