CAN SMALL INCENTIVES HAVE LARGE EFFECTS? THE IMPACT OF TAXES VERSUS BONUSES ON DISPOSABLE BAG USE

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INTRODUCTION

CAN SMALL INCENTIVES HAVE LARGE EFFECTS on prosocial behavior? Standard economic theory suggests that financial incentives will be effective if the costs an individual associates with changing his behavior are smaller than the incentive provided for doing so. For example, small fees on residential trash collection have been shown to increase recycling (Fullerton & Kinnaman, 1996), while small "sin" taxes on soft drinks had only a negligible effect on consumption (Sturm et al., 2010). While, in practice, financial incentives can either take the form of a fee for bad behavior or a bonus for good behavior, this theory suggests that individuals should respond similarly to the two types of incentives, provided that they are the same amount. In contrast, evidence from the field of behavioral economics (Kahneman & Tversky, 1979) suggests that individuals perceive losses more strongly than gains, implying that a fee would be more effective than a bonus of the same size. I address whether small incentives and their design matter through the evaluation of two policies in the Washington Metropolitan Area aimed at reducing the use of disposable grocery bags: a 5-cent tax on disposable bag use and a 5-cent bonus for reusable bag use. Using variation in incentive policies across time and location, I am able to determine if the framing of the incentive influences the policy's effectiveness.

Growing concern over the environmental impact of plastic bags has prompted several governments across the world to regulate the use of disposable bags; many countries in Europe, Asia, and Africa require grocery stores to charge a fee for each bag the store provides. In 2010, Washington, DC, became the first city in the United States to pass legislation calling for grocery stores to tax customers for the use of disposable bags. Two years later, Montgomery County, an area of Maryland bordering DC, passed its own bag tax. Similar legislation has been passed in several counties and cities in California, Colorado, and Washington.

Despite the growing popularity of such laws, rigorous empirical work that assesses their effectiveness has been lacking. This is the first study to use design-based research to estimate the effectiveness of such a policy in the U.S. context. Scanner data from a retail chain of grocery stores provides a description of disposable bag use after the tax and suggests a large decline in bag use in the first few weeks of implementation. I also collected data on individual-level consumption of disposable and reusable bags by observing customers as they exited the grocery store. The data set contains information on over 16,000 customers in Montgomery County, and in surrounding areas outside of the county, in the months before and after the tax's implementation. This data allows me to analyze the effect of the tax on demand using a difference-in-differences research design. While 82 percent of customers in Montgomery County used at least one disposable bag per shopping trip prior to the tax, this estimate declined by 42 percentage points after the tax was implemented. Additionally, customers who continued to use disposable bags after the tax used fewer bags per trip, leading to an overall reduction in demand of just over one disposable bag per shopping trip. These effects imply a reduction of over 18 million disposable bags per year if each household in Montgomery County shopped once per week.

It is possible that the tax reduced disposable bag use through purely economic channels – if 5 cents is larger than the cost customers attach to the inconvenience of bringing a reusable bag or carrying one's groceries without a bag, they will use fewer disposable bags. If this is the case, neoclassical economics suggests that a 5-cent bonus should have the same impact on behavior as a 5-cent tax.

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However, if customers are loss-averse, in that they adjust their behavior more in response to losses than in response to gains, the bonus is likely to be less effective than a tax of the same magnitude.

Prior to the implementation of the tax, several stores offered their own incentive to reduce the use of disposable bags: a 5-cent bonus for reusable bag use. I use the cross-sectional variation in policies across stores to compare the effect of the bonus to the effect of the tax. In stores that offer no incentive, 84 percent of customers use at least one disposable bag. While 82 percent of customers in bonus stores used disposable bags, only 39 percent of customers in stores that charge a tax used disposable bags. These results suggest that, while the tax has a substantial impact on disposable bag use, a bonus of the same amount has almost no effect on behavior, evidence consistent with a model of loss aversion. A survey of consumer attitudes on the effectiveness of bag taxes and bonuses also supports a role for loss aversion in explaining the observed pattern of consumer behavior.

I present a simple model of reference-dependent preferences and estimate this model using my observational data. I estimate a coefficient of loss aversion that is larger than those previously found in the literature. I explore the possibility that customers receive an added benefit from acquiring a product, i.e., a disposable bag, for free (Shampanier et al., 2007). This would generate a discontinuous jump in the utility function at a zero-price reference point, leading to an estimate of the coefficient of loss aversion.

The paper concludes by exploring mechanisms other than loss aversion that may have caused customers in stores charging a tax to use fewer disposable bags than customers in stores offering a bonus. First, I show that differences in demographic composition of customers at the two types of stores do not affect my results. Second, while survey data suggests that customers are less aware of the bonus than the tax, the differences in awareness cannot fully account for the difference in effectiveness of the two policies. Next, I investigate whether the results are driven by customers responding to a shift in social norms associated with the tax. I surveyed customers on their attitudes about the use of disposable bags and pollution regulation before and after the implementation of the Montgomery County tax and found no change in social norms between the two periods. Lastly, recent evidence suggests that customers are more likely to avoid any charge that is framed as a tax (as opposed to a fee). To explore the possibility that such "tax aversion" explains the discrepancy in consumer behavior when faced with a bonus versus a tax, I conducted an experiment in which participants were asked how they would respond to a hypothetical 5-cent penalty for using a disposable bag, randomizing whether the penalty was framed as a government tax or as a fee instituted by the store. I find no difference between the two scenarios.

This paper is organized as follows. Section I reviews the history of disposable bag regulations, both internationally and domestically. Section II presents two models of the customer's choice to bring a reusable bag. Section III describes the various data sources used in the empirical analysis. Section IV presents estimates of the impact of the disposable bag taxes in the Washington Metropolitan Area. Section V contains an analysis of the mechanisms that may have contributed to the effectiveness of the tax policy. Section VI concludes.

BACKGROUND ON DISPOSABLE BAG REGULATIONS

International Policies

Plastic bags were first introduced to grocery store customers in the 1970s and are now used in almost every store in the United States. Clapp and Swanston (2009) report that Americans consume 100 billion plastic bags each year, with worldwide estimates reaching as high as 1.5 trillion. While these plastic bags are often recyclable, the Environmental Protection Agency (EPA) estimated that only 5.2 percent of plastic bags in the United States in 2005 were actually recycled (USEPA, 2006). The uncontrolled disposal of plastic bags has caused environmental problems across the globe.

In an effort to reduce pollution caused by the consumption of disposable bags, several domestic and international governments have passed various policies to curb plastic bag consumption. Starting in the early 2000s, several countries, mostly in Africa, banned the use of plastic bags. As an alternative to an outright ban, Ireland became one of the first countries to levy a tax on consumers for plastic bag use; the €0.15 tax per bag led to a dramatic 94 percent decrease in consumption in the first year (Convery et al., 2007). South Africa

combined the two types of policies, banning the use of all plastic bags under a certain thickness as well as prohibiting stores from offering free plastic bags.[1] Dikgang et al. (2012) and Hasson et al. (2007) conclude that these policies led to an immediate reduction in plastic bag use. A similar policy in China led to a 49 percent reduction in plastic bag consumption (He, 2010).

Washington Metropolitan Area Disposable Bag Regulations

The Anacostia River, located in Washington, DC and Maryland, suffers from excessive litter and pollution. The buildup of disposable bags degrades water quality, harms aquatic life, and causes flooding by clogging storm drains.[2] In December 2008, the District Department of the Environment (DDOE) conducted a study to assess the types and sources of trash that were polluting the river. The study showed that plastic bags comprised 47 percent of all trash in tributary streams and estimated that it would cost $32.4 million to clean up the river (DDOE, 2008).

In response to the report, DC enacted the Anacostia River Cleanup and Protection Act in 2009. This law requires all retailers in the district that sell food[3] to charge 5 cents per single-use plastic or paper bag starting on January 1, 2010, making DC the first city in the United States to charge a fee for the use of disposable bags. The law also requires that the fee be charged at the point of purchase and not be included in the cost of other items. One to two cents of the tax goes to the retailer to cover costs associated with the tax's implementation while the remainder goes to a fund dedicated to cleaning up the Anacostia River.[4]

Inspired by DC's policy, Montgomery County, an affluent county in Maryland that borders DC to the northwest, passed a similar initiative. As of January 1, 2012, all retail establishments[5] in Montgomery County were required to charge a 5-cent tax for each disposable bag that a customer used. Proceeds from the tax enter the county's Water Quality Protection Charge. Similar bills have been suggested in other jurisdictions in the Washington Metropolitan Area, but none have passed as of this date.

Additionally, prior to the implementation of either tax, several retail chains offered their own incentive for bringing a reusable bag. Customers shopping at these stores receive a 5-cent bonus for each reusable bag they use instead of taking a new disposable bag. Of the four stores with the largest marketshare in the Washington Metropolitan Area, two provided such a bonus.

Other Domestic Regulation of Disposable Bags

The state of California has been a hotbed for disposable bag regulation over the past few years. San Francisco became the first U.S. city to regulate the use of disposable bags with a ban on plastic bags in 2007. On July 1, 2011, Los Angeles County not only banned plastic bags, but began charging a minimum of 10 cents for paper bags. Over the next year, the cities of Santa Monica, San Jose, and Sunnyvale, as well as the counties of Marin, Santa Clara, and Santa Cruz passed similar laws.

As of this date, disposable bag taxes have been proposed in states as diverse as Arizona and Pennsylvania. While I will focus mostly on the impact of the policies in DC and Montgomery County, I will provide some descriptive evidence on the effectiveness of regulations in other locations as well.

MODELING RESPONSES TO FINANCIAL INCENTIVES

Consider a customer who is choosing whether or not to use a disposable bag or bring a reusable bag. A customer has utility $U_i(w_i, b_i)$, where w_i represents customer i's wealth and b_i is a binary choice variable that equals one if the customer chooses to bring a reusable bag and zero otherwise. Customers also have idiosyncratic preferences for reusable bag use and incur a utility cost for bringing a reusable bag, c_i, which can be a positive cost (for example, a psychological cost for remembering to bring a bag) or a negative cost (for example, a warm glow from helping the environment). For simplicity, customers must use one of the two types of bags and require only one bag. Assume that c_i enters the utility function linearly and that the customer's utility is additively separable between c_i and w_i so that utility when there is no external incentive can be defined as $U_{N,i}(w_i, b_i) = u(w_i) - b_i c_i$. Now suppose that customers are subject to a tax of x for using a disposable bag. The individual's utility function then becomes $U_{T,i}(w_i, b_i) = u(w_i - (1 - b_i)x) - b_i c_i$. Similarly, if we consider a policy where customers receive a bonus of x for using a reusable bag, the utility function becomes $U_{B,i}(w_i, b_i) = u(w_i + b_i x) - b_i c_i$.

When will customers choose to bring a reusable bag rather than use a disposable bag? The table below outlines the conditions under which a customer would choose to bring a reusable bag under different policies. If no financial incentives are provided, customers will bring a bag if $0 > c_i$, i.e., if they derive a personal benefit from bringing a reusable bag. If customers are charged a tax for disposable bag use, they will bring a reusable bag if the decrease in utility they suffer from having to pay the tax is larger than the cost of bringing a reusable bag. Similarly, if customers are awarded a bonus for reusable bag use, they will bring a reusable bag if the utility gain from receiving the bonus is larger than the cost of bringing a reusable bag.

Should we expect that customers will have the same response to a bonus and a tax of the same size? The following section presents two models with different predictions for the relative effectiveness of the tax and bonus policies.

Neoclassical Model

In this paper, I consider the effect of tax and bonus policies with a very small x, i.e., 5 cents. Standard economic theory predicts that if c_i is also very small, these incentives could still have large effects on consumer behavior. In other words, a small financial incentive will be effective as long as demand for disposable bags is elastic.

Suppose customers maximize utility over wealth and that utility is strictly increasing and weakly concave ($u'(w_i) > 0$ and $(u''(w_i) \leq 0)$, i.e., marginal utility is diminishing in wealth. Then customers will derive less utility from a gain in wealth than from a loss of the same magnitude due to the curvature of the utility function, and the proportion of customers bringing a reusable bag will be larger under the tax policy than under the bonus policy. However, Rabin (2000) demonstrates that individuals must be approximately risk-neutral over small stakes in order for expected-utility models to imply reasonable levels of risk aversion over large stakes. His calibrations suggest that the consumption value of a dollar should not change significantly over changes in wealth up to $1000 dollars. Given that the incentives considered in this study are only 5 cents per bag, it is reasonable to assume that utility is linear, i.e., $u(w_i) = \gamma w_i$, over the change in wealth caused by these policies. With this assumption, neoclassical economics predicts that the conditions under which customers would bring a reusable bag under the tax policy and under the bonus policy are the same (see table at top of page 68).

Reference-Dependent Model

Prospect theory, developed by Kahneman and Tversky (1979), proposes that, while utility is defined in terms of net wealth, value is defined in terms deviation from a reference point (i.e., gains and losses). They suggest that individuals perceive losses more strongly than gains of the same size, a phenomenon referred to as loss aversion. Consider a simple reference-dependent utility function where utility is linear in wealth but with a kink at a reference point, w^*:

$$u(w_i) = \begin{cases} \gamma(w_i - w^*) & \text{if } w_i > w^* \\ \alpha\gamma(w_i - w^*) & \text{if } w_i \leq w^* \end{cases}, \text{where } \alpha > 1.$$

	Utility Function	*Condition to Bring a Bag*
No Incentive	$U_{N,i}(w_i, b_i) = \begin{cases} u(w_i) - c_i & \text{if } b_i = 1 \\ u(w_i) & \text{if } b_i = 0 \end{cases}$	$0 > c_i$
Tax Policy	$U_{T,i}(w_i, b_i) = \begin{cases} u(w_i) - c_i & \text{if } b_i = 1 \\ u(w_i - x) & \text{if } b_i = 0 \end{cases}$	$u(w_i) - u(w_i - x) > c_i$
Bonus Policy	$U_{B,i}(w_i, b_i) = \begin{cases} u(w_i + x) - c_i & \text{if } b_i = 1 \\ u(w_i) & \text{if } b_i = 0 \end{cases}$	$u(w_i + x) - u(w_i) > c_i$

	Utility Function	*Condition to Bring a Bag*
No Incentive	$U_{N,i}(w_i, b_i) = \begin{cases} \gamma w_i - c_i & if\ b_i = 1 \\ \gamma w_i & if\ b_i = 0 \end{cases}$	$0 > c_i$
Tax Policy	$U_{T,i}(w_i, b_i) = \begin{cases} \gamma w_i - c_i & if\ b_i = 1 \\ \gamma(w_i - x) & if\ b_i = 0 \end{cases}$	$\gamma x > c_i$
Bonus Policy	$U_{B,i}(w_i, b_i) = \begin{cases} \gamma(w_i + x) - c_i & if\ b_i = 1 \\ \gamma w_i & if\ b_i = 0 \end{cases}$	$\gamma x > c_i$

If an individual's reference point is his wealth level in the absence of any incentive policy, then the conditions for using a reusable bag simplify to the equations in the table below.

Since $\alpha > 1$, this model predicts that customers are more likely to bring a reusable bag when the financial incentive takes the form of a tax rather than a bonus. The following sections empirically test whether customers respond similarly to the two policies, as predicted by neoclassical theory, or if customers exhibit loss aversion.

DATA

The first part of this paper assesses the effectiveness of the tax in reducing the use of disposable bags using two data sets. First, I use transaction-level scanner data from a large retail chain of grocery stores in several areas that have implemented a disposable bag regulation. The data set includes a 10 percent sample of all transactions in multiple stores in DC, Montgomery County, Santa Monica, San Jose, and Santa Cruz County in the months following the implementation of the disposable bag tax in each area.[6] Each observation corresponds to a purchased product and includes information on date, store location, and a transaction identifier used to link all purchases in a given transaction. In addition, the data includes a line item for whether or not the customer was charged for the use of a store-provided paper or plastic bag. This data allows me to calculate the percent of customers using at least one disposable bag in the days following the implementation of the tax; however, I am not able to compare demand before and after the tax, nor am I able to compare demand in cities with a tax to demand in cities without a tax.

To address this limitation, the main analysis utilizes a data set I collected containing information on demand for disposable[7] and reusable[8] bags before and after the implementation of the Montgomery County tax. I collected data at 16 stores in the Washington Metropolitan Area – eight stores in Montgomery County, four stores in Virginia, and four stores in DC – approximately two months before and two months after the implementation

	Utility Function	*Condition to Bring a Bag*
No Incentive	$U_{N,i}(w^*, b_i) = \begin{cases} -c_i & if\ b_i = 1 \\ 0 & if\ b_i = 0 \end{cases}$	$0 > c_i$
Tax Policy	$U_{T,i}(w^*, b_i) = \begin{cases} -c_i & if\ b_i = 1 \\ -\gamma\alpha x & if\ b_i = 0 \end{cases}$	$\gamma\alpha x > c_i$
Bonus Policy	$U_{B,i}(w^*, b_i) = \begin{cases} \gamma x - c_i & if\ b_i = 1 \\ 0 & if\ b_i = 0 \end{cases}$	$\gamma x > c_i$

of the tax.[9] These stores include three different grocery store chains and one organic market chain. To obtain measures of demand, I stood by the register at each store for an average of 10 30-minute intervals per store, randomizing the order in which I visited each store, and recorded the number and type of bags each customer used, as well as the customer's gender and race. The final sample contains information on 16,251 customers. This data set enables me to compare the change in demand in Montgomery County before and after the policy to that in control stores in DC and Virginia. The stores in Maryland and Virginia that I selected for this study are located in the cities of Bethesda, Silver Spring, and Arlington, which border DC and are popular communities for those employed in the district. While the city of DC is poorer and more diverse than these suburban commuter towns, the DC stores selected for this study are located in the wealthier areas of the city in order to maintain comparability to the samples from Maryland and Virginia.[10]

The second part of this paper addresses the question of whether a 5-cent bonus for using a reusable bag can have the same effect on behavior as a tax of the same amount. The observational data mentioned above was collected at four different grocery store chains – two of which offered a bonus program, two of which did not. The primary analysis uses this data to determine whether customers shopping at stores that charge a 5-cent tax for disposable bag use exhibit similar behavior to those shopping at stores offering a 5-cent bonus for reusable bag use.

I use two additional data sets to investigate whether the differences in behavior I observe in bonus versus tax stores suggests that customers are loss-averse with respect to incentives for reusable bag use or if there are other mechanisms at work that could cause this discrepancy. First, I conducted in-person surveys of customers as they exited the store after their shopping trip before and after the policy change in Montgomery County. These surveys were conducted at 12 different locations at two grocery store chains in Maryland, Virginia, and DC. I collected data for the pre-period from September to October of 2011 and returned to the same stores[11] to conduct the post-period interviews in March of 2012.[12] The survey yielded a response rate of 56 percent for a total of 1,624 respondents. Customers were asked how many disposable and reusable bags they used that day, whether they knew if the store provided a bonus for bringing a reusable bag or charged for taking a disposable bag, personal demographic characteristics, subjective measures of how much both of these policies did or would encourage them to use a reusable bag, and attitudes toward plastic bag use, environmentalism, and government regulation of pollution. Second, in order to test customers' response to other hypothetical disposable bag regulations, I use data from an online survey administered through Amazon's Mechanical Turk (Mturk), a crowdsourcing web service.[13]

THE EFFECT OF THE WASHINGTON METROPOLITAN AREA BAG TAX

Can small financial incentives deter undesirable behavior? This section reviews previous studies on this question and provides evidence of the effectiveness of the tax policies in the Washington Metropolitan Area at reducing consumption of disposable bags.

Literature Review on Small Financial Incentives

For decades, taxes on commodities that impose negative externalities on society have been popular among federal and local governments. Several of these "sin taxes" have not only provided a substantial source of government revenue, but they have also been effective in curbing behavior that is unhealthy for the individual or harmful to the public. For example, cigarette taxes have been shown to decrease smoking rates, leading to better health outcomes for smokers and their families (Chaloupka & Warner, 2000). However, these taxes constitute a substantial portion of the after-tax price of the commodity.[14] In contrast, taxes on soft drinks, which are much smaller – around 4 percent – showed only a very small impact on consumption (Sturm et al., 2010).

Similarly, evidence on the effectiveness of other types of monetary incentives is mixed. Fullerton and Kinnaman (1996) show that charging individuals for residential waste disposal reduced waste and increased recycling. Lacetera et al. (2012) present evidence that financial incentives positively affect blood donations and that the effect increases with the size of the incentive. However, Titmuss (1970) suggests that financial incentives may not, in fact, increase public goods contributions and, in some cases, could deter such prosocial behavior. Several theories have been proposed for why incentives

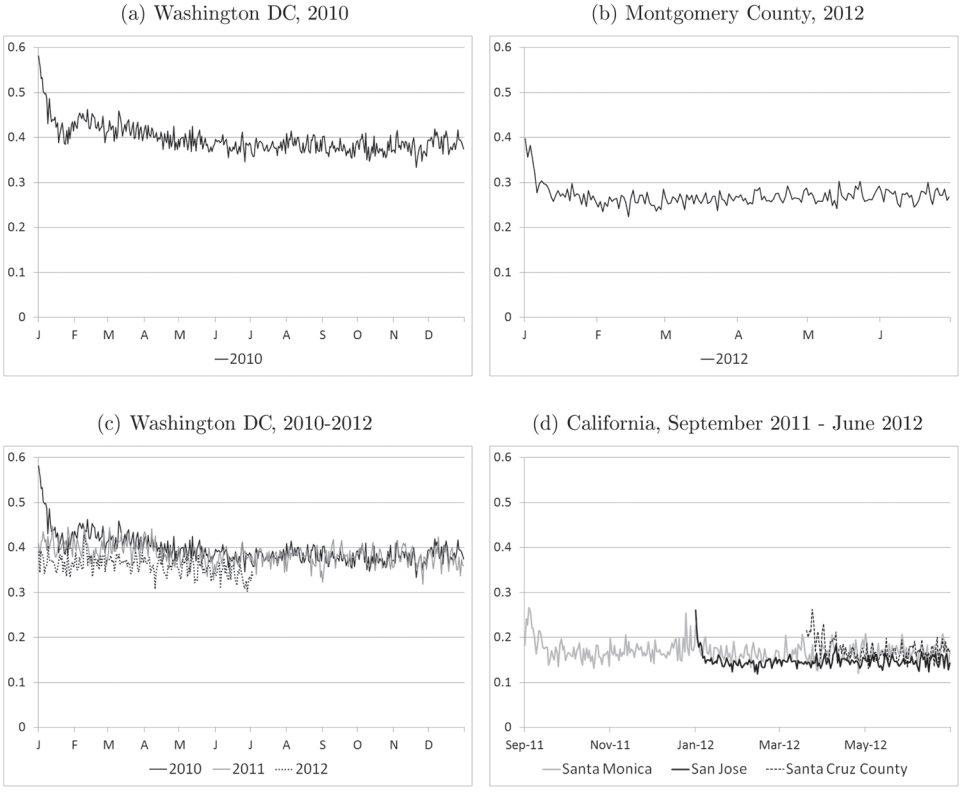
aimed at promoting prosocial behavior may have these unintended consequences. Gneezy and Rustichini (2000b) show that students asked to collect money door-to-door for charity exhibit less effort when offered a small financial incentive and suggest that this extrinsic motivation (i.e., the financial incentive) crowds out an individual's intrinsic motivation (e.g., altruism). Another theory suggests that the introduction of a financial incentive shifts the decision to contribute to the public good from a social frame to a monetary frame (Gneezy & Rustichini, 2000a; Heyman & Ariely, 2004).

Demand for Disposable Bags After Tax Implementation

As a first step, I use grocery store scanner data to investigate consumers' disposable bag use in the weeks following a tax's implementation. This data allows me to determine if a customer was charged for using a disposable bag during a given transaction.[15] Because the measure of disposable bag use is derived from bag tax collections, I only have information on disposable bag consumption in areas that charge a tax and only after a store has implemented the tax. Therefore, I cannot compare consumption before and after the policy, nor can I compare stores that charge a tax to those that do not. However, this data provides a description of how disposable bag use changed in the first few weeks after implementation, as well as in the long-term.

Figure 1a plots the percent of customers using a disposable bag in stores located in DC for the first year of the tax policy, starting on January 1, 2010.[16] The figure shows that 58.1 percent of customers used at least one disposable bag on the first day the tax was implemented and 52.7 percent used a disposable bag in the first week of implementation. This estimate decreased to 41.5 percent by the last week in January and remains at or below 40 percent for most of the year. I replicate this analysis for

Figure 1: **Proportion of Customers Using a Disposable Bag**



stores located in Montgomery County in figure 1b. This figure shows that on January 1, 2012, the first day of the Montgomery County tax, 39.8 percent of customers used at least one disposable bag. By the last week in January, only 26.3 percent of customers were charged a tax.

One concern with interpreting changes in behavior as a response to the tax is that there may be seasonal fluctuations in disposable bag use that could conflate the effect of the tax. While I do not have data on bag use in either area before the tax was implemented, figure 1c compares behavior in DC in the first year of implementation to behavior in the following two years. While the figure shows a substantial drop in disposable bag use during the first month of 2010 (when the tax was implemented), it does not show a similar change in behavior during the first month of 2011 or 2012. This suggests that differences in bag use across different dates in January are unlikely to be driving these results.

As mentioned in "Other Domestic Regulation of Disposable Bags," several cities and counties in California banned the use of plastic bags and imposed a 10-cent charge for disposable paper bags. Figure 1d plots the percent of customers charged for a paper bag in stores in the cities of Santa Monica and San Jose, as well as unincorporated areas of the Santa Cruz County. Santa Monica implemented its policy on September 1, 2011, San Jose on January 1, 2012, and Santa Cruz County on March 20, 2011. While the data for the California locations is much noisier than the data from DC and Montgomery County due to the smaller number of stores in the sample, there is still a slight decrease in paper bag use during the first week of the policy. It is also interesting to note that the percent of customers using a paper bag on all dates is notably lower in the California stores than in the stores in the Washington Metropolitan Area. This may have to do with differences in policies – the California policy involves a plastic bag ban and charges a higher fee for paper bag use – or may be due to differences in behavior across locations prior to policy implementation.

The Effect of the Montgomery County Bag Tax: A Difference-in-Differences Analysis

While the scanner data allows a precise descriptive analysis of bag use behavior in the months following the implementation of the tax, the lack of pre-tax scanner data prevents me from using the data to draw any causal interpretations about the tax's effect. Evaluations of the South African plastic bag levy (Hasson et al., 2007; Dikgang et al., 2012) suffer from the same criticism – both studies use firm-level data from a small number of retailers to examine plastic bag consumption over time, but neither includes data prior to the policy implementation. While the evaluations of the Irish bag tax (Convery et al., 2007) and the Chinese bag fee (He, 2010) utilize plastic bag consumption data before and after the policy, neither study collects data on a set of control stores or locations. This can be a problem if there are factors that affect bag consumption other than the plastic bag regulation that were changing at the same time as the policy implementation, i.e., shifts in social norms around environmental behavior, seasonal patterns in disposable bag use, or changing economic conditions that affected either production of disposable bags or grocery shopping behavior.

To deal with these issues, I expand on the descriptive analysis using data on grocery bag demand collected before and after the implementation of the Montgomery County bag tax. As mentioned in the "Data" section, I collected data on disposable and reusable bag use at 16 stores in the Washington Metropolitan Area, including stores in Montgomery County (where there is a policy change), DC (where a tax had already been imposed two years prior to data collection), and Virginia (which has no bag tax) before and after the implementation of the Montgomery County tax. This allows me to perform a difference-in-differences analysis to assess the impact of the tax on various measures of bag consumption.

Table 1 contains the mean values of the demographic characteristics of customers in the sample by state and time period. While the three locations vary slightly in their racial composition, all three areas are predominantly white with a similar gender ratio. In addition, the demographics within a location do not change significantly between the two time periods.

The analysis begins with a simple comparison of means of various measures of demand across locations and time periods. While reusable bags are the most common substitute for disposable bags, customers may opt to not use any bags at all; therefore, the majority of the analyses presented in this paper will include measures of demand for both disposable and reusable bags to create a complete picture of the changes in behavior as a result of the

Table 1
Demographics

	DC		*Maryland*		*Virginia*	
	Pre (1)	*Post* (2)	*Pre* (3)	*Post* (4)	*Pre* (5)	*Post* (6)
Female	58.49	59.73	59.78	61.22	53.09	56.85
	(49.29)	(49.06)	(49.04)	(48.73)	(49.92)	(49.54)
White	63.79	63.25	59.31	59.69	77.77	76.59
	(48.08)	(48.23)	(49.13)	(49.06)	(41.59)	(42.35)
Black	23.28	21.95	27.93	26.31	10.12	9.72
	(42.28)	(41.41)	(44.87)	(44.04)	(30.17)	(29.63)
N	1,207	1,649	3,799	4,515	2,006	3,075

Standard deviations in parentheses.
Table reports mean values of each variable.

bag regulations. Figures 2a and 2b show the percent of customers using any disposable and any reusable bags, respectively, in the three locations before and after the implementation of the Montgomery County tax. Recall that in DC, stores are required to charge a 5-cent tax in both periods, while there is no bag regulation in Virginia in either period. In the pre-period, customers in the Virginia sample used at least one disposable bag 82 percent of the time while customers in DC used a disposable bag only 45 percent of the time. Similarly, Virginia customers rarely brought a reusable bag when shopping, only 16 percent of the time, compared to 46 percent in DC. These numbers changed only slightly between the two periods. In contrast, demand in Montgomery County shifted dramatically after the implementation of the tax. Behavior in the pre-period resembled that observed in Virginia – 82 percent of customers used at least one disposable bag while only 16 percent brought a reusable bag. However, behavior in Montgomery County after the tax mirrored the behavior observed in DC – 40 percent of customers used a disposable bag while 49 percent brought a reusable bag. Table 2 contains the statistics corresponding to those displayed in the figures as well as means for additional measures of bag demand. I consider demand for the two types of bags on the extensive margin (the percent of customers using each type of bag), the intensive margin (how many bags each customer uses given that they use that particular type of bag), and overall demand (the unconditional number of bags of each type the customer uses). While the effect of the tax seems to have the largest impact on demand on the extensive margin, Montgomery County customers who continue to use disposable bags after the tax use fewer bags per trip. The data also shows an increase in the proportion of customers choosing not to use any bags at all.

I then use a regression framework to evaluate the effect of the Montgomery County tax on these measures of demand controlling for various individual- and store-level covariates. The empirical model follows a difference-in-differences strategy and takes the following form:

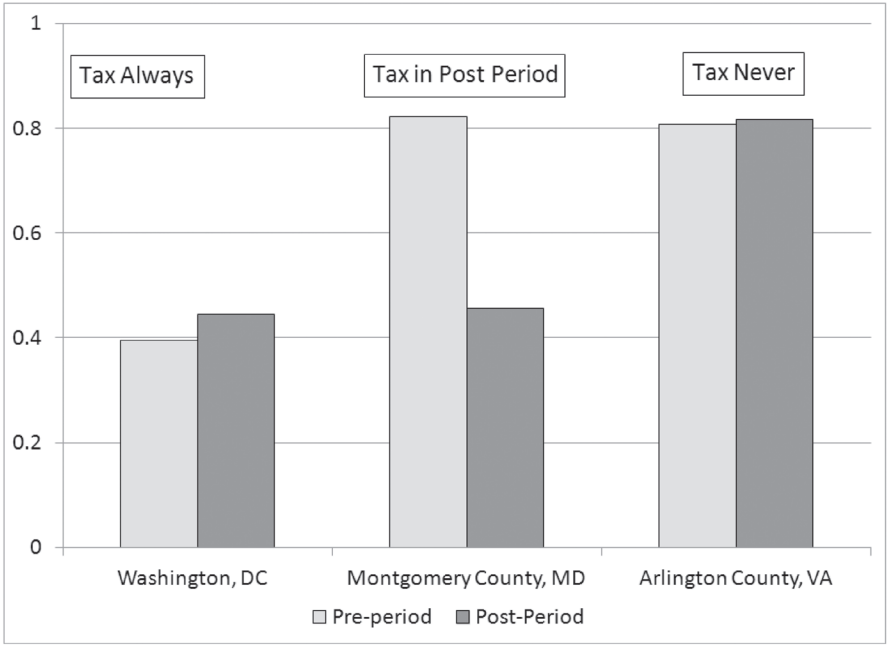
$$Y = \theta_0 + \theta_1 MD * Post + \theta_2 Post + \theta_3 MD + \lambda X + \varepsilon,$$

where Y is a measure of demand on the extensive and intensive margin, respectively; *Post* is an indicator for observations after the implementation of the Montgomery County tax; *MD* is an indicator for customers shopping in Montgomery County; and X is a set of controls.[17] The coefficient of interest is θ_1, the coefficient on the interaction of *Post* and *MD*, which measures the effect of the tax on demand in Montgomery County relative to changes in demand in the control stores.

Table 3 presents results for the effect of the tax on one measure of consumption, demand for disposable bags on the extensive margin, using different control variables in each specification. The model in column 1 controls for time period, state, and the interaction of shopping in Montgomery County and shopping in the post-period only. The results show that the tax caused a decrease in the proportion of customers using at least one disposable bag by 41.7 percentage points. Column 2 adds controls for the available individual-level demographic characteristics, race and gender.

Figure 2: **Demand by Location and Time Period**

(a) Proportion of Customers Using a Disposable Bag



(b) Proportion of Customers Using a Reusable Bag

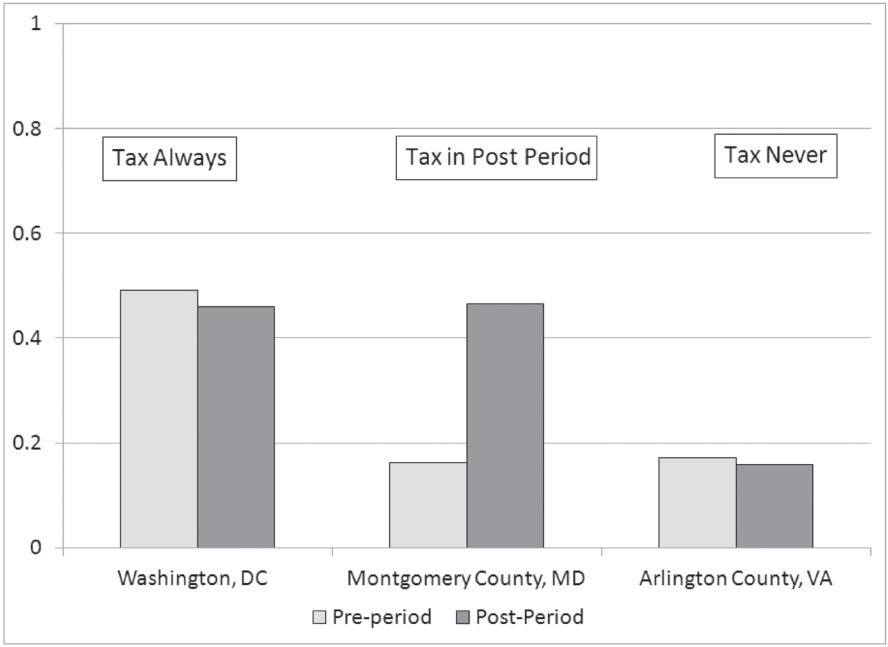


Table 2
Demand Before and After the Montgomery County Bag Tax

	DC		*Maryland*		*Virginia*	
	Pre (1)	*Post* (2)	*Pre* (3)	*Post* (4)	*Pre* (5)	*Post* (6)
Extensive Margin						
Disposable	44.5	45.7	81.7	39.6	82.2	80.8
	(49.7)	(49.8)	(38.6)	(48.9)	(38.3)	(39.4)
Reusable	46.0	46.6	15.9	49.2	16.3	17.2
	(49.9)	(49.9)	(36.5)	(50.0)	(36.9)	(37.7)
No Bags	14.9	11.3	5.7	15.4	4.7	4.8
	(35.6)	(31.7)	(23.2)	(36.1)	(21.1)	(21.5)
Intensive Margin						
Disposable	2.23	1.76	2.32	1.76	2.37	2.14
	(2.17)	(1.43)	(2.05)	(1.43)	(2.02)	(1.82)
Reusable	1.63	1.52	1.67	1.66	1.79	1.65
	(1.07)	(0.95)	(1.14)	(1.09)	(1.27)	(1.15)
Overall Demand						
Disposable	1.00	0.81	1.90	0.70	1.95	1.73
	(1.82)	(1.31)	(2.06)	(1.25)	(2.04)	(1.84)
Reusable	0.75	0.71	0.26	0.82	0.29	0.28
	(1.09)	(1.00)	(0.76)	(1.13)	(0.84)	(0.78)
N	1,207	1,649	3,799	4,515	2,006	3,075

Standard deviations in parentheses.

Table reports the probability of using a bag (extensive), demand among users (intensive), and unconditional demand (overall) for each type of bag.

If certain demographic groups are more likely to use reusable bags instead of disposable bags, differences in demographics across locations and time periods could bias my results. While minorities and males are more likely to use a disposable bag in general, the estimate of the effect of the tax is unchanged by the inclusion of these controls. Third, while I randomized the order in which I visited each store, differences in the time of data collection across locations could affect the results. I control for time of day in column 3 and find only the slightest change in the estimates.[18] Finally, the study includes several different chains of grocery stores in various locations throughout the cities considered. While I attempted to choose comparable stores, differences in the location or size of the store, additional store policies about reusable bag use, or neighborhood demographics could affect whether customers choose to use a disposable bag. To account for this possibility, my preferred specification in column 4 includes store fixed effects. As with the other controls, the addition of store-level fixed effects has little impact on the estimated effect of the tax.

Using this preferred specification, table 4 repeats the analysis for the other measures of demand. The table includes measures of demand for both disposable and reusable bags on the extensive and intensive margins, respectively, as well as a binary measure for using no bags of either type. On the extensive margin, the imposition of the tax led to a decrease in disposable bag use of 42.0 percentage points and an increase in reusable bag use of 32.7 percentage points. In addition, the percent of customers who used no bags at all increased by 11.1 percentage points.[19] On the intensive margin, I observe smaller, but still statistically significant, effects on bag consumption – the number of bags used by disposable bag users decreased by 0.22 bags and the number of bags used by reusable bag users increased by 0.15 bags, a change of approximately 8 and 9 percent, respectively.

Table 3
Effect of Tax Policy on Disposable Bags - Extensive Margin

	(1)	*(2)*	*(3)*	*(4)*
Post*MD	-0.417***	-0.417***	-0.419 ***	-0.420 ***
	(0.014)	(0.014)	(0.014)	(0.014)
Post	-0.005	-0.003	-0.002	-0.002
	(0.010)	(0.010)	(0.010)	(0.010)
MD	0.001	-0.013	-0.009	
	(0.010)	(0.010)	(0.010)	
DC	-0.362***	-0.372***	-0.372 ***	
	(0.011)	(0.011)	(0.011)	
Black		0.100 ***	0.100 ***	0.099 ***
		(0.009)	(0.009)	(0.009)
Other Race		0.025 **	0.025 **	0.025 **
		(0.010)	(0.010)	(0.010)
Female		-0.068 ***	-0.067 ***	-0.066 ***
		(0.007)	(0.007)	(0.007)
Afternoon			0.005	0.003
			(0.008)	(0.008)
Evening			0.027 ***	0.026 ***
			(0.008)	(0.009)
Store FE	No	No	No	Yes
N	16,251	16,251	16,251	16,251

Robust standard errors in parentheses.
Outcome variable: probability of using at least one disposable bag.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In order to provide a measure of the overall effect of the tax on demand, I can combine the extensive and intensive margin estimates following McDonald and Moffitt (1980). In particular, I can decompose the conditional expectation of demand into its extensive and intensive components:

$$E[y \mid x] = E[y \mid x, y > 0] * P(y > 0 \mid x),$$

where y represents demand and x represents the covariates. Using the product rule, the total effect of a change in one of the covariates on demand is given by:

$$\frac{\partial E[y \mid x]}{\partial x} = \frac{\partial E[y \mid x, y > 0]}{\partial x} * P(y > 0 \mid x) + \frac{\partial P(y > 0 \mid x)}{\partial x} * E[y \mid x, y > 0].$$

By utilizing sample estimates of $P(y > 0|x)$ and $E[y|x, y > 0]$, evaluated at the sample mean of each covariate, I can combine the estimated coefficients from the extensive and intensive margin regressions into a rough estimate of the overall effect of the taxes on demand.[20] Table 5 presents these results. The estimates suggest that the tax decreased the number of disposable bags used by 1.26 bags and increased the number of reusable bags used by 0.62 bags per customer per shopping trip.[21]

LOSS AVERSION AND INCENTIVE DESIGN

Can a bonus for reusable bag use have the same impact on consumer behavior as a tax on disposable bag use? The previous section documented that Montgomery County's 5-cent tax was associated with a substantial reduction in consumers' use of disposable bags. Prior to the implementation of both the DC and Montgomery County taxes,

Table 4
Effect of Tax Policy on Demand - Extensive and Intensive Margins

	Extensive Margin			*Intensive Margin*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
	Disposable	*Reusable*	*No Bags*	*Disposable*	*Reusable*
Post*MD	-0.420***	0.327***	0.111***	-0.215***	0.150**
	(0.014)	(0.013)	(0.009)	(0.070)	(0.069)
Post	-0.002	-0.002	-0.006	-0.227***	-0.116**
	(0.010)	(0.010)	(0.006)	(0.051)	(0.047)
Black	0.099***	-0.102***	-0.001	-0.153***	-0.185***
	(0.009)	(0.009)	(0.006)	(0.046)	(0.039)
Other Race	0.025**	-0.057***	0.022***	-0.133***	-0.217***
	(0.010)	(0.010)	(0.007)	(0.051)	(0.043)
Female	-0.066***	0.153***	-0.061***	0.381***	0.203***
	(0.007)	(0.007)	(0.005)	(0.035)	(0.031)
Afternoon	0.003	0.031***	-0.024***	0.265***	0.026
	(0.008)	(0.008)	(0.006)	(0.043)	(0.038)
Evening	0.026***	0.009	-0.032***	0.270***	-0.062*
	(0.009)	(0.008)	(0.006)	(0.043)	(0.037)
Store FE	Yes	Yes	Yes	Yes	Yes
N	16,251	16,251	16,251	10,314	5,003

Robust standard errors in parentheses.

Outcome variables: probability of using at least one bag or no bags (extensive) and demand among users (intensive) for disposable and reusable bag demand, respectively.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

several grocery store chains in the Washington Metropolitan Area offered customers a 5-cent bonus for each reusable bag they used instead of taking a disposable bag. In this section, I use this natural experiment to compare the effect of these two policies to assess the importance of framing when designing financial incentives.

Literature Review

For customers shopping in stores that offer a bonus program, the economic incentive to use a reusable versus disposable bag is 5 cents, the same as under the tax. Consequently, neoclassical models of behavior suggest that these two policies should have the same effect on behavior; the form that the incentive takes – a bonus versus a tax – should not affect demand. However, work in behavioral economics suggests that this equivalence may not hold in practice. Evidence from both lab and field experiments (Kahneman et al., 1991; DellaVigna, 2009) indicates that individuals perceive losses more strongly than gains of the same size. If grocery store customers are loss-averse, then a policy that charges customers for disposable bag use may be more effective than a policy that rewards customers for using reusable bags, even if the incentives are financially equivalent.

Several recent studies conduct experiments that test the effectiveness of economic incentives with these behavioral insights in mind. New York University's (NYU) School of Law conducted an experiment in which the university randomized the framing of an income-contingent loan repayment program that encourages graduates to enter the public sector. Students who received the tuition subsidy upfront, but were told that they would need to repay the amount if they did not enter the public sector upon graduating (the "loss" group), were more likely to take a job in public interest law and more likely to enroll at NYU than students whose loans would be repaid only after entering the public sector (the "gain" group) (Field, 2009). Using a similar experimental design, Hossain and List (2009) altered whether employees in a Chi-

Table 5
Effect of Tax Policy on Demand - Overall Effect

	(1) Disposable	*(2) Reusable*
Post*MD	-1.260***	0.622***
	0.057	0.033
Post	-0.143***	-0.037*
	0.039	0.022
Black	0.077**	-0.253***
	0.035	0.020
Other Race	-0.081**	-0.191***
	0.039	0.021
Female	-0.025	0.307***
	0.029	0.016
Afternoon	0.059*	0.032*
	0.035	0.019
Night	0.129***	-0.032*
	0.034	0.019
Store FE	Yes	Yes
N	16,251	16,251

Robust standard errors in parentheses.
Outcome variables: bag demand in levels.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

nese manufacturing facility received performance bonuses before production that were then reduced if certain productivity quotas were not met or if they were awarded a bonus only after they reached the quota. They found that employees who received bonuses framed as a loss were more productive than those who received bonuses framed as a gain. Most recently, Fryer et al. (2012) tested the effectiveness of a pay-for-performance program for teachers in Chicago public schools and found that students of teachers in the "loss" treatment showed significant gains in reading and math, while students of teachers in the "gain" treatment did not perform any better than those whose teachers did not receive any financial incentive.

This paper contributes to this growing literature by investigating the impact of incentive-framing and provides new insights on a variety of dimensions. To my knowledge, this is the first paper to determine the existence of these behavioral mechanisms in the context of prosocial environmental behavior. This is also the first study to use taxes as a policy tool to exploit the influence of framing. Lastly, the majority of papers that test for loss aversion in the field provide individuals with rather large incentives. For example, the highest performing teachers in the Chicago schools experiment received an $8,000 bonus, which is roughly equivalent to 16 percent of the average teacher salary in the area. To put that value in context of the incentives examined in this paper, a customer would need to use 438 bags per day for a full year in order for these incentives to be equivalent. This study provides evidence as to whether these behavioral findings hold with low-stakes incentives.

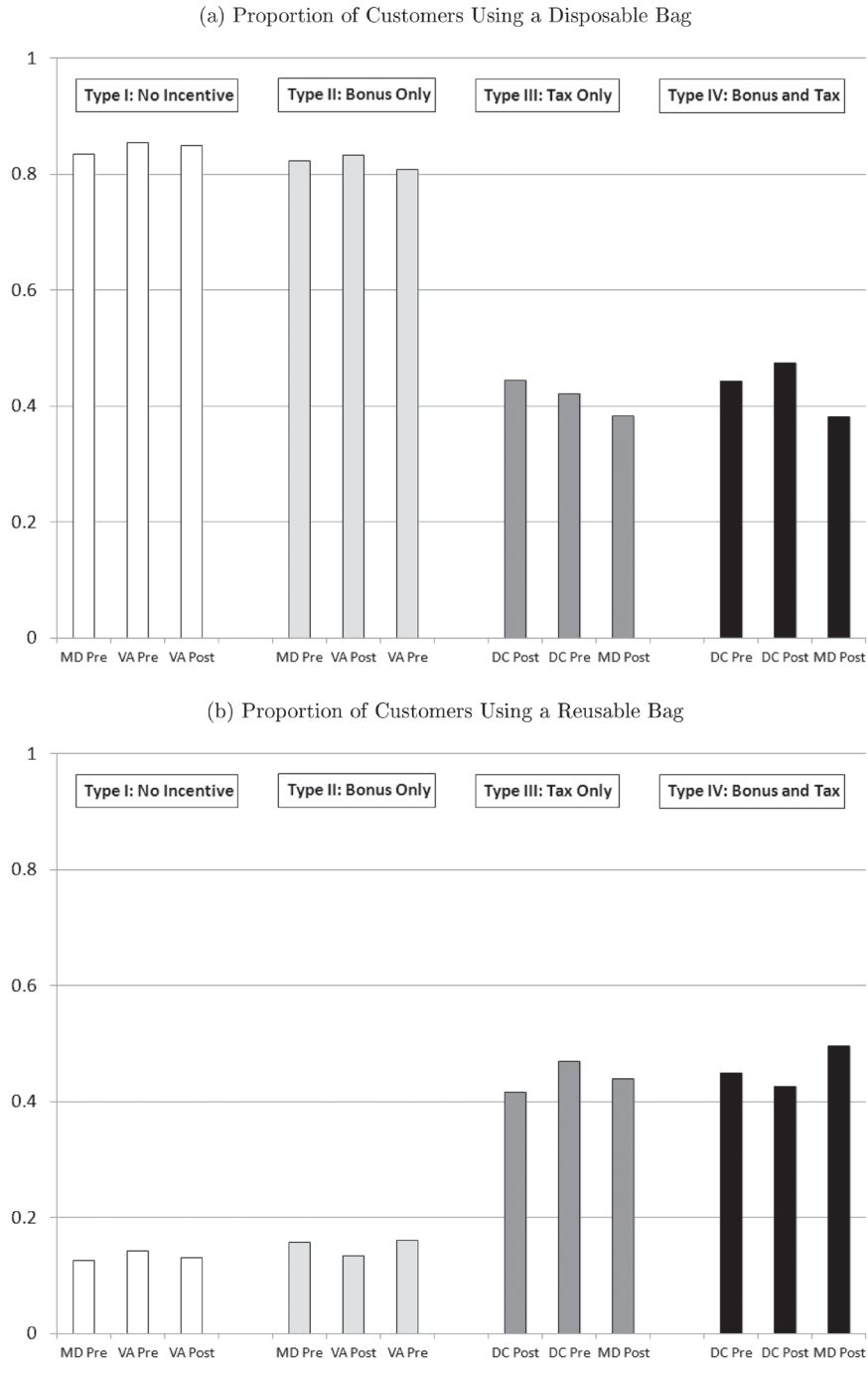
The Effect of Taxes versus Bonuses

Evidence from Observational Data in the Washington Metropolitan Area

Unlike with the tax policy, I do not have data before and after the implementation of the bonus program; therefore, I cannot perform a difference-in-differences analysis on the effectiveness of the bonus policy as I have with the tax. However, I am able to provide a cross-sectional comparison of the behavior of customers at stores with different policies. Of the 12 stores considered in this analysis, six of them offer a 5-cent bonus per reusable bag.[22] Each store falls into one of four policy types. Type I stores provide no incentives for using a reusable bag or reducing use of disposable bags. These are grocery store chains that do not offer a bonus and were not required to charge a tax. Type II stores offer a bonus for reusable bag use, but do not charge a tax for disposable bag use. Type III stores do not offer a bonus, but do charge a tax. Finally, Type IV stores offer both a bonus for reusable bag use and charge a tax for disposable bag use, since all of the stores in the sample that provided a bonus prior to the tax continued to provide a bonus after the tax was implemented. Figures 3a and 3b show the percent of customers using at least one disposable (reusable) bag by policy type with each bar representing a policy-location-period. For example, bonus stores in Montgomery County represent a bar in the Type II category in the pre-period and a bar in the Type IV category in the post-period.

In figure 3a, an average of 84.3 percent of customers use at least one disposable bag in type I stores, i.e., stores with no incentive policy. This estimate is much higher than that in stores with both a tax and a bonus – only 40.4 percent of customers used a disposable bag in type IV stores. What is most striking, however, is the comparison of stores that offer only a 5-cent incentive but that differ in whether the incentive takes the form of a tax or a

Figure 3: **Demand by Store Policy**



bonus. Customers in stores with only a tax used a disposable bag 40.8 percent of the time, similar to customers in stores offering both a tax and a bonus. However, customers in stores that offered only a bonus used a disposable bag 81.9 percent of the time. This estimate is much closer to the percent of customers using a disposable bag in stores that provided no incentive than it is to stores offering an incentive of the *same amount*, but in the form of a tax instead of a bonus.

Figure 3b tells a similar story for the proportion of customers using a reusable bag. Customers shopping in stores with both a bonus and a tax used a reusable bag 47.8 percent of the time, which is similar to, though statistically significantly larger than, the 44.2 percent of customers who used a reusable bag in stores that charge a tax but do not provide a bonus. However, only 15.4 percent of customers bring a reusable bag in stores that offer a bonus only. This estimate is much smaller than that in stores that charge a tax, though only slightly larger than the 13.1 percent of customers who shop at stores with no incentive policies.[23]

I then consider a similar analysis using a regression framework with the following econometric model that allows me to control for factors that might confound the simple comparison of means:

$$Y = \theta_0 + \theta_1 Tax + \theta_2 Bonus + \lambda X + \varepsilon.$$

Y is a measure of bag demand; *Tax* is an indicator for whether a store charges a 5-cent tax; *Bonus* is an indicator for whether the store offers a 5-cent bonus for reusable bag use; and *X* is a set of controls, including individual-level demographics, time of day, and store location. If I assume that, conditional on these controls, there are no unobservable differences between the customers of bonus and non-bonus stores that would affect their response to the two types of incentives or to their demand in the absence of a bag regulation, I can interpret estimates of θ_1 as the effect of the tax policy and θ_2 as the effect of the bonus policy.

Table 6 presents the results for disposable and reusable bag use on the extensive margin. Columns 2 and 4 control for individual demographic characteristics and time of day while columns 1 and 3 do not. As with the evaluation of the tax policy in table 4, men and minority racial groups are more likely to use disposable bags, but the inclusion of these controls does not change the estimates of the effect of the tax or bonus policies. Customers are significantly less likely to use a disposable bag in stores that charge a tax – 44.5 percentage points lower – whereas customers shopping at stores that offer a bonus program do not differ significantly from those shopping at stores without the program. While customers are significantly less likely to use a reusable bag in both tax and bonus stores than in stores that offered no incentive, the magnitude of difference is much larger in tax stores than in bonus stores – 32.7 versus 2.9 percentage points.[24]

As mentioned before, I do not have a natural experiment around the implementation of the bonus, so the comparisons in this section should not be interpreted as a causal relationship. If customers choose to shop at the store closest to where they live and stores that offer a bonus program are located in areas where customers are less likely to use a reusable bag regardless of the incentive policy, then the tax and bonus policies could be equally effective, and the results in this paper could still be observed. However, given that many of the stores in the sample that offer a bonus program are within a 10 minute walk from those that do not, it is unlikely that differences in local demographics are driving the results. Similarly, one might expect that customers who already bring reusable bags might choose to shop at stores that reward them for doing so. However, this pattern would likely bias my approach *against* finding evidence of loss aversion.

Survey Measure of Policy Effectiveness

To investigate loss aversion without assuming comparability between customers at bonus and non-bonus stores, I surveyed grocery store customers about how they would respond to a hypothetical tax or bonus policy. I asked respondents if a 5-cent incentive influenced their decision to bring a reusable bag when shopping at that store, randomizing whether the incentive was framed as a tax or a bonus.[25] Participants were instructed to give one of the following five responses: definitely, quite a bit, somewhat, very little, or not at all. Table 7 presents results of the following linear probability model:

$$Y = \theta_0 + \theta_1 Tax + \theta_2 Bonus + \lambda X + \varepsilon.$$

where *Y* is the probability that the survey participant responded that the incentive would definitely influence his decision to bring a reusable bag or influence his decision quite a bit (the top two categories); *Tax* is an indicator variable that takes the value of one if the participant was asked about

Table 6
Effect of Tax vs. Bonus Policy on Demand - Extensive Margin

	Disposable		*Reusable*	
	(1)	*(2)*	*(3)*	*(4)*
Tax	-0.445***	-0.445***	0.329***	0.327***
	(0.011)	(0.011)	(0.011)	(0.011)
Bonus	-0.009	-0.013	0.026***	0.029***
	(0.008)	(0.008)	(0.008)	(0.008)
MD	-0.003	-0.015	0.001	0.014
	(0.009)	(0.010)	(0.009)	(0.009)
DC	0.057***	0.041**	-0.027	-0.008
	(0.017)	(0.017)	(0.017)	(0.017)
Black		0.102***		-0.102***
		(0.010)		(0.010)
Other Race		0.027**		-0.064***
		(0.011)		(0.011)
Female		-0.055***		0.150***
		(0.008)		(0.008)
Afternoon		0.013		0.033***
		(0.010)		(0.009)
Evening		0.032***		0.011
		(0.010)		(0.009)
F-stat	949.19	946.44	465.23	471.99
prob>F	0.00	0.00	0.00	0.00
N	11,678	11,678	11,678	11,678

Robust standard errors in parentheses.

Outcome variable: probability of using at least one disposable (reusable) bag.

Tax is a binary variable with a value of one if the store charges a 5-cent tax per disposable bag. *Bonus* is a binary variable with a value of one if the store offers a 5-cent bonus per reusable bag.

The F-stat is associated with the test of equality between the tax and bonus coefficients.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

a tax policy and zero for a bonus policy; and X is a vector of individual demographic characteristics including gender, race, age, education, and income. Customers who were asked about the influence of the bonus program responded 28.1 percent of the time that the policy would definitely influence their decision or influence their decision quite a bit. This average is significantly lower – 31.4 percentage points lower – than the proportion of customers who responded similarly when the incentive was framed as a tax.[26]

Estimating the Coefficient of Loss Aversion

The section "Modeling Responses to Financial Incentives" described two models with different predictions for the relative effectiveness of the tax and the bonus policies. The neoclassical model predicts that, while the response to either incentive depends on the change in utility due to the incentive relative to the cost of bringing a reusable bag, the response to the two types of incentives should be the same, as long as the incentives are small. In contrast, the reference-dependent preferences model predicts that a tax should have a larger effect than a bonus of the same size. The empirical analysis shown in the previous section suggests that customers were much more likely to use a reusable bag when the incentive was framed as a tax rather than a bonus, evidence that is consistent with a model of loss aversion rather than the neoclassical model.

Table 7
Effect of Tax vs. Bonus Policy on Demand - Survey Measure of Influence

	(1)
Tax (vs. Bonus)	0.293***
	(0.025)
White	-0.104***
	(0.028)
Female	0.053**
	(0.026)
Age	-0.004
	(0.005)
Age Squared	0.000
	(0.000)
>=High School	0.042
	(0.034)
Income<$50k	0.025
	(0.032)
N	1,279

Robust standard errors in parentheses.

Outcome variable: probability respondent answered "definitely" or "quite a bit" when asked if the 5-cent incentive influenced his decision to bring a reusable bag.

Tax is a binary variable equal to one if the incentive was framed as a tax and zero if it was framed as a bonus.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In the reference-dependent utility function used in the Section "Washington Metropolitan Area Disposable Bag Regulations," α is the slope of the utility function for wealth levels above the reference point (w^*) relative to the slope below the reference point, i.e., the sharpness of the kink in the utility function at w^*. This parameter is often referred to as the "coefficient of loss aversion" (Wakker & Tversky, 1993). Several papers have estimated the coefficient of loss aversion using lab experiments and find $\alpha \approx 2$. In this section, I provide an estimate of α using my observational data.

The table below repeats the conditions required for a customer to choose to bring a reusable bag under the three policies assuming reference-dependent preferences from "Washington Metropolitan Area Disposable Bag Regulations." If F is the distribution of c_i, the proportion of customers bringing a reusable bag when there is no incentive, when there is a tax, and when there is a bonus are $F(0)$, $F(\gamma\alpha x)$, and $F(\gamma x)$, respectively. Recall that we observe these proportions in the data in the previous section. Therefore, if I make an assumption about the distribution of c_i, I can estimate the coefficient of loss aversion.

If I take a first-order Taylor approximation of $F(\gamma\alpha x)$, the proportion of customers bringing a reusable bag under the tax policy around zero yields the equation $F(\gamma\alpha x) \approx F(0) + \gamma\alpha x f(0)$. Similarly, I can approximate the proportion of customers bringing a reusable bag under the bonus policy as $F(\gamma x) \approx F(0) + \gamma x f(0)$. From these two equations, α is equivalent to the ratio of the increase in reusable bag usage under the tax policy to the increase in reusable bag usage under the bonus policy: $\alpha \approx F(\gamma\alpha x) - F(0)/F(\gamma x) - F(0)$. Therefore, if I assume that the first-order approximation is exact (for example, if c_i is locally uniformly distributed) then $\alpha = 13.9$. However, if it is the case that f' is large on the interval between zero and x, a first-order approximation will not be good estimate. As a robustness check, I assume that c_i is normally

	Utility Function	*Condition to Bring a Bag*	*% Bringing a Bag*	*% Bringing a Bag (from Data)*
No Incentive	$U_{N,i}(w^*, b_i) = \begin{cases} -c_i & \text{if } b_i = 1 \\ 0 & \text{if } b_i = 0 \end{cases}$	$0 > c_i$	$F(0)$	13.1
Tax Policy	$U_{T,i}(w^*, b_i) = \begin{cases} -c_i & \text{if } b_i = 1 \\ -\gamma\alpha x & \text{if } b_i = 0 \end{cases}$	$\gamma\alpha x > c_i$	$F(\gamma\alpha x)$	44.2
Bonus Policy	$U_{B,i}(w^*, b_i) = \begin{cases} \gamma x - c_i & \text{if } b_i = 1 \\ 0 & \text{if } b_i = 0 \end{cases}$	$\gamma x > c_i$	$F(\gamma x)$	15.4

distributed with a mean of $-\Phi^{-1}(.131)$ and a variance of one and find an estimate of $\alpha = 9.5$.

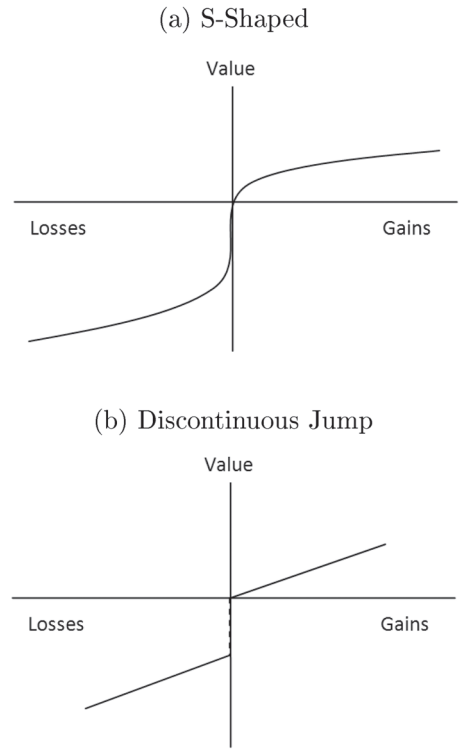
These estimates of α are considerably larger than previous estimates from the literature. Why might this data imply large values of α? The majority of the literature that estimates the coefficient of loss aversion does so using outcomes that are much larger than 5 cents. Kahneman and Tversky (1979) propose that the value function is generally concave for gains, convex for losses (i.e., S-shaped), and is steeper for losses than for gains. Loewenstein and Prelec (1992) extend this model to account for various discounted utility anomalies. They suggest that the value function is more elastic for outcomes that are larger in absolute magnitude, meaning that, for small outcomes the value function is steep, but, for large outcomes, it straightens out. Therefore, if previous studies calculate α on the flatter portion of the value function and this study calculates α directly around the reference point, it may not be surprising that this data estimates an α larger than two. Experimental literature supports the idea that the gain-loss asymmetry is larger for small outcomes than for large outcomes (Thaler, 1981; Benzion et al., 1989). Figure 4a presents a value function that satisfies these properties.

An alternative model of reference-dependent preferences assumes that, for certain reference points, there is a discontinuous jump in utility at the reference point rather than a kink. Shampanier et al. (2007) present a model of this kind suggesting that the benefits derived from receiving a free product are larger than the simple reduction in price. For example, individuals may receive higher intrinsic benefit from receiving free goods or, alternatively, may experience lower costs from not having to pay for a non-free good. This theory implies that, if a disposable bag is a typical consumption good, a customer's utility should decrease discretely when the store policy shifts from offering no incentive to charging a tax (i.e., when the good is no longer free) by some amount δ:

$$u(w_i) = \begin{cases} \gamma w_i & if\ w_i \geq w^* \\ \gamma w_i - \delta & if\ w_i < w^* \end{cases}, where\ \delta > 0.$$

Figure 4b presents a value function with this form. My data does not allow me to distinguish between these two possible models of reference-dependent preferences; however, previous evidence that suggests that zero is a special price may shed some light on why I estimate such a large coefficient of loss aversion. Suppose that prior to the implementation of any incentive policy, grocery stores charged customers 10 cents per disposable bag. Since neither a 5-cent tax nor a 5-cent bonus would cause disposable bags to be free, perhaps we would not observe such a dramatic difference in response to the two types of incentives.

Figure 4: **Value Functions**



Alternative Mechanisms

This paper provides evidence of the relative effectiveness of the two policies that is consistent with a model in which individuals are loss-averse, causing them to respond to the tax but not to the bonus policy. However, loss aversion is not the only possible explanation for the observed difference in behavior across stores with different policies. This section investigates other potential theories or mechanisms that might explain the results described above.

Marketing and Awareness

One reason the tax may have been more effective at changing customer behavior is that consumers were more aware of the tax than the bonus. The tax was highly visible in several dimensions. First, both DC and Montgomery County conducted a campaign that informed residents of the impending tax. Second, stores in the sample posted announcements by the register detailing the rules involved with the new law. Third, the tax was covered widely in the press during the weeks leading up to its implementation. While stores that offered a bonus advertised the policy through announcements posted at the register and on the racks where reusable bags were sold, the additional marketing involved with the implementation of the tax may have generated a difference in awareness of the two policies.

To investigate possible discrepancies in awareness, I surveyed customers at the sample stores about their knowledge of the store's tax and bonus policies. While almost all customers (98 percent) were aware of the tax, only 52 percent of customers in stores that offered a bonus were aware of that program.

To determine whether these differences in awareness could generate the observed difference in demand across stores with different policies, I develop the following model. The previous analysis tested the null hypothesis that demand in stores that charge a tax was equal to demand in stores that offered a bonus of the same amount:

$$H_0 : P(Y \mid NB, T) = P(Y \mid B, NT)$$

where Y is a measure of bag demand; B and NB indicate the presence and absence of a bonus program, respectively; and T and NT indicate the respective presence and absence of a tax, respectively.

Using language borrowed from the literature on local average treatment effects, I define three types of consumers. "Always Takers" are customers who would use a reusable bag (or not take a disposable bag) regardless of whether the store offers an incentive. "Never Takers" are customers who do not use a reusable bag even if the store provides an incentive. Lastly, "Compliers" are customers who bring a reusable bag only if the store offers an incentive to do so.

Using these terms, I can reinterpret the components of the null hypothesis. In stores with a tax policy, both the always takers and the tax policy compliers will bring a reusable bag so $P(Y|NB, T) = P(Always_T) + P(Complier_T)$. Similarly, $P(Y| B,NT) = P(Always_B) + P(Complier_B)$. Since always takers bring a reusable bag regardless of the store policy, and I am assuming that customers in the two types of stores are equivalent, $P(Always_T) = P(Always_B) = P(Always)$. In terms of measures defined in the data, $P(Always)$ is equivalent to $P(Y|NB, NT)$. Using these definitions, I can redefine the null hypothesis as:

$$H_0 : P(Complier_T) = P(Complier_B).$$

That is, the null hypothesis states that the fraction of customers who are compliers with respect to a tax is equal to the fraction of customers who are compliers with respect to a bonus.

Now suppose that not all customers are aware of a store's policy. As seen with the survey data, this is the case for the bonus policy, but not the tax policy. Since always takers will bring a reusable bag regardless of the store policy, it does not matter whether these customers are aware of the bonus. In contrast, only compliers who are *aware* of the policy will bring their own bags in stores that offer a tax or bonus. In particular, $P(Y|B, NT) = P(Always) + P(Complier_B)*P(Always_B|Complier_B)$, where $P(Always_B|Complier_B)$ is the probability that a customer is aware of the bonus program given that he is a bonus complier. So, unlike with the tax policy, the effect of the bonus policy may be muted due to under-awareness.

Adjusting for awareness of the bonus policy, a little bit of algebra yields the following null hypothesis:

$$H_0 : P(Y \mid NB,T) - P(Y \mid NB,NT) = \frac{P(Y \mid B,NT) - P(Y \mid NB,NT)}{P(Aware_B \mid Complier_B)}$$

While I observe the majority of the components in the equation above in the data, I do not have a measure of awareness of the bonus among compliers, since I cannot identify who is a bonus complier in the survey data. Customers who use a reusable bag in bonus stores are either bonus compliers who were aware of the bonus or always takers. Similarly, customers who do not use a reusable bag in bonus stores are either bonus compliers who were unaware of the bonus or never takers. However, I can provide plausible bounds on the awareness of bonus policy among bonus compliers using estimates from the survey data. This allows me to

determine if my results may simply be driven by the fact that more customers are aware of the tax than the bonus.

Table 8 presents these results. Estimates in each column assume that 100 percent of customers are aware of the tax policy.[27] In contrast, each column assumes a different value of the awareness of the bonus program among bonus compliers. Case I assumes complete awareness of the bonus policy, a lower bound on the effectiveness of the bonus policy. Case II assumes that the percent of compliers who are aware of the bonus program is equivalent to that of all survey participants shopping in stores with a bonus program, regardless of whether they used a reusable or a disposable bag – 52.0 percent. Lastly, case III assumes that compliers have an equivalent awareness to that of survey participants who did not use a reusable bag on the day of the survey – 38.0 percent. As mentioned above, this group contains a combination of bonus compliers who were unaware of the bonus and never takers. If I assume that awareness among the never takers is no larger than the awareness of bonus compliers, this estimate is an upper bound for the effectiveness of the bonus.

Recall that 84.3 percent of customers used a disposable bag in stores with no incentive policy, 81.9 percent in stores with only a bonus program, and 40.8 percent in stores with only a tax policy (see panel A of table 8). Panel B of table 8 presents estimates of the effect of the two policies after adjusting for awareness. In all cases, the estimate of the effect of the tax policy ($P(Complier_T)$) is equivalent to the difference in behavior between customers at stores with a tax policy and stores that offer no incentive to bring a reusable bag ($P(Y|NB,T) - P(Y|NB,NT)$) – a decrease of 43.5 percentage points. Similarly, case I assumes that compliers are completely aware of the bonus policy so the estimate of the effect of the bonus policy ($P(Complier_B)$) is equivalent to the difference in behavior between customers at stores with a bonus policy and stores that offer no incentive to bring a reusable bag ($P(Y|B, NT) - P(Y|NB, NT)$), which is 2.4 percentage points. In contrast, case II and III incorporate the possibility for less-than-perfect

Table 8

Effect of Tax vs. Bonus Policy on Extensive Margin Demand - Awareness Adjustment

Panel A	*Disposable* (1)	*Reusable* (2)
Demand Under Different Policies		
No Incentive ($P(Y\|NB, NT)$)	0.843	0.131
	(0.007)	(0.007)
Tax Policy ($P(Y\|NB, T)$)	0.408	0.442
	(0.010)	(0.010)
Bonus Policy ($P(Y\|B, NT)$)	0.819	0.154
	(0.006)	(0.006)

	Disposable			*Reusable*		
Panel B	*Case I* (1)	*Case II* (2)	*Case III* (3)	*Case I* (4)	*Case II* (5)	*Case III* (6)
Awareness Among Compliers ($P(Aware\|Complier)$)						
Tax Policy	1.000	1.000	1.000	1.000	1.000	1.000
Bonus Policy	1.000	0.520	0.380	1.000	0.520	0.380
Effect of Policy Adjusted for Awareness ($P(Complier)$)						
Tax Policy	-0.435	-0.435	-0.435	0.311	0.311	0.311
Bonus Policy	-0.024	-0.046	-0.063	0.023	0.044	0.061

Robust standard errors in parentheses in Panel A.

Outcome variable in Panel A: probability of using at least one disposable (reusable) bag in percent.

The effect of policy i, $P(Complier_i)$, is equivalent to $[P(Y|i, Nj) - P(Y|Ni, Nj)]/P(Aware_i|Complier_i)$ for i in $\{Tax, Bonus\}$ and j in $\{Bonus, Tax\}$.

awareness of the bonus policy and the estimate of the effect of the bonus policy becomes $P(Y|B, NT) - P(Y|NB,NT)/P(Aware_B|Complier_B)$. In case II, 4.6 percent of customers did not use a disposable bag as a result of the bonus program. In case III, the upper bound of the effect of the bonus, this estimate increases only slightly to 6.3 percent, which is seven times smaller than the estimated effect of the tax. In fact, in order for the effect of the bonus to be as large as the effect of the tax, it would require that only 5.5 percent of bonus compliers were aware of the bonus, which is unlikely given the survey estimates of awareness. Results for the percent of customers using a reusable bag are presented in columns 4 through 6 and tell a qualitatively similar story. So while differences in awareness may affect the observed impact of the two different policies, it is unlikely that increasing awareness of the bonus policy could account for all of the differential responses to the tax and the bonus.

I can also use this adjustment procedure to re-evaluate the estimates of the coefficient of loss aversion in the "Estimating the Coefficient of Loss Aversion" section. Using the lower bound awareness estimates from case III, I estimate an α of 3.9 if I assume that c_i is normally distributed with a variance of one and an α of 5.1 if c_i is uniformly distributed. These estimates are still large, but are much closer to the estimates previously found in the literature.

Changing Social Norms

Many legal theorists have investigated the "expressive function of law," the idea that a law has an effect on behavior independent of the sanction. For example, the law may shift individual preferences by making a statement about what behavior warrants punishment. Funk (2007) shows that voter turnout in Switzerland decreased significantly after a mandatory voting law with negligible penalties (less than one dollar) was repealed. Galbiati and Vertova (2008) conduct an experiment in which participants play a public goods game that requires players to contribute a minimum amount or pay a small fine for refusing and finds that this "obligation" increases contributions even when the optimal strategy is to free-ride.

This theory would suggest that a small tax on disposable bags may have a larger effect than a bonus of a similar size, because the passage of the policy changes social norms about bag consumption. It is difficult to rule out the hypothesis that the tax caused a shift in preferences; however, this section provides some evidence that the law may not have had a large impact on social norms.

Recall that the main analysis of the effectiveness of the tax focuses on the implementation of the Montgomery County tax. However, this was not the first tax of its kind in the Washington Metropolitan Area – DC passed a similar tax two years prior. Given that the sample draws from stores in areas that are close to DC, it is likely that many of the customers in the sample had been exposed to the DC bag tax prior to the implementation of the Montgomery County tax. Results from the in-store survey show that 73.7 percent of respondents in Virginia and 83.7 percent of Montgomery County respondents were aware of the DC tax.[28] In addition, 50.3 percent of respondents in Montgomery County were aware that the Montgomery County law had been approved in the pre-period survey and that they would soon be charged 5 cents for each disposable bag. This suggests that if individuals adjust their behavior simply due to the moral statement made by the announcement of the law, these customers should have already changed their behavior before the beginning of the sample period; however, I still observe a large change in behavior after the implementation of the Montgomery County tax.

Additionally, I collected survey data at seven grocery stores before and after the implementation of the Montgomery County bag tax that included questions aimed at measuring social norms about the use of disposable bags. I use the same difference-in-differences strategy as described in the section "The Effect of the Montgomery County Bag Tax: A Difference-in-Differences Analysis," controlling for gender, race, age, education, and income. Customers were asked if they felt guilty when they used a disposable bag ("Guilt"), felt social pressure to use fewer disposable bags ("Pressure"), got upset when they saw other customers use too many disposable bags ("Upset"), thought the number of disposable bags they used was wasteful ("Wasteful"), and whether they would support a law that required stores to tax customers 5 cents for each disposable bag ("Support"). If the implementation of the tax were to cause a shift in social norms, the results should show positive and significant estimates of the coefficient on *Post*MD*, the difference-in-difference estimator, for each of these measures. Table 9 presents the results of this

Table 9

Change in Social Norms after Implementation of Tax Policy

	(1) *Guilt*	*(2)* *Pressure*	*(3)* *Upset*	*(4)* *Wasteful*	*(5)* *Support*
Post*MD	0.072	-0.059	0.027	-0.103	0.040
	(0.073)	(0.073)	(0.063)	(0.074)	(0.068)
Post	-0.036	0.044	0.052	-0.133**	-0.042
	(0.056)	(0.056)	(0.048)	(0.057)	(0.050)
MD	-0.074	0.087	0.006	0.003	0.019
	(0.069)	(0.069)	(0.055)	(0.071)	(0.067)
DC	0.087	0.113**	0.023	-0.088	0.120**
	(0.055)	(0.056)	(0.048)	(0.056)	(0.052)
Female	0.220***	0.102***	0.108***	0.032	0.169***
	(0.035)	(0.035)	(0.031)	(0.036)	(0.035)
White	0.068*	0.064	-0.033	-0.008	0.063
	(0.040)	(0.040)	(0.036)	(0.041)	(0.041)
Age	0.008	0.007	-0.007	0.002	-0.006
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Age Squared	-0.000**	-0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
>=High School	-0.086*	0.004	0.007	-0.046	-0.066
	(0.044)	(0.044)	(0.042)	(0.046)	(0.048)
Income<$50k	-0.040	-0.008	0.023	-0.090**	-0.058
	(0.043)	(0.042)	(0.039)	(0.043)	(0.045)
N	743	742	742	742	685

Robust standard errors in parentheses.

Outcome variable: probability of responding affirmatively to the social norms survey question.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

analysis. I do not find that any of these measures of social norms significantly change as a result of the implementation of the tax. While the standard errors are rather large, the sign of the various measures are not all in the same direction – for example, the percent of customers reporting that they felt guilty when using a plastic bag increased after the implementation of the tax, while the percent reporting that they felt social pressure to use fewer plastic bags decreased. These results are by no means conclusive, but they do not provide any evidence that the law changed customers' social norms regarding the use of disposable bags.

Tax Aversion

Another potential explanation for why more customers use reusable bags in stores with a 5-cent penalty than in stores with a 5-cent bonus may be that the penalty takes the form of a tax rather than a fee. Recent work by Sussman and Olivola (2011) present evidence that consumers are "tax averse," in that they are more likely to avoid taxes than other costs of the same amount. This model would suggest that customers respond more strongly to the tax simply because it is a tax, and not because it is framed as a loss rather than a gain.

I am not aware of any existing policies that charge a fee for disposable bag use that is not framed as a tax, so I am not able to exploit policy variation of this kind in the field. Instead, I use an online survey to run a randomized experiment to test for tax aversion in this context. The survey questions mirror the questions asked in the in-store survey described in "The Effect of Taxes versus Bonuses," but instead of asking customers

Table 10
Effect of Tax vs. Fee on Demand - Survey Measure of Influence

	(1)
Tax (vs. Fee)	0.025
	(0.082)
White	0.080
	(0.097)
Female	0.183**
	(0.083)
Age	-0.029
	(0.027)
Age Squared	0.000
	(0.000)
>=High School	0.032
	(0.090)
Income<$50k	0.034
	(0.083)
N	147

Robust standard errors in parentheses.

Outcome variable: probability respondent answered "definitely" or "quite a bit" when asked if the 5-cent incentive influenced his decision to bring a reusable bag.

Tax is a binary variable equal to one if the incentive was framed as a tax and zero if it was framed as a fee.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

about their perceived response to a bonus versus a tax, they are asked how they believed they would respond to a store-imposed fee versus a government-imposed tax. I use the same specifications and controls as in "The Effect of Taxes versus Bonuses" and present results in table 10. I observe no difference in the likelihood of reporting that the tax would influence whether a customer brought a reusable bag compared to a fee of the same amount.

CONCLUSION

This paper investigates the impact of a new "eco-sin" tax, a 5-cent tax on disposable bags. I find that the tax policy reduced the overall demand for disposable bags by over half and prompted consumers to substitute reusable alternatives; this is particularly notable given the relatively small size of the tax itself. The large effect of the tax is also striking in light of the similarity between reusable bag use at stores offering a 5-cent bonus and stores that offered no financial incentive in the period before the tax was imposed, a result that is consistent with a model in which customers are loss-averse. I show that differences in awareness of the two policies and changes in social norms cannot fully account for my results.

These findings suggests the importance of accounting for behavioral insights when designing a wide variety of environmental incentives. For example, Starbucks Coffee rewards customers who bring their own coffee mugs with a 10-cent discount. My results suggest that this policy might be more effective if Starbucks instead reduced the price of coffee by 10 cents, but charged for using a paper cup. Similarly, the federal government awards a tax credit to customers who purchase environmentally-friendly Energy Star products. This policy might increase consumption of these products if they were taxed for purchasing energy-inefficient products.

It is interesting to note that the effect of this tax is not only large in absolute terms, but also in comparison to previous estimates of the impact of other types of sin taxes. There are several possible explanations for this discrepancy. First, the elasticity of demand for disposable bags may be substantially greater than the elasticity of demand for other goods. Second, the visibility of the bag tax, which is prominently displayed at grocery store registers, may help explain why it has had a larger effect than other taxes, which tend to be less salient (Goldin, 2012). Third, the large change in demand for disposable bags following the tax may stem from levying a price on a good that had previously been free (Shampanier et al., 2007). Finally, even a small initial impact of the tax can generate large effects if the reputational costs of using disposable bags increases by way of a social multiplier (Benabou & Tirole, 2011).

Notes

[1] While the price per bag was originally fixed, after three months retailers were able to set the price of a bag without restriction. This led to a substantial decrease in the charge per bag (Dikgang et al., 2012).

[2] In addition, the river is in danger of violating the EPA's Total Maximum Daily Load (TMDL) of allowable trash, which could cost DC millions of dollars in fines.

[3] This includes all retailers holding a Retail Food Establishment or Class A & B liquor license holders, i.e., grocery stores, food vendors, convenience stores, drug stores, restaurants, and liquor stores.

[4] Retailers who offer customers a discount for bringing a reusable bag retain 2 cents for every 5 collected; all other retailers retain 1 cent.

[5] Unlike in DC, the Montgomery County tax applies to all retailers, not just those selling food or alcohol. Additionally, retailers do not receive any financial incentive for offering a reusable bag bonus program.

[6] The data set includes 11 stores in DC, 16 in Montgomery County, three in Santa Monica, 10 in San Jose, and three in Santa Cruz County. The sample includes an average between 2000-2500 transactions per day for DC, Montgomery County, and San Jose, and between 500-1000 transactions for Santa Monica and Santa Cruz County.

[7] A disposable bag refers to either paper or plastic single-use bags. I do not consider the two types of bags separately because almost all customers chose to use plastic bags when they were offered. Additionally, four of the stores in the sample are an organic retail chain that only provide paper bags.

[8] A reusable bag refers to any multiple-use bag. While most customers used typical reusable bags sold by the store, this category also includes shopping carts, backpacks, tote bags, or disposable bags brought from home.

[9] Data in the pre-period was collected from late September to early November of 2011, while data in the post-period was collected from late February to early March of 2012. All data was collected from Monday through Friday between the hours of 11 a.m and 8 p.m.

[10] The cities of Bethesda and Silver Spring have a median household income of $133,480 and $67,918, respectively, with a non-Hispanic white population of 78 and 36 percent, respectively. Arlington's population is 64 percent non-Hispanic white with a median household income of $94,880. The percent non-Hispanic white ranges from 32-81 percent in the four DC zip codes considered and median household income ranges from $64,134 to $153,174.

[11] Although I attempted to include the same stores in the pre- and post-period, two of the 12 stores include data from only one period. Exclusion of these two stores does not change the results shown in Section IV.

[12] I approached customers as they exited the store between the hours of 12 p.m.-6 p.m. and asked if they would be willing to participate in a short survey for a research project on shopping behavior. If a customer chose not to participate in the survey, I recorded him as a non-respondent and moved on to the next customer who exited the store.

[13] While Mturk participants tend to be younger and more educated than the general population, Paolacci et al. (2010) show that the sample population is generally representative of the U.S. population, and they are able to replicate the findings of several well-known behavioral economics experiments using this subject pool.

[14] In 2011, state and federal cigarette excise taxes ranged from 25-54 percent of the total price of a pack of cigarettes (Orzechowski & Walker, 2011).

[15] The data allows me to compute aggregate daily averages of the percent of customers using disposable bags, but are not informative as to the number of bags used by a particular consumer.

[16] I drop two days in February 2010 where I observe an unusually low number of transactions, likely due to a blizzard in the area.

[17] I estimate demand on the extensive margin with a linear probability model. A Probit model yields similar results.

[18] Time of day is broken into three categories: 11 a.m.-1:30 p.m. ("Morning"), 2 p.m.-4:30 p.m. ("Afternoon"), and 5 p.m.-8 p.m. ("Evening").

[19] A small fraction of customers used both reusable and disposable bags, which is why the increase in reusable bag use and customers choosing not to use any bags is not completely offset by the decrease in plastic bag use on the extensive margin.

[20] When calculating standard errors for the aggregate effect, I ignore uncertainty in the sample averages of $P(y > 0|x)$ and $E[y|x, y > 0]$.

[21] The estimates are larger but qualitatively similar when using a Tobit model, as opposed to the combined demand model used above.

[22] I exclude four stores from a large organic market chain from this analysis. Since this analysis, unlike that in the previous section, compares store policies across chains, it relies on the comparability of the chains in all aspects other than the store's bag regulation. Reusable bag use in all locations and time periods is slightly higher in these stores than in the non-organic chains, possibly due to the environmentally-conscious reputation of the company. Based on this, I believe that these stores are different enough from the other stores considered to warrant excluding them from the analysis. However, inclusion of these stores leaves the results in this section qualitatively unchanged.

[23] See table 8 for corresponding standard errors.

[24] In order to test for possible non-linearities in the effect of the incentives, I include a term for the interaction of the two policies. This term is positive and significant, though small in magnitude, for reusable bag use and insignificant for disposable bag use. This suggests that increasing the total economic incentive to 10 cents has little effect on behavior, at least when the additional incentive is framed as a bonus.

[25] This question was phrased as a hypothetical for customers in stores that did not already have the policy or for customers who were previously unaware of the existence of the policy.

[26] The results are qualitatively similar when the dependent variable is the probability that the survey participant responded that the incentive would definitely influence his decision to bring a reusable bag only or when using an ordered probit.

[27] While the survey data shows that awareness of the tax policy is slightly less than perfect, I assume 100 percent awareness of the tax in order to provide the most conservative estimates.

[28] This question was only asked in the post-period. While this should not affect the validity of the responses from Virginia, the Montgomery County results may be biased upward since they may have learned about the DC tax only after the implementation of the Montgomery County tax.

References

Benabou, Roland and Jean Tirole. Laws and Norms. Cambridge, MA: National Bureau of Economic Research Working Paper 17579, 2011.

Benzion, Uri, Amnon Rapoport, and Joseph Yagil. Discount Rates Inferred from Decisions: An Experimental Study. *Management Science* 35(1989): 270-284.

Chaloupka, Frank and Kenneth Warner. The Economics of Smoking. In Anthony Culyer and Joseph Newhouse, eds. *Handbook of Health Economics,* Vol. 1 Part B: 1539-1627. New York: Elsevier Science B.V., 2000.

Clapp, Jennifer and Linda Swanston. Doing Away with Plastic Shopping Bags: International Patterns of Norm Emergence and Policy Implementation. *Environmental Politics* 18(2009): 315-332.

Convery, Frank, Simon McDonnell, and Susana Ferreira. The Most Popular Tax in Europe? Lessons from the Irish Plastic Bags Levy. *Environmental and Resource Economics* 38(2007): 1-11.

District of Columbia Department of the Environment (DDOE). Washington DC: Anacostia Watershed Trash Reduction Plan, 2008.

DellaVigna, Stefano. Psychology and Economics: Evidence from the Field. *Journal of Economic Literature* 47(2009): 315-372.

Dikgang, Johane, Anthony Leiman, and Martine Visser. Elasticity of Demand, Price and Time: Lessons from South Africa's Plastic-Bag Levy. *Applied Economics* 44(2012): 3339-3342.

Field, Erica. Educational Debt Burden and Career Choice: Evidence from a Financial Aid Experiment at NYU Law School. *American Economic Journal: Applied Economics* 1(2009): 1-21.

Fryer, Roland G., Steven D. Levitt, John List, and Sally Sadoff. Enhancing the Efficacy of Teacher Incentives through Loss Aversion: A Field Experiment. Cambridge, MA: National Bureau of Economic Research Working Paper 18237, 2012.

Fullerton, Don and Thomas C. Kinnaman. Household Responses for Pricing Garbage by the Bag. *American Economic Review* 86(1996): 971-984.

Funk, Patricia. Is There An Expressive Function of Law? An Empirical Analysis of Voting Laws with Symbolic Fines. *American Law and Economics Review* 9(2007): 135-159.

Galbiati, Roberto and Pietro Vertova. Obligations and Cooperative Behaviour in Public Good Games. *Games and Economic Behavior* 64(2008): 146-170.

Gneezy, Uri and Aldo Rustichini.
A Fine Is a Price. *The Journal of Legal Studies* 29(2000a): 1-17.
Pay Enough or Don't Pay at All. *The Quarterly Journal of Economics* 115(2000b): 791-810.

Goldin, Jacob. Optimal Tax Salience. Princeton, NJ: Princeton University Industrial Relations Section Working Paper 571, 2012.

Hasson, Reviva, Anthony Leiman, and Martine Visser. The Economics of Plastic Bag Legislation in South Africa. *South African Journal of Economics* 75(2007): 66-83.

He, Haoran. The Effects of an Environmental Policy on Consumers: Lessons from the Chinese Plastic Bag Regulation. Beijing, China: University of Gothenburg and Beijing Normal University Working Papers in Economics 453, 2010.

Heyman, James and Dan Ariely. Effort for Payment: A Tale of Two Markets. Psychological Science 15(2004): 787-793.

Hossain, Tanjim and John A. List. The Behavioralist Visits the Factory: Increasing Productivity Using Simple Framing Manipulations. Cambridge, MA: National Bureau of Economic Research Working Paper 15623, 2009.

Kahneman, Daniel and Amos Tversky. Prospect Theory: An Analysis of Decision under Risk. *Econometrica* 47(1979): 263-292.

Kahneman, Daniel, Jack L. Knetsch, and Richard H. Thaler. Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias. *The Journal of Economic Perspectives* 5(1991): 193-206.

Lacetera, Nicola, Mario Macis, and Robert Slonim. Will There Be Blood? Incentives and Displacement Effects in Pro-social Behavior. *American Economic Journal: Economic Policy* 4(2012): 186-223.

Loewenstein, George and Drazen Prelec. Anomalies in Intertemporal Choice: Evidence and an Interpretation. *The Quarterly Journal of Economics* 107(1992): 573-597.

McDonald, John F. and Robert A. Moffitt. The Uses of Tobit Analysis. *The Review of Economics and Statistics* 62(1980): 318-321.

Orzechowski and Walker. The Tax Burden on Tobacco. Arlington, VA: Orzechowski and Walker, 2011.

Paolacci, Gabriele, Jesse Chandler, and Panagiotis G. Ipeirotis. Running Experiments on Amazon Mechanical Turk. *Judgment and Decision Making* 5(2010): 411-419.

Rabin, Matthew. Risk Aversion and Expected-Utility Theory: A Calibration Theorem. *Econometrica* 68(2000): 1281-1292.

Shampanier, Kristina, Nina Mazar, and Dan Ariely. Zero as a Special Price: The True Value of Free Products. *Marketing Science* 26(2007): 742-757.

Sturm, Roland, Lisa M. Powell, Jamie F. Chriqui, and Frank J. Chaloupka. Soda Taxes, Soft Drink Consumption, and Children's Body Mass Index. *Health Affairs* 29(2010): 1052-1058.

Sussman, Abigail B. and Christopher Y. Olivola. Axe the Tax: Taxes Are Disliked More than Equivalent Costs. *Journal of Marketing Research* 48(2011): S91-S101.

Thaler, Richard. Some Empirical Evidence on Dynamic Inconsistency. *Economics Letters* 8(1981): 201-207.

Titmuss, Richard M. *The Gift Relationship*. London, UK: Allen and Unwin, 1970.

United States Environmental Protection Agency (USEPA). Washington DC: Municipal Solid Waste in the United States: Facts and Figures, 2006.

Wakker, Peter and Amos Tversky. An Axiomatization of Cumulative Prospect Theory. *Journal of Risk and Uncertainty* 7(1993): 147-175.