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Can Small Incentives Have Large Effects? The Impact of Taxes versus Bonuses on Disposable Bag Use[†]

By Tatiana A. Homonoff*

This paper examines a simple element of financial incentive design whether the incentive takes the form of a fee for bad behavior or a reward for good behavior to determine if the framing of the incentive influences the policy's effectiveness. I investigate the effect of two similar policies aimed at reducing disposable bag use: a $0.05 tax on disposable bag use and a $0.05 bonus for reusable bag use. While the tax decreased disposable bag use by over 40 percentage points, the bonus generated virtually no effect on behavior. These results are consistent with a model of loss aversion. (*JEL* D12, D91, H23)

When can small incentives have large effects on behavior? Standard economic theory suggests that financial incentives aimed at encouraging desirable behaviors or discouraging harmful behaviors will be effective only if the magnitude of the incentive exceeds the costs an individual associates with changing his behavior. While in practice financial incentives can take the form of either a fee for bad behavior or a reward for good behavior, the standard model suggests that individuals should respond similarly to the two types of incentives provided that they are of the same monetary amount. In contrast, evidence from the field of behavioral economics suggests that individuals perceive losses more strongly than gains, i.e., they are "loss-averse," implying that a fee would be more effective than a reward of the same size (Kahneman and Tversky 1979). A growing body of research aims to document this gain-loss asymmetry using field data in a variety of contexts.[1] For example, Field (2009) finds that public interest tuition subsidies are significantly more effective when framed as a loss than as a gain. Fryer et al. (2012) and Hossain and List (2012) find similar patterns for pay-for-performance bonuses. However, less is known about whether this gain-loss asymmetry holds in the field for very

* Robert F. Wagner School of Public Service, New York University, 295 Lafayette Street, 2nd Floor, New York, NY 10010 (email: tah297@nyu.edu). I would like to thank Henry Farber, Jacob Goldin, Nikolaj Harmon, Anna Knoell, David Lee, Alex Mas, and Abigail Sussman for reading earlier drafts of this paper and providing helpful feedback. I also thank seminar participants at Princeton University, Cornell University, Wharton University, Harvard Business School, University of Toronto, Haverford College, and NBER Summer Institute for conversations and suggestions that have greatly improved the quality of this project. Jason Somerville provided excellent research assistance. All errors are my own. I gratefully acknowledge support from Princeton University's Industrial Relations Section.

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[1] Recent work includes research in labor supply (Camerer et al. 1997; Oettinger 1999), tax compliance (Engström et al. 2015; Rees-Jones 2017), and sports (Allen et al. 2017; Pope and Schweitzer 2011). For an overview of related literature, see DellaVigna (2009).

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small stakes incentives.[2] In fact, evidence from a separate area of behavioral economics suggests that offering very small incentives for behavior change can actually be demotivating by crowding out an individual's intrinsic motivation (Gneezy and Rustichini 2000a, b; Gneezy, Meier, and Rey-Biel 2011). This paper contributes to the literature on loss-framed nudges in a new policy context where the incentives considered are very small in magnitude. Specifically, I investigate whether the framing of an incentive has an impact on the policy's effectiveness through the evaluation of two real-world policies aimed at reducing the use of disposable shopping bags: a \$0.05 tax on disposable bag use and a \$0.05 bonus for reusable bag use.

Concern over the environmental impact of plastic bags has prompted several governments across the world to regulate the use of disposable bags. 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, the neighboring County of Montgomery, Maryland also passed a law requiring a \$0.05 tax per disposable bag. Since then, similar legislation has been passed in several counties and cities across the United States.

While these laws were the first policies in the United States to tax disposable bags, they were not the first policies to offer financial incentives that discouraged disposable bag use. Prior to the implementation of the tax, several stores in the area offered their own incentive to reduce the use of disposable bags: a \$0.05 bonus for reusable bag use. If disposable and reusable bags are substitutes, standard models predict that the tax policy and the bonus policy should have the same impact on bag use since both policies provide customers a \$0.05 incentive for using a reusable bag instead of a disposable bag. However, if customers are loss-averse, in that they adjust their behavior more in response to losses than to gains, a bonus is likely to be less effective than a tax of the same magnitude.

Despite the growing popularity of policies that incentivize reusable bag use, rigorous empirical work measuring the effectiveness of such policies has been lacking.[3] To assess the impact of these policies, I collected a unique dataset on individual-level use of disposable and reusable bags by observing shopping behavior of grocery store customers during the months before and after the implementation of the Montgomery County tax in three counties in the Washington Metropolitan Area: Washington, DC (which had a tax in all time periods), Arlington County, Virginia (which had proposed a tax, but never passed one), and Montgomery County, Maryland (which changed its policy during the study period). The final dataset contains information on bag use for over 16,000 customers. Using variation in incentive

[2] One exception considers the framing of pay-for-performance bonuses for standardized test performance for Chicago public school children in the range of \$10 to \$20 and finds similar evidence of loss aversion Levitt et al. (2016). However, one could argue that these incentives are actually rather large for the population of interest.

[3] Two exceptions are recent studies conducted in California Taylor and Villas-Boas (2016) and Chicago (http://www.ideas42.org/wp-content/uploads/2017/04/Chicagoans-Reduce-Disposable-Bag-Use-by-Over-Forty-Percent-Since-Implementation-of-Checkout-Bag-Tax.pdf), both of which follow the same research design used in this paper. While the tax policies considered are slightly different than those in the Washington Metropolitan area the California law banned single-use plastic bags and required stores to charge a minimum fee of \$0.05 for all other bags (paper or reusable plastic bags) and the Chicago law required stores to levy a \$0.07 tax for all disposable bags the two studies found very similar effects on disposable bag use as those reported in this paper. Neither of these studies compared the effect of the tax to the effect of a comparably sized reusable bag bonus.

policies across time and location, I investigate whether the framing of the incentive influences the policys effectiveness.

Using a difference-in-differences analysis, I find that, while 82 percent of customers in Montgomery County used at least one disposable bag per shopping trip prior to the tax, this fraction 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. If each household in Montgomery County were to shop once per week, these effects would imply a reduction of over 18 million disposable bags per year. These results are particularly surprising given the small size of the financial incentive—five cents per bag.

In contrast to the overwhelming impact of the \$0.05 tax, I find that a \$0.05 bonus for reusable bag use had almost no impact on disposable bag use. Using cross-sectional variation in policies across stores, as there was no change in the bonus policy during the study period, I find that customers shopping in stores that offered a bonus were almost as likely to use a disposable bag as in stores that offered no financial incentive—82 versus 84 percent, respectively. An important concern with cross-sectional analyses of this type is that differences in reusable bag use between stores may reflect unobserved differences in the stores rather than the bonus policy. However, even if one assumes that every customer shopping in a bonus store would have used a disposable bag were it not for the policy (and that no customer uses a disposable bag if and only if the store offers a bonus), this would suggest that the effect of the bonus was still less than half of the effect of the tax.[4] Taken together, these results are consistent with a model of loss aversion.

While these results are consistent with a model in which customers are loss-averse, there are a number of other reasons why the tax could have been more effective than the bonus. I address several competing explanations using survey data from over 1,600 shoppers collected before and after the implementation of the Montgomery County tax. First, I measure whether there are differences in awareness of the two policies that could cause the asymmetric response to the incentives. I find that customers are much less aware of the bonus than the tax—52 percent of customers are aware of the bonus while 98 percent of customers are aware of the tax—likely causing a substantial portion of the differential response to the two policies. However, the differences in awareness cannot fully account for the difference in response to the two policies, even after adjusting for under-awareness of the bonus policy, I estimate a coefficient of loss aversion that is on the high end of those previously found in the literature. Another possibility is that the imposition of the tax shifted consumer attitudes towards disposable bag use, whereas the bonus did not affect consumer attitudes in this way. However, the survey also provides suggestive evidence that customer attitudes toward disposable bag use and pollution regulation did not change after the tax was implemented, suggesting that it is unlikely that the results are fully explained by a shift in social norms. That being said, I cannot rule

[4] Another concern with the cross-sectional analysis is that the assignment of customers to stores is nonrandom. As described in more detail below, the most plausible selection stories along these lines would bias my results towards finding a *larger* effect of the bonus.

out that social norms played a contributing role in the relative effectiveness of the tax; indeed, the magnitude of the estimated coefficient of loss aversion suggests that some other phenomena may also have contributed to the discrepancy between the effect of the tax and the effect of the bonus.

This paper is organized as follows. Section I reviews the history of disposable bag regulations. Section II presents two models of the customer's choice to bring a reusable bag. Section III describes the data sources used in the empirical analysis. Section IV presents estimates of the impact of the tax and bonus policies in the Washington Metropolitan Area. Section V discusses possible explanations for the difference in responses to the two policies. Section VI considers alternative models of reference dependence and measures the coefficient of loss aversion. Section VII concludes.

I. Background on Disposable Bag Regulations

Americans consume 100 billion plastic bags each year, with worldwide estimates reaching as high as 1.5 trillion (Clapp and Swanston 2009). 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 2007).

In an effort to reduce pollution, policymakers have passed a variety of policies to curb disposable bag consumption. Starting in the early 2000s, several countries in Europe, Asia, and Africa implemented policies that required retailers to charge customers for their plastic bag use.[5] In response to the District Department of the Environment report on water pollution levels in Washington, DC (Anacostia Watershed Society 2008), the Anacostia River Cleanup and Protection Act created a law that made Washington, DC the first city in the United States to charge a fee for the use of disposable bags. As of January 1, 2010, all food retailers in the district were required to charge five cents per single-use plastic or paper bag at the point of purchase.[6] Exactly two years later (January 1, 2012), Montgomery County, Maryland, which borders Washington, DC to the northwest, enacted a similar $0.05 tax on all disposable bags.[7] Similar bills have been suggested in other jurisdictions in the Washington Metropolitan Area, but none have passed as of the date of this study.[8]

While these policies were two of the first laws in the United States that required customers to pay a tax for disposable bag use, they were not the first financial incen-

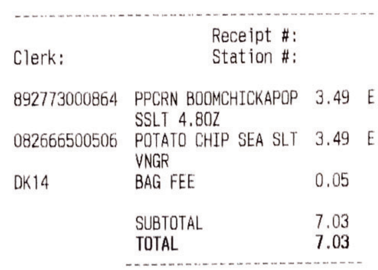
[5] Researchers have evaluated the effects of plastic bag regulations in South Africa (Hasson, Leiman, and Visser 2007; Dikgang, Leiman, and Visser 2012), Ireland (Convery, McDonnell, and Ferreira 2007), and China (He 2010) and find large effects of the policies. However, these policies were implemented countrywide causing these evaluations to suffer from a lack of a counterfactual.

[6] One to two cents of the tax went to the retailer to cover costs associated with the tax's implementation while the remainder entered a fund dedicated to cleaning up the Anacostia River.

[7] Unlike in Washington, DC, the Montgomery County tax applies to all retailers, not just those selling food or alcohol. Proceeds from the tax enter the countys Water Quality Protection Charge.

[8] More recently, jurisdictions in many other parts of the country have passed similar legislation. For example, Seattle passed a $0.05 bag tax in July of 2012 while several counties in California charge $0.05 or $0.10 cents for paper bags and ban single-use plastic bags altogether (see Taylor and Villas-Boas 2016 for a thorough history of the California disposable bag laws).

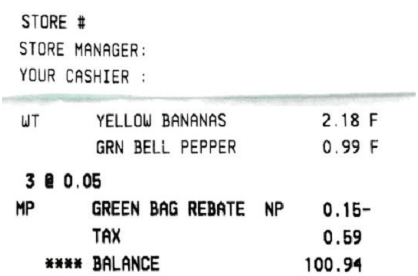
Panel A. Disposable bag tax



Receipt #:
Clerk: Station #:

892773000864	PPCRN BOOMCHICKAPOP SSLT 4.8OZ	3.49	E
082666500506	POTATO CHIP SEA SLT VNGR	3.49	E
DK14	BAG FEE	0.05	
	SUBTOTAL	7.03	
	TOTAL	7.03	

Panel B. Reusable bag bonus



STORE #
STORE MANAGER:
YOUR CASHIER :

WT	YELLOW BANANAS	2.18	F
	GRN BELL PEPPER	0.99	F
3 @ 0.05			
MP	GREEN BAG REBATE NP	0.15-	
	TAX	0.59	
	**** BALANCE	100.94	

Figure 1. Sample Receipts

tive policies aimed at discouraging disposable bag use. Prior to the implementation of either tax, half of the grocery stores in the Washington Metropolitan Area with the largest market share offered customers a \$0.05 bonus for each reusable bag a customer used in lieu of a new disposable bag. The bonus operated much like the tax, but rather than paying five cents for each disposable bag, the customers final bill was credited five cents for each reusable bag the customer used (see Figure 1 for sample receipts).

II. Modeling Responses to Financial Incentives

Consider a customer who is choosing whether to use a disposable or reusable bag. Customers have idiosyncratic preferences for bag use and incur a utility cost from bringing a reusable bag, c_i, which can be positive (for example, a psychological cost for remembering to bring a bag) or negative (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. Let w_i denote consumer i's wealth and let b_i indicate whether the consumer brings a reusable bag. Assume that utility is additively separable between c and w so that when there is no external incentive, utility for consumer i 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 magnitude 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 $U_{B,i}(w_i, b_i) = u(w_i + b_i x) - b_i c_i$.

Consumers will bring a reusable bag when the benefit of doing so exceeds the costs: $b_i = 1 \Leftrightarrow U_i(w_i, 1) \geq U_i(w_i, 0)$. The table below outlines this condition 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

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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.

	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	$U_{T,i}(w_i, b_i) = \begin{cases} u(w_i) - c_i & \text{if } b_i = 1 \\ u(w_i - x) & \text{if } b_i = 0 \end{cases}$	$u(w_i) - u(w_i - x) > c_i$
Bonus	$U_{B,i}(w_i, b_i) = \begin{cases} u(w_i + x) - c_i & \text{if } b_i = 1 \\ u(w_i) & \text{if } b_i = 0 \end{cases}$	$u(w_i + x) - u(w_i) > c_i$

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.

A. *Neoclassical Model*

In this paper, I consider the effect of tax and bonus policies with a very small x, i.e., \$0.05. Standard economic theory predicts that if c_i is also very small, a small financial incentive could still have a large effect on behavior, i.e., small incentives will be effective as long as demand for disposable bags is elastic.

Suppose that customers maximize utility over wealth and that utility is strictly increasing and weakly concave in wealth ($u'(w_i) > 0$ and $u''(w_i) \leq 0$). 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 \$1,000. Given that the incentives considered in this study are only \$0.05 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 incentive policies. With this assumption, the conditions under which customers would bring a reusable bag under the tax policy and under the bonus policy are exactly the same (see table below).

	Utility function	Condition to bring a bag
No incentive	$U_{N,i}(w_i, b_i) = \begin{cases} \gamma w_i - c_i & \text{if } b_i = 1 \\ \gamma w_i & \text{if } b_i = 0 \end{cases}$	$0 > c_i$
Tax	$U_{T,i}(w_i, b_i) = \begin{cases} \gamma w_i - c_i & \text{if } b_i = 1 \\ \gamma(w_i - x) & \text{if } b_i = 0 \end{cases}$	$\gamma x > c_i$
Bonus	$U_{B,i}(w_i, b_i) = \begin{cases} \gamma(w_i + x) - c_i & \text{if } b_i = 1 \\ \gamma w_i & \text{if } b_i = 0 \end{cases}$	$\gamma x > c_i$

B. *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 of deviations from a reference point (i.e., gains and losses). This model 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^*:

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

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 following table.

	Utility function	Condition to bring a bag
No incentive	$U_{N,i}(w^*, b_i) \;=\; \begin{cases} -c_i & \text{if } b_i \;=\; 1 \\ 0 & \text{if } b_i \;=\; 0 \end{cases}$	$0 \;>\; c_i$
Tax policy	$U_{T,i}(w^*, b_i) \;=\; \begin{cases} -c_i & \text{if } b_i \;=\; 1 \\ -\gamma\alpha x & \text{if } b_i \;=\; 0 \end{cases}$	$\gamma\alpha x \;>\; c_i$
Bonus policy	$U_{B,i}(w^*, b_i) \;=\; \begin{cases} \gamma x - c_i & \text{if } b_i \;=\; 1 \\ 0 & \text{if } b_i \;=\; 0 \end{cases}$	$\gamma x \;>\; c_i$

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 behavior consistent with a model of loss aversion.

III. Data

To assesses the relative effectiveness of the tax and bonus policies, I use a unique dataset on bag use in the Washington Metropolitan Area around the implementation of the Montgomery County, Maryland tax. To collect the data, researchers stood by the exit of a grocery store and recorded individual-level data on the number and type of bags each customer used,[9] as well as visually assessable demographic characteristics, such as sex and race, of all customers exiting the store during the sample

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

period. Researchers visited a given store in 30 minute shifts, randomizing the time and location of the visit. The visits took place between eleven in the morning and eight at night during weekdays only. Each store received an average of nine visits for a final sample of 16,251 individual customers.

The sample period began approximately three months before and ended three months after the implementation of the tax on January 1, 2012.[10] The sample includes data on bag use from 16 stores, spanning 3 different counties, each with a different tax policy regime. Eight stores were located in Montgomery County, Maryland (where there was a tax policy change during the sample period), four stores in Washington, DC (which implemented a tax two years before data collection began), and four stores in Arlington County, Virgina (which had proposed a bag tax, but never passed one). See Figure 2, panel A for a map of sample stores by county.

The sample stores in this dataset vary not only in whether they charge customers a tax for disposable bag use, but also whether they reward customers for reusable bag use. The 16 stores belong to 4 of the largest chains in the Washington Metropolitan Area, 2 of which offer \$0.05 bonuses for reusable bag use both before and after the implementation of the Montgomery County tax. These stores were chosen to be comparable on all aspects other than bag policy. Comparability is particularly important when estimating the effect of the bonus since, unlike with the tax policy, the bonus policy had been implemented prior to any data collection, so analyses estimating the effect of the bonus rely on cross-sectional variation in store policy. First, all four chains had locations in the three counties considered in this sample. Second, sample stores were drawn from neighborhoods with similar demographic characteristics.[11] In fact, most sample stores that offered a bonus were located within a ten-minute walk from a sample store that did not offer a bonus (see Figure 2 panel B for a map of stores by bonus policy). Third, since customers who drive to the grocery store may differ from customers who use public transportation, all sample stores had a parking lot and were also accessible by the Washington Metropolitan Area Transit Authority's Metrorail. Fourth, the stores were roughly the same size containing between 15 and 25 lanes. Fifth, all stores sold reusable bags by the checkout counter as well as in other locations throughout the store. Lastly, one of the sample chains that offers a bonus is an organic food chain. Since customers shopping at organic food chains may differ in their reusable bag use, the four sample stores belonging to this chain are dropped from certain analyses. Of the 12 stores remaining stores, half offer a \$0.05 bonus per reusable bag and half do not. See Table 1 for a list of store and customer characteristics by store.

[10] 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.

[11] Since the main policy change considered in this paper took place in Montgomery County, an affluent county with a low proportion of racial minorities, stores were selected to match these demographic characteristics. The Montgomery County sample stores are located in the cities of Chevy Chase, Bethesda, and Silver Spring, while the Arlington County stores are located in the city of Arlington. These cities border Washington, DC and are popular communities for those employed in the district. While the city of Washington, DC is more racially and economically diverse than these suburban commuter cities, the Washington, DC stores selected for this study are located in the Northwest quadrant of Washington, DC, an affluent area of the city, in order to maintain comparability to the samples from Maryland and Virginia.

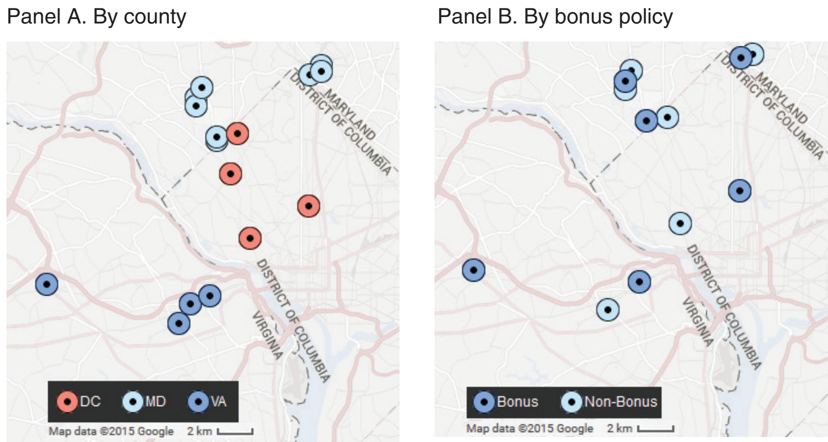

FIGURE 2. MAP OF SAMPLE STORES

TABLE 1—SUMMARY STATISTICS BY SAMPLE STORE

Store	Observations	Location	Tax	Bonus	Organic	% female	% white
1	432	DC	x (2010)			60.0	75.5
2	779	DC	x (2010)			62.0	71.6
3	800	DC	x (2010)	x		49.6	33.6
4	845	DC	x (2010)	x	x	65.3	78.1
5	888	MD	x (2012)			53.9	34.3
6	851	MD	x (2012)			53.1	64.0
7	613	MD	x (2012)			64.1	76.7
8	1,528	MD	x (2012)	x		51.7	42.8
9	805	MD	x (2012)	x		66.1	63.5
10	1,264	MD	x (2012)	x		66.0	77.9
11	1,353	MD	x (2012)	x	x	63.5	53.5
12	1,012	MD	x (2012)	x	x	68.8	74.6
13	1,331	VA				51.1	76.0
14	878	VA		x		57.5	76.8
15	1,509	VA		x		54.1	76.7
16	1,363	VA		x	x	59.5	78.7
Observations	16,251						

Note: Table reports the number of observations per store, store location (Washington DC, Maryland, or Virginia), the date the store implemented a \$0.05 tax per disposable bag, whether the store offered a \$0.05 bonus per reusable bag, whether the store belonged to an organic market chain, and the fraction of sample members who were female and white, respectively.

I use two survey datasets to investigate various mechanisms that may have led to differential responses to the two policies. First, I collected in-person surveys of customers as they exited the store after their shopping trip.[12] These surveys were conducted at 12 different locations at two grocery store chains in Maryland, Virginia,

[12] Researchers approached customers as they exited the store between the hours of noon and six 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, the researcher recorded her as a non-respondent and moved on to the next customer who exited the store.

and Washington, DC shortly before and after the implementation of the Montgomery County tax.[13] Data collection took place during September and October of 2011 and March of 2012. The survey yielded a response rate of 56 percent for a total of 1,496 respondents. Respondents completed a two-minute survey that contained questions on how many disposable and reusable bags they used during their shopping trip, awareness of the bonus and tax policies, measures of how much they believed each of these policies did or would encourage them to use a reusable bag, attitudes toward plastic bag use, environmentalism, and government regulation of pollution, and personal demographic characteristics. In order to test customers response to other hypothetical disposable bag regulations, I use data from an online survey administered through Amazons Mechanical Turk (Mturk), a crowd-sourcing web service.[14]

Lastly, I use transaction-level scanner data from a large retail chain of grocery stores to measure the long-term impact of the tax policy on disposable bag use. The dataset includes a 10 percent sample of all transactions from 11 stores in Washington, DC and 16 stores in Montgomery County in the time period following the implementation of the disposable bag tax in each area. The dataset includes transactions from January 1, 2010 (the first day of the Washington, DC tax) to June 30, 2012. The total sample includes an average between 2,000 and 2,500 transactions per day for each of the two counties. Each transaction includes information on the products purchased, date, and store location. In addition, the data includes a line item indicating if a customer was charged a tax for using a disposable bag.

IV. The Relative Effectiveness of the Tax and Bonus Policies

A. *Tax Policy*

As mentioned in the previous section, the primary dataset contains individual-level data on bag use before and after the Montgomery County tax was implemented in sixteen stores across Montgomery County and two control counties: Washington, DC, which implemented a similar tax two years prior to the Montgomery County tax, and Arlington County, which proposed a similar tax, but had not passed the tax. Table 1 contains the mean values of the demographic characteristics of customers in the sample by store. While the three counties vary slightly in their racial composition, all three areas are predominantly white, with a similar fraction of female customers. In addition, the demographic composition of shoppers is similar across the two time periods.[15]

Figure 3 presents data on bag use in each of the three counties before and after the Montgomery County tax was implemented. While reusable bags are the most com-

[13] The retail chains are a subset of the chains visited in the main analysis due to store manager cooperation. Many of the same stores visited when collecting the observational data were also used in the survey sample. Researchers collected data at 10 of the 12 stores in both the pre- and post-period; however two stores were only visited during one of the two time periods. Exclusion of these two stores does not change the results shown in Section V.

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

[15] See the Appendix for the mean values of the demographic characteristics by state and time period.

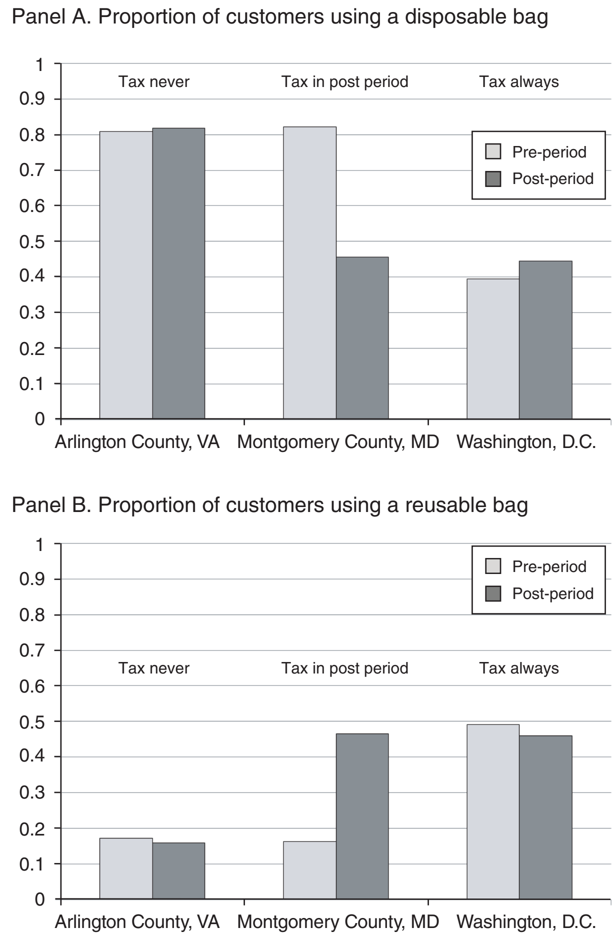

Figure 3. Extensive Margin Bag Use by Location, Time Period, and Bag Type

mon 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 bag regulations.

Figure 3, panels A and B show the percent of customers using any disposable and any reusable bags, respectively. In the pre-period, customers in the Arlington County sample used at least one disposable bag 82 percent of the time while customers in Washington, DC used a disposable bag only 45 percent of the time. Similarly, Arlington County customers rarely brought a reusable bag when shopping, only 16 percent of the time, compared to 46 percent in Washington, DC. Bag use was very stable across the two periods in each of these control counties. In contrast, bag use in Montgomery County changed dramatically after the implementation of the tax. Behavior in Montgomery County during the pre-period resembled that observed in Arlington County, which had no tax policy—82 percent of customers used at least one disposable bag, while only 16 percent brought a reusable bag. However,

TABLE 2—BAG USE 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)
Observations	1,207	1,649	3,799	4,515	2,006	3,075

Notes: This table reports the fraction using a bag (extensive), average number of bags used among users (intensive), and unconditional average number of bags used (overall) for each type of bag. Standard deviations are in parentheses. Customers using both types of bags are counted in both categories. "Pre" and "Post" refer to the sample periods before and after the implementation of the Montgomery County tax.

behavior in Montgomery County in the post-period mirrored the behavior observed in Washington, DC, which did have a tax policy—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 use: demand for the two types of bags on the extensive margin (the percent of customers using each type of bag or no bags at all), the intensive margin (how many bags each customer uses given that she uses 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 be operating primarily through changes in bag use on the extensive margin, customers who continue to use disposable bags after the tax use fewer bags per trip. The data also show an increase in the proportion of customers choosing not to use any bags at all.

The following model uses a difference-in-differences strategy to evaluate the effect of the Montgomery County tax on bag use controlling for various individual characteristics and location-level controls:

$$Y_{isdt} = \alpha + \beta MD \times Post_{st} + \gamma Post_t + \eta Z_s + \lambda X_i + \delta Q_d + \varepsilon_{isdt};$$

Y is a measure of bag use, *Post* is an indicator for individuals observed after the implementation of the Montgomery County tax, $MD \times Post$ is an indicator for customers shopping in Montgomery County in the post period, Z is a set of store-level

Table 3—Effect of Tax Policy on Disposable Bag Use

	(1)	(2)	(3)	(4)
MD×Post	−0.417	−0.417	−0.419	−0.420
	(0.024)	(0.024)	(0.023)	(0.023)
Post	−0.005	−0.003	−0.002	−0.002
	(0.009)	(0.009)	(0.008)	(0.007)
MD	0.001	−0.013	−0.009	
	(0.022)	(0.019)	(0.018)	
DC	−0.362	−0.372	−0.372	
	(0.024)	(0.025)	(0.025)	
Black		0.100	0.100	0.099
		(0.012)	(0.012)	(0.016)
Other nonwhite		0.025	0.025	0.025
		(0.012)	(0.012)	(0.012)
Female		−0.068	−0.067	−0.066
		(0.008)	(0.008)	(0.009)
Afternoon			0.005	0.003
			(0.010)	(0.009)
Evening			0.027	0.026
			(0.010)	(0.010)
Store fixed effects	No	No	No	Yes
Observations	16,251	16,251	16,251	16,251

Notes: Standard errors clustered at the store level are in parentheses. Outcome variable: indicator for using at least one disposable bag. Column 1 controls for store county. Column 2 adds individual demographics (race and sex). Column 3 adds fixed effects for shopping trip time-of-day. Column 4 adds store fixed effects.

controls, and X is a set of individual-level demographic characteristics for individual i shopping in location s during time of day d at time period t.[16] The coefficient of interest is β, which measures the effect of the tax on bag use in Montgomery County relative to changes in use in the control stores. Standard errors are clustered at the store level to allow for correlation within store across time.[17]

Table 3 presents results for the effect of the tax on demand for disposable bags on the extensive margin using different control variables in each specification.[18] The model in column 1 controls only for time period, state, and an indicator for shopping in Montgomery County in the post-period. 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. 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 these results. While nonwhite and male customers are more likely to use a disposable bag in general, the estimate of the

[16] Time of day is separated into three categories: 11AM to 1:30PM ("Morning"), 2PM to 4:30PM ("Afternoon"), and 5AM to 8PM ("Evening").

[17] Because the dataset contains data on only 16 stores, clustering at the store level could yield poor approximations of the true standard errors. As a robustness check, I also calculate wild-bootstrap p-values following Cameron, Gelbach, and Miller (2008). Accounting for the small-cluster problem does not change any of the qualitative results in the paper.

[18] Regressions presented in this table use a linear probability model to estimate the change in demand. A Probit model yields similar results.

Table 4—Effect of Tax Policy on Bag Use: Extensive and Intensive Margins

	Extensive margin			Intensive margin	
	Disposable (1)	Reusable (2)	No bags (3)	Disposable (4)	Reusable (5)
MD×*Post*	−0.420	0.327	0.111	−0.215	0.150
	(0.023)	(0.017)	(0.017)	(0.070)	(0.069)
Post	−0.002	−0.002	−0.006	−0.227	−0.116
	(0.007)	(0.012)	(0.008)	(0.051)	(0.047)
Black	0.099	−0.102	−0.001	−0.153	−0.185
	(0.016)	(0.009)	(0.012)	(0.046)	(0.039)
Other race	0.025	−0.057	0.022	−0.133	−0.217
	(0.012)	(0.012)	(0.011)	(0.051)	(0.043)
Female	−0.066	0.153	−0.061	0.381	0.203
	(0.009)	(0.011)	(0.009)	(0.035)	(0.031)
Afternoon	0.003	0.031	−0.024	0.265	0.026
	(0.009)	(0.009)	(0.009)	(0.043)	(0.038)
Evening	0.026	0.009	−0.032	0.270	−0.062
	(0.010)	(0.009)	(0.008)	(0.043)	(0.037)
Store fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	16,251	16,251	16,251	10,314	5,003

Notes: Standard errors clustered at the store level are in parentheses. Outcome variables: indicator for using at least one bag or no bags (extensive) and number of bags used among users (intensive) for disposable and reusable bags, respectively.

effect of the tax is unchanged by the inclusion of these controls. Column 3 adds controls for time of day, since the behavior or composition of customers may vary throughout the day. Again, the estimates are largely unchanged. Finally, 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.

Table 4 repeats the analysis for the other measures of bag use using the specification from column 4 in Table 3. The outcomes in the first three columns are measures of disposable and reusable bag use on the extensive margin, respectively, as well as a binary measure for using no bags of either type. These results show that 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.[19,20] 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.[21]

[19] A small fraction of customers used both reusable and disposable bags, which explains 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] These results are very similar to results found in Taylor and Villas-Boas (2016) who examine a policy in Richmond, California that bans single-use plastic bags and charges $0.05 for paper bags, as well as a study conducted by the Chicago Mayor's office that evaluates a 2017 tax of $0.07 on all disposable bags. These studies find that disposable bag use decreases by 35 and 33 percentage points, respectively, shortly after the implementation of the policy.

[21] It is important to note that 10 of the 16 stores included in this analysis had a bonus policy in place during the time of the implementation of the tax. Stores that offered a bonus did so in the pre- and post-period and are located

TABLE 5—EFFECT OF TAX POLICY ON NUMBER OF DISPOSABLE AND REUSABLE BAGS USED

	Linear demand model		Double-hurdle model	
	Disposable (1)	Reusable (2)	Disposable (3)	Reusable (4)
MD×Post	−1.009	0.579	−1.260	0.622
	(0.171)	(0.061)	(0.212)	(0.048)
Post	−0.169	−0.031	−0.143	−0.037
	(0.036)	(0.016)	(0.036)	(0.017)
Black	0.103	−0.219	0.077	−0.253
	(0.072)	(0.017)	(0.081)	(0.024)
Other non-white	−0.019	−0.163	−0.081	−0.191
	(0.035)	(0.020)	(0.058)	(0.028)
Female	0.116	0.305	−0.025	0.307
	(0.040)	(0.026)	(0.100)	(0.013)
Afternoon	0.176	0.058	0.059	0.032
	(0.044)	(0.023)	(0.075)	(0.033)
Evening	0.236	−0.014	0.129	−0.032
	(0.053)	(0.021)	(0.059)	(0.032)
Observations	16,251	16,251	16,251	16,251

Notes: Standard errors clustered at the store level are in parentheses. Outcome variable: number of disposable or reusable bags used. Columns 1 and 2 consider a linear demand model, while columns 3 and 4 use a double-hurdle model following McDonald and Moffitt (1980). All regressions control for individual demographics (race and sex), time-of-day fixed effects, and store fixed effects.

Table 5 considers two different models that estimate the overall effect of the tax on demand. Columns 1 and 2 present results from a simple linear demand model where the outcome of interest is the total number of bags used. The results show that the tax reduced the number of disposable bags used by just over one bag per shopping trip, cutting the average number of disposable bags used roughly in half. Columns 3 and 4 use an alternative demand model, a "double-hurdle" model, that combines demand on the extensive and intensive margins to estimate the impact on overall demand (McDonald and Moffitt 1980). I decompose the conditional expectation of demand into its extensive and intensive components:

$$E[y|x] = E[y|x, y > 0] \times \Pr(y > 0|x),$$

where y represents demand and x represents the covariates. The total effect of a change in one of the covariates on demand is given by

$$\frac{\partial E[y|x]}{\partial x} = \frac{\partial E[y|x, y > 0]}{\partial x} \Pr(y > 0|x) + \frac{\partial \Pr(y > 0|x)}{\partial x} E[y|x, y > 0].$$

in all three counties (see Table 1). To study whether the effect of the tax is different in stores that offer a bonus and those that do not, the Appendix repeats the analysis in Table 4 including an interaction term for whether a store offers a bonus or not. Results show that the tax had a similar impact on disposable bag use in both types of stores, but that customers in bonus stores were more likely to switch to reusable bag use than to opt to use no bags at all.

Estimates of $\Pr(y > 0|x)$ and $E[y|x, y > 0]$ come from the data with each evaluated at the sample mean the covariates and are combined with the extensive and intensive margin regression coefficients in Table 4 to generate a rough estimate of the overall effect of the taxes on demand.[22] Table 5 presents these results. The estimates suggest that the tax decreased the number of disposable bags used by 1.26 bags and an increased the number of reusable bags used by 0.62 bags per customer per shopping trip. These results are qualitatively similar to the results from the linear demand model presented in columns 1 and 2.

One concern with the analyses presented in this section is that the composition of customers shopping at a given store may have changed as a result of the tax. For example, shoppers in Montgomery County may try to avoid paying the tax by shopping in a different county after the policy was implemented. Scanner data from one large retail chain suggests that this is not the case: the number of daily transactions in a given store (as well as several measures of purchasing behavior, such as basket size) did not change after the tax was implemented. See the Appendix for a detailed analysis.

B. *Bonus Policy*

This section compares the behavior of customers at stores with different incentive policies. Each sample store falls into one of four policy types. The first type of store provides no incentives for reducing the use of disposable bags. These are grocery store chains that do not offer a bonus and were not required to charge a tax. The second type of store offers a bonus for reusable bag use, but does not charge a tax for disposable bag use. The third type of store does not offer a bonus, but does charge a tax. Finally, the last group of stores both offers a bonus for reusable bag use and charges 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. Again, if disposable bags and reusable bags are substitutes, bonus-only and tax-only stores offer customers a \$0.05 incentive for using a reusable bag while bonus-plus-tax stores offer customers a \$0.10 incentive for the same behavior.

As mentioned in Section III, the bonus policy was implemented prior to data collection, so the estimation of the impact of the bonus on bag use relies on cross-sectional variation in whether a store chose to offer a bonus for reusable bag use. While the differences in bag use across stores with different incentives may reflect omitted store-level characteristics, these comparisons can still be informative if the customers shopping at bonus and non-bonus stores are similar in terms of their shopping behavior.

A few pieces of evidence suggest comparability of customers across the various store types. As mentioned in Section III, the sample stores were drawn from the largest four chains in the Washington Metropolitan Area, each of which had locations in all three counties considered in this study. Additionally, all sample stores had a

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

Table 6—Demographic Characteristics by Bonus Policy

	Bonus stores (1)	Non-bonus stores (2)
Female	57.1	56.1
	(49.6)	(49.6)
White	62.6	65.7
	(48.4)	(47.5)
Black	22.6	20.6
	(41.8)	(40.5)
Observations	6,784	4,894

Notes: Standard errors clustered at the store level are in parentheses. This table reports mean values of each demographic characteristic for stores that provide a bonus (column 1) and stores that do not (column 2). Organic stores are excluded from the analysis.

parking lot, were accessible by public transportation, and had a similar number of checkout lanes (between 15 and 25 lanes). Bonus and non-bonus stores were located within the same neighborhoods, with most bonus stores located within walking distance of a non-bonus store in the sample (see Figure 2, panel B). As a result, customers in the two types of stores had very similar demographic characteristics (see Table 6). Lastly, this analysis excludes observations from the one organic chain that provided a bonus, since reusable bag use among these customers may not be comparable due to the environmentally-conscious reputation of the company.[23]

Figure 4, panels A and B show the fraction of customers using at least one disposable bag or at least one reusable bag, respectively, by policy type with each bar representing a policy-location-period. For example, bonus stores in Montgomery County are included in the bonus-only category in the pre-period and in the bonus-plus-tax category in the post-period. In Figure 4, panel A, an average of 84.3 percent of customers use at least one disposable bag in 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 these stores.

What is most striking, however, is the comparison of stores that offer only a \$0.05 incentive but that differ in whether the incentive takes the form of a tax or a 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 4, panel B 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

[23] Reusable bag use in these stores is slightly higher than in the nonorganic stores; however, inclusion of these stores leaves the results in this section qualitatively unchanged.

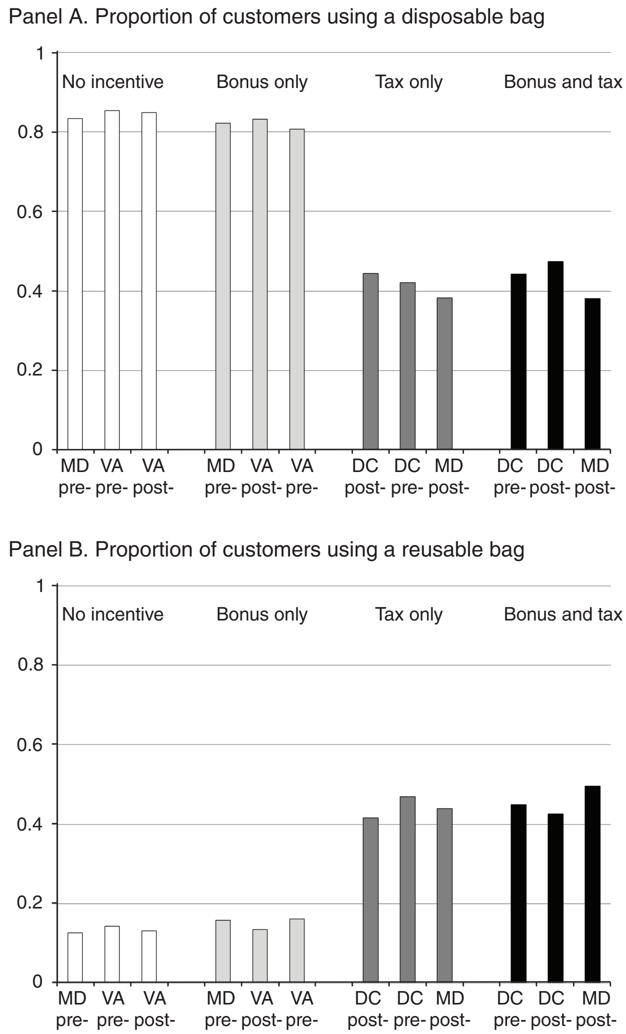

Figure 4. Extensive Margin Bag Use by Store Policy and Bag Type

customers brought 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.

While effort was taken to choose stores that had similar characteristics, unobserved differences between bonus and non-bonus stores may bias these results. To investigate the potential magnitude of this bias, suppose that, were it not for the bonus, none of the customers shopping in bonus-only stores would have used a reusable bag. Note that this assumption provides an upper-bound for the effect of the bonus: at most, the bonus increased reusable bag use from 0 to 15.4 percent.[24]

[24] This statement also requires the plausible assumption that no customer uses a disposable bag if and only if the store offers a bonus for reusable bag use.

If I compare this upper-bound estimate to the estimate of the effect of the tax policy found in Section IVA, the impact of the tax (32.7 percentage points) was still more than twice as large as the impact of the bonus. Therefore, while the comparison of bag use in Figure 4, panels A and B, is purely cross-sectional, this example shows that even with extreme selection of customers across stores, it is reasonable to conclude that a \$0.05 tax is considerably more effective at increasing reusable bag use than a bonus of the same amount.[25]

The comparison of bag use by store policy can be repeated using the following econometric model that controls for factors that might confound the simple comparison of means:

$$Y_{isdt} \ = \ \alpha + \beta Tax_{st} + \gamma Bonus_s + \eta Z_s + \lambda X_i + \delta Q_d + \varepsilon_{isdt};$$

Y is a measure of bag demand, *Tax* is an indicator for whether a store charges a \$0.05 tax, *Bonus* is an indicator for whether the store offers a \$0.05 bonus for reusable bag use, Z is a set of state-level controls, and X is a set of individual-level demographic characteristics for individual i shopping in state s during time of day d at time period t. 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, then β is the effect of the tax policy and γ is the effect of the bonus policy.

Table 7 presents the results for disposable and reusable bag use on the extensive margin. Columns 2 and 4 control for demographic characteristics and time of day while columns 1 and 3 do not. As with the evaluation of the tax policy in Table 3, 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 more 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.[26,27] While, to my knowledge, no other studies rigorously test the effect of a reusable bag bonus, these null results are in line with anecdotal evidence on the ineffectiveness of reusable bag bonuses. For example, Kroger, the largest grocery chain in the United States, discontinued policies that

[25] In fact, one of the more plausible scenarios for selection of customers across stores with different policies is that customers who would choose to bring a reusable bag in the absence of any incentive policy might choose to shop at stores that reward them for doing so. However, this pattern would suggest I am overestimating the causal impact of the bonus policy due to selection.

[26] In order to test for possible nonlinearities 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 ten cents has little effect on behavior, at least when the additional incentive is framed as a bonus.

[27] In an effort to avoid issues of comparability across stores with different policies, the Appendix includes an additional analysis on how participants of the survey mentioned in Section III reported that they would respond to a *hypothetical* \$0.05 tax or bonus policy. Nineteen percent of respondents said that a bonus would definitely influence their decision to use a reusable bag. This estimate increased by 29 percentage points when the hypothetical policy was a tax instead of a bonus.

Table 7—Effect of Tax versus Bonus Policy on Bag Use

	Disposable		Reusable	
	(1)	(2)	(3)	(4)
Tax	−0.445	−0.445	0.329	0.327
	(0.023)	(0.023)	(0.017)	(0.016)
Bonus	−0.009	−0.013	0.026	0.029
	(0.019)	(0.011)	(0.021)	(0.013)
MD	−0.003	−0.015	0.001	0.014
	(0.017)	(0.012)	(0.014)	(0.011)
DC	0.057	0.041	−0.027	−0.008
	(0.033)	(0.030)	(0.023)	(0.021)
Black		0.102		−0.102
		(0.017)		(0.012)
Other non-white		0.027		−0.064
		(0.014)		(0.015)
Female		−0.055		0.150
		(0.007)		(0.014)
Afternoon		0.013		0.033
		(0.010)		(0.012)
Evening		0.032		0.011
		(0.010)		(0.012)
F-stat	234.05	287.12	130.28	207.27
Prob > *F*	0.00	0.00	0.00	0.00
Observations	11,678	11,678	11,678	11,678

Notes: Standard errors clustered at the store level are in parentheses. Outcome variable: indicator for using at least one disposable bag (columns 1 and 2) or at least one reusable bag (columns 3 and 4). *Tax* is an indicator for whether a store charges a \$0.05 tax per disposable bag. *Bonus* is an indicator for whether a store offers a \$0.05 bonus per reusable bag. All regressions control for store county, individual demographics (race and sex), and shopping trip time-of-day fixed effects. The *F*-stat is associated with the test of equality between the tax and bonus coefficients.

offered bonuses for reusable bag use in 2011 citing that "the company has found no significant difference between reusable bag frequency in markets with rebates and those without them" (Sewell 2011).

V. Reasons for Asymmetric Responses to Taxes and Bonuses

A. *Loss Aversion*

As mentioned in Section II, standard economic models suggest that the tax and bonus policies should have the same effect on behavior; however, Kahneman and Tversky (1979) suggest that if individuals are loss-averse, they will respond more to a policy in which the incentive is framed as a loss than a gain, even when the incentives are the same financial amount. In the context of this paper, if a customer is accustomed to receiving a disposable bag for free (i.e., her reference point is a price of zero), then a policy that charges customers \$0.05 per disposable bag causes her to experience a loss, while a policy that offers a \$0.05 bonus per reusable bag is considered to be a gain.

Recent evidence from the field supports this theory in a wide variety of contexts including decisions involving labor supply (Camerer et al. 1997; Oettinger 1999), tax compliance (Rees-Jones 2018; Engström et al. 2015), sports performance (Allen et al. 2017; Pope and Schweitzer 2011), and trading (Odean 1998; Genesove and Mayer 2001), to name a few. A second set of papers most related to this study uses gain-loss framing as a policy tool to nudge people toward a desirable behavior. For example, Fryer et al. (2012) finds that framing pay-for-performance bonuses for public school teachers as a loss (providing all teachers with a bonus upfront, but rescinding it if their students under-performed) is more effective at increasing test scores than a traditional bonus framed as a gain. Hossain and List (2012) and Field AQ2 (2009) use a similar experimental design and find evidence of loss aversion in the context of productivity bonuses for factory workers and tuition subsidies for law students entering public interest careers, respectively.

It is important to note that the incentives considered in the studies above that use loss aversion in a more prescriptive way are quite large—several thousands of dollars per year. While the theoretical literature on loss aversion does not suggest that the gain-loss asymmetry should fade as the size of the incentive decreases, a second line of literature from behavioral economics suggests that small financial incentives for pro-social behavior can actually be demotivating since the extrinsic motivation (i.e., the financial incentive) crowds out an individual's intrinsic motivation for pro-social behavior. Several studies show that providing small financial incentives for pro-social behavior actually *decrease* the desired behavior (Gneezy and Rustichini 2000a, b; Gneezy, Meier, and Rey-Biel 2011).

To my knowledge, this is the first study to test the effectiveness of nudges that use loss aversion as a policy tool when the incentives are very small. One exception is Levitt et al. (2016), which provides small pay-for-performance incentives (between $10 and $20) to students for standardized test performance, varying the gain-loss framing of the incentive as in the studies above and finds that incentives framed as a loss are more effective; however, while small in magnitude, these incentives may actually be quite large for the relevant population. The results presented in this paper are also consistent with a model in which customers are loss averse even when the incentives are very small—the tax policy is more effective at reducing disposable bag use than the bonus policy—and show no evidence of crowd out of intrinsic motivation.

B. *Marketing and Awareness*

One crucial concern with interpreting the results from Section IV as evidence of loss aversion is that awareness of the two policies may differ. For example, the tax was covered widely in the press in the weeks leading up to its implementation. In spite of the fact that all sample stores marketed the two types of incentives in similar ways (e.g., both bonus and tax policies were advertised in announcements posted at the register and other locations throughout the store), it is likely that the additional marketing involved with the implementation of the tax may have generated a difference in awareness of the two policies.

To estimate these discrepancies in awareness, I surveyed customers at 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 about half (52 percent)

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of customers in stores that offered a bonus were aware of that program. This under-awareness of the bonus policy could mute the estimate of the effect of the incentive relative to the tax. In order to account for the relative unawareness of the bonus, I rescale the estimate of the effect of the bonus policy from Table 7 by dividing the estimate by the fraction of customers who were aware of the policy.[28] However, even after rescaling, the effect of the tax on the proportion of customers using a reusable bag was still much larger than the effect of the bonus—33.4 versus 5.6 percentage points.[29] In fact, in order for differences in awareness to fully account for the relative effectiveness of the two policies, *no more than 9 percent* of customers who would have switched from disposable to reusable bags had they known about the bonus could have actually been aware of the policy. So while it is clear that substantial differences in awareness contributed to the relative effectiveness of the tax policy, this cannot completely account for the observed asymmetry in responses to the two policies.

C. *Social Norms*

Another possibility is that the two policies led to differentials shift in social norms. For example, since the tax was a law while the bonus was simply a store policy, shoppers may interpret the tax policy as a statement about what behavior warrants punishment, a legal theory known as the "expressive function of law."[30]

It is difficult to rule out the hypothesis that the tax caused a shift in social norms, largely because social norms are difficult to measure. Nonetheless, I collected survey measures of attitudes toward disposable bag use at seven grocery stores before and after the implementation of the Montgomery County bag tax. This allows me to use the same difference-in-differences strategy as described in Section IVA to evaluate the effect of the implementation of the tax on these self-reported social norms measures.[31] Table 8 presents the results of this analysis. While the standard errors are rather large, none of the measures show a significant change after the tax was implemented; in fact, the signs of the different measures are not even 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. While these results are by no means conclusive, they provide suggestive evidence that the implementation of the law did not cause a detectable shift in self-reported social norms regarding the use of disposable bags.

[28] Note that this method assumes that customers who were unaware of the bonus policy would have responded to the policy in the same way as those who were aware of the policy had they known about the bonus.

[29] A slightly more conservative estimate assumes that customers who would respond to the bonus policy if they were aware of it have an awareness rate equal to that of survey participants who did not use a reusable bag on the day of the survey—38.0 percent. This would imply that the bonus led to an increase in reusable bag use of 7.6 percentage points, still dramatically lower than the effect of the bonus.

[30] For example, Funk (2007) shows that voter turnout in Switzerland decreased significantly after a mandatory voting law with negligible penalties (less than one dollar) was repealed.

[31] 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 five cents for each disposable bag ("Support").

Table 8—Change in Social Norms after Implementation of Tax Policy

	Guilt (1)	Pressure (2)	Upset (3)	Wasteful (4)	Support (5)
MD×Post	0.072	−0.059	0.027	−0.103	0.031
	(0.054)	(0.123)	(0.092)	(0.125)	(0.114)
Post	−0.036	0.044	0.052	−0.133	0.002
	(0.043)	(0.119)	(0.086)	(0.049)	(0.047)
MD	−0.074	0.087	0.006	0.003	0.018
	(0.042)	(0.094)	(0.059)	(0.076)	(0.052)
DC	0.087	0.113	0.023	−0.088	0.138
	(0.032)	(0.024)	(0.043)	(0.006)	(0.024)
Female	0.220	0.102	0.108	0.032	0.138
	(0.032)	(0.027)	(0.018)	(0.022)	(0.022)
White	0.068	0.064	−0.033	−0.008	−0.090
	(0.040)	(0.043)	(0.034)	(0.029)	(0.048)
Age	0.008	0.007	−0.007	0.002	−0.004
	(0.007)	(0.006)	(0.007)	(0.003)	(0.006)
Age squared	−0.000	−0.000	0.000	−0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\geq$ High school	−0.086	0.004	0.007	−0.046	−0.050
	(0.026)	(0.076)	(0.039)	(0.056)	(0.034)
Income $<$ \$50k	−0.040	−0.008	0.023	−0.090	−0.050
	(0.029)	(0.033)	(0.039)	(0.039)	(0.033)
Dependant variable mean	0.398	0.329	0.244	0.394	0.679
Observations	743	742	742	742	739

Notes: Standard errors clustered at the store level are in parentheses. Outcome variable: indicator for responding affirmatively to the social norms survey question. Respondents 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 five cents for each disposable bag ("Support"). All regressions control for store county and respondent characteristics including sex, race, age, education, and income.

One additional point to note is that the Montgomery County tax was implemented on January 1, 2012, but was passed in May of 2011. The change in behavior estimated in this paper is measured at the law's implementation. Survey data from the pretax period suggests that just over half of survey respondents in Montgomery County were aware that the law had been approved and that they would soon be charged \$0.05 per disposable bag. Additionally, the Montgomery County tax 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. The survey data shows that 73.7 percent of respondents in Virginia and 83.7 percent of Montgomery County respondents were aware of the DC tax.[32] This suggests that any change in social norms among customers shopping at a given store would have needed to take

[32] 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.

place only when the tax was implemented in that store's county rather than at the passage of the law or the implementation of similar laws in neighboring counties.

D. *Utility from Free Goods*

Shampanier, Mazar, and Ariely (2007) present an alternative model of reference-dependent preferences in which 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, conversely, may experience lower utility costs from not having to pay for a non-free good. Note that this model is a specific case of reference-dependent preferences in which customers only exhibit reference dependence when the reference point in question is a customer's wealth when a good is free. Additionally, their model suggests that there is a discontinuous jump in utility at this zero-price reference point rather than a kink. This would imply that a customer's utility should decrease discretely when a store policy shifts from offering no incentive to charging a tax (i.e., when the good is no longer free) by some amount δ:

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

Since the reference point considered in this paper is a customer's wealth when disposable bags are free, this model could also explain the results from Section IV. While my data cannot distinguish between this specific case of reference-dependent preferences or the more general model described in Section IIB, nor can it determine whether the change in utility is a kink versus a discontinuous jump, it rejects any model that does not predict asymmetry around this particular reference point.

E. *Additional Explanations*

There are several other possible explanations that may contribute to the difference in responses to the two incentive policies. For example, while both policies offer a \$0.05 incentive per bag for those who use a reusable bag instead of a disposable bag, the incentives are not symmetric for individuals who choose to use no bag—customers who change their behavior from using a disposable bag to using no bags are \$0.05 richer under the tax policy, but are financially unchanged under the bonus policy. However, the large majority of customers in the sample use one of the two types of bags rather than carrying their groceries in their arms. Similarly, if reusable bags are larger than disposable bags, the tax policy provides a larger incentive than the bonus policy. As with the asymmetries in awareness in Section VB, the difference in the size of the two types of bags would need to be substantial—reusable bags would need to be roughly ten times as large as a disposable bag—to generate the results found in Section IV. Another concern is that the behavior of the cashiers may have changed after the tax was implemented, either in how they bagged the groceries or how they reminded customers of the tax policy. While I cannot rule out this mechanism, I did not observe this type of behavior while collecting data at the sample stores. Lastly, recent work by Li, Linn, and Muehlegger (2014) and Sussman and Olivola (2011) present evidence that consumers are "tax-averse," which suggests that customers may respond more strongly to the tax simply because it is labeled as a tax and not a fee. While there were no existing policies that charged a fee for disposable bag use that is not framed as a tax in the sample stores, Appendix E presents evidence from an online experiment that elicited participants' responses to a hypothetical store-imposed fee versus a government-imposed tax and finds no differences in responses to the two policies.

VI. Estimating Loss Aversion

A. *The Coefficient of Loss Aversion*

As mentioned in the previous section, there are several explanations for the asymmetric response to the two incentive policies observed in the data. This section accounts for the differences in policy awareness from Section VB then uses estimates from Section IV to measure the degree of loss aversion in the population if the remaining asymmetry in responses to the tax and bonus policies were attributed to loss aversion. In the reference-dependent utility function described in Section IIB, 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" (Tversky and Kahneman 1991).

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 Section IIB. To connect the model with the data, I divide through by γ so that all variables are in money-metric units. 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 bonus, and when there is a tax are $F(0)$, $F(x)$, and $F(\alpha x)$, respectively. Recall that we observe these proportions in the data in the previous section.

	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
Bonus policy	$U_{B,i}(w^*, b_i) = \begin{cases} x - c_i & \text{if } b_i = 1 \\ 0 & \text{if } b_i = 0 \end{cases}$	$x > c_i$	$F(x)$	15.4
Tax policy	$U_{T,i}(w^*, b_i) = \begin{cases} -c_i & \text{if } b_i = 1 \\ -\alpha x & \text{if } b_i = 0 \end{cases}$	$\alpha x > c_i$	$F(\alpha x)$	44.2

To provide a back-of-the-envelope estimate of the coefficient of loss aversion, suppose that $F(\cdot)$ is a normal distribution with mean μ and variance σ^2. Using the first two moments in the above table, μ and σ^2 are just-identified, with $\mu = \$0.56$ and $\sigma = \$0.50$. Using these parameters, the coefficient of loss aversion can be estimated by choosing α to fit the third moment, $F(\alpha x) = 0.442$. After adjusting for under-awareness of the bonus, this approach yields an estimate of $\alpha = 5.3$.

In words, this estimated coefficient of loss aversion suggests that a bonus would have to be \$0.25 in order to have the same behavioral impact as the \$0.05 tax. Bootstrapping this approach yields a 95 percent confidence interval of $[3.3, 14.8]$.[33] Previous papers that estimate the coefficient of loss aversion using lab experiments, such as Tversky and Kahneman (1991), typically estimate values of α of just over 2, which are exceeded by even the lower end of this range of estimates. The large estimated value of α is consistent with loss aversion being stronger in this setting than in other contexts in which it has been observed or, alternatively, may suggest that one or more of the other explanations discussed in Section V could be contributing to the large effect of the tax.

B. *Expectations-Based Reference Points*

Up to this point, analyses in this paper involving reference-dependent preferences assume that a customer's wealth in the absence of an incentive policy serves as her reference point, i.e., her reference point is her wealth when disposable bags are free. However, work by Kőszegi and Rabin (2006) suggests that reference points are generated by an individual's expectations about their wealth. If a customer believes that disposable bags are free, then a \$0.05 tax will feel like a loss. Alternatively, if a customer expects to pay a \$0.05 tax per bag, this theory of reference point formation suggests that she will not experience a loss when paying the tax because she expected to pay the tax. If reference points are indeed based on expectations, this suggests that customers may decrease their disposable bag use before their expectations have adjusted to the new policy (e.g., in the early days of implementation), but that this effect should rebound once customers adjust their expectations.

This section analyzes a transaction-level scanner dataset from a large retail chain in Washington, DC and Montgomery County to estimate the long-term impact of the tax on disposable bag use. This data includes a line item that indicates if a customer was charged a tax during a given transaction that can be used to calculate daily estimates of the fraction of customers using at least one disposable bag following the implementation of the tax.[34] The data includes transactions from January 1, 2010 to June 30, 2012, which allows me to track disposable bag use for two and a half years in Washington, DC and six months in Montgomery County.

Figure 5, panel A plots the percent of customers using a disposable bag in stores located in Washington, DC starting on the first day of the tax policy on January 1, 2010.[35] The figure shows that 58.1 percent of customers used at least one dispos-

[33] Specifically, I resample from the data without replacement to generate new means for the fraction of consumers bringing a reusable bag, and use the new means to estimate a new value of α. I repeat this procedure 1,000 times. The 95 percent confidence interval for α is obtained by selecting the values of α that correspond to the fifth and ninety-fifth percentile of the αs generated by this approach.

[34] This data includes information on whether a customer was charged for using a disposable bag during a given transaction which 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. Additionally, since I only have a measure of bag use when a customer is charged a tax, I do not have data on disposable bag use in periods prior to the implementation of the tax or in locations that did not pass a tax policy. Lastly, this particular chain did not offer customers a bonus, so I cannot use this data to analyze the relative effectiveness of a tax versus a bonus policy.

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

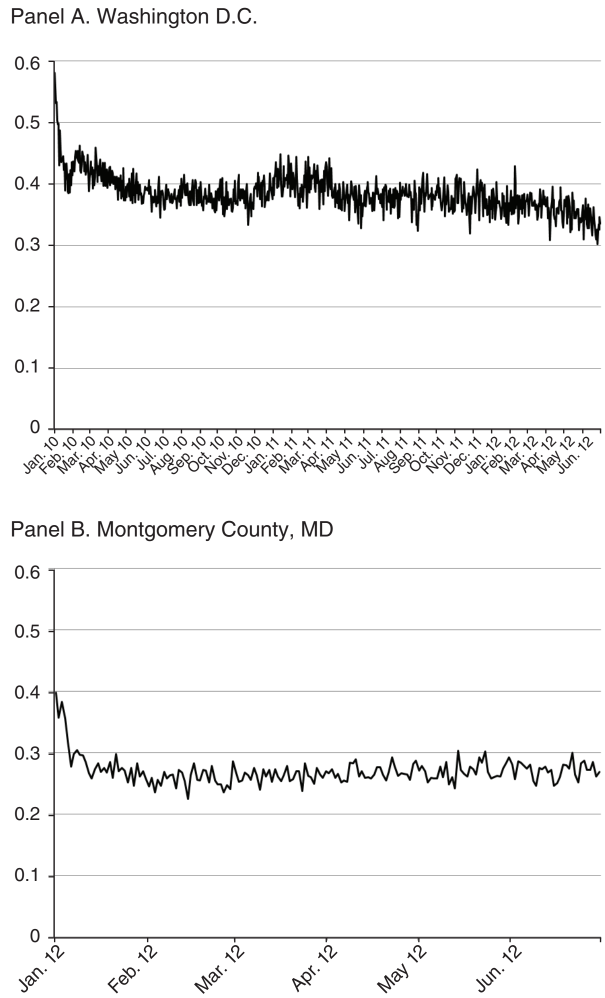

Figure 5. Proportion of Customers Using a Disposable Bag after Implementation of the Tax

able bag on the first day the tax was implemented, but that this estimate decreased to 41.5 percent by the last week of the month. The figure does not show a decrease in disposable bag use during the month of January in the two subsequent years, suggesting that the decrease in bag use is likely associated with the implementation of the tax and not simply due to seasonal fluctuations in bag use. Figure 5, panel B shows a similar pattern in Montgomery County after the implementation of its tax on January 1, 2012. On the first day of the Montgomery County tax, 39.8 percent of customers used at least one disposable bag, but by the last week in January, this estimate decreased to 26.3 percent.

What is particularly remarkable about this change in behavior is its persistence. While disposable bag use in both Washington, DC and Montgomery County decreased by roughly 15 percentage points over the first month of the tax, this estimate remained at the new lower level for the rest of the sample period. In contrast,

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a model of expectations-based reference dependence would predict that bag use would rebound to its pre-tax level once customers grew accustomed to the tax. While these results do not rule out the possibility of such a model—for example, the absence of a rebound effect could be explained by habit formation of using a reusable bag—the data is more consistent with a model of reference dependence in which a customer's reference point is fixed at her wealth level when disposable bags have a price of zero.

VII. Conclusion

This paper investigates the relative impact of two incentives aimed at reducing the use of disposable shopping bags: a \$0.05 tax on disposable bag use and a \$0.05 bonus for reusable bag use. I find that the tax policy reduced the overall demand for disposable bags by over half and prompted consumers to substitute to reusable alternatives; this is particularly notable given the relatively small size of the tax itself. The large effect of the tax is also striking given that the bonus had almost no impact of bag use, a result that is consistent with a model of loss aversion. I present evidence that differences in awareness of the two policies and changes in social norms cannot fully account for my results.

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—the average consumer may be willing to forgo the convenience of using a disposable bag, but not willing to cut back on her consumption soda or other taxed 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 (Chetty, Looney, and Kroft 2009; Goldin 2015). 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, Mazar, and Ariely 2007). Finally, even a small initial impact of the tax can generate large effects if the reputation costs of using disposable bags increases by way of a social multiplier (Benabou and Tirole 2011).

The results from this study have implications for several existing policies that use small financial incentives to nudge individuals toward a desirable behavior. Policies that provide discounts to coffee drinkers who use their own mug may not be as effective as those that charge for the use of a paper cup. Similarly, government programs that award tax credits to customers who purchase environmentally friendly Energy Star products may be less effective than policies that tax energy-inefficient products. Outside of environmental policies, Rees-Jones (2017) suggests that altering income tax withholding policies (resulting in fewer taxpayers having a tax liability versus a refund) could have significant effects on tax evasion. Most recently, a Supreme Court case[36] challenged state laws that prohibit retailers from imposing

[36] *Expressions Hair Design v. Schneiderman*, No. 15-1391.

surcharges on credit card purchases to cover "swipe fees," but allow for discounts on non-credit card purchases. This paper suggests that the framing of the policy—the First Amendment issue in question—could have a significant impact on credit card use, even when the incentives are very small (credit card companies charge merchants swipe fees of 2 to 3 percent of the sales price). As Justice Breyer pointed out during the case, "a discount and a surcharge are the same thing economically. But we live in a world in which not everyone is an economist" Liptak (2017).

Appendix

A. *Demographic Characteristics by Location and Time Period*

Table A1—Demographic Characteristics

	Washington, DC		Maryland		Virginia	
	Pre (1)	Post (2)	Pre (3)	Post (4)	Pre (5)	Post (6)
Female	58.5	59.7	59.8	61.2	53.1	56.9
	(49.3)	(49.1)	(49.0)	(48.7)	(49.9)	(49.5)
White	63.8	63.3	59.3	59.7	77.8	76.6
	(48.1)	(48.2)	(49.1)	(49.1)	(41.6)	(42.4)
Black	23.3	22.0	27.9	26.3	10.1	9.7
	(42.3)	(41.4)	(44.9)	(44.0)	(30.2)	(29.6)
Observations	1,207	1,649	3,799	4,515	2,006	3,075

Notes: This table reports mean values of each variable. Standard deviations are in parentheses. Pre- and post-periods refers to the sample period before and after the implementation of the Montgomery County tax.

B. *The Effect of the Tax in Bonus versus Non-bonus Stores*

The main analysis of the effect of the tax in Section IVA includes stores that also offered customers a $0.05 bonus for reusable bag use. This section estimates whether the tax had a differential impact in stores that offered a bonus and stores that did not by including interactions for whether the store provided a bonus. The results in Table A2 show that the effect of the tax on the likelihood of using a disposable bag is slightly smaller (2.2 percentage points) in bonus stores, but this difference is not statistically significant. The table also shows that the effect of the tax on any reusable bag use is slightly higher in bonus stores while the effect on using no bags is significantly lower, though neither effect is statistically significant. Taken together, this suggests that the tax has a similar impact on disposable bag use in both types of stores, but that customers in bonus stores were somewhat more likely to switch to reusable bag use than to opt to use no bags at all.

C. *The Effect of the Tax on Store Volume and Purchase Behavior*

This section investigates whether the tax policy had an impact on store volume (total expenditure and the number of transactions) as well as on shopping

Table A2—Effect of Tax Policy in Bonus versus Non-bonus Stores

	Extensive margin			Intensive margin	
	Disposable (1)	Reusable (2)	No bags (3)	Disposable (4)	Reusable (5)
MD×Post	−0.4353	0.2989	0.1561	−0.3012	0.1310
	(0.0466)	(0.0294)	(0.0326)	(0.1891)	(0.1430)
MD×Post × Bonus	0.0215	0.0405	−0.0642	0.1121	0.0197
	(0.0544)	(0.0362)	(0.0368)	(0.2306)	(0.1673)
Observations	16,251	16,251	16,251	10,314	5,003

Notes: Standard errors clustered at the store level are in parentheses. Outcome variables: indicator for using at least one bag or no bags (extensive) and number of bags used among users (intensive) for disposable and reusable bags, respectively.

Table A3—Effect of Tax Policy on Store Volume and Basket Size

	Transactions (1)	Expenditure (2)	Basket size (3)
Post DC tax × DC	−0.0485	−0.0225	0.0120
	(0.0312)	(0.0336)	(0.0108)
Post MD tax × MD	0.0029	−0.0187	−0.0160
	(0.0203)	(0.0239)	(0.0102)
Observations	62,123	62,123	62,123

Notes: Standard errors clustered at the store level are in parentheses. Scanner data from 31 stores from Washington DC, Montgomery County, and Arlington County from January 2007 to June 2012. All outcomes are measured at the store-day level in logs. Includes store and calendar month fixed effects.

behavior (average basket size per transaction). Table A3 presents results from a difference-in-differences analysis using scanner data from 31 stores across the 3 sample counties belonging to one large retail chain from January 2007 to June 2012. This store did not offer a bonus at any point during the sample period. Since the data spans the implementation of both the Washington, DC and Montgomery County tax, I use the following specification:

$$Y_{isdmy} \ = \ \alpha + \beta_{DC} DD_{DC,\,sy} + \beta_{MD} DD_{MD,\,sy} + \gamma_m + \delta_y + \varepsilon_{isdmy},$$

where Y is a measure of shopping behavior in individual store i in state s on day d of month m in year y, DD_{DC} is an indicator for stores in Washington, DC after the tax was passed, DD_{MD} is an indicator for stores in Montgomery County after the tax was passed, and γ and δ are a set of month and year fixed effects. The coefficients of interest, β_{DC} and β_{MD}, are the difference-in-difference estimates of the effect of the Washington, DC and Montgomery County taxes on shopping behavior, respectively.

Results show that neither the Washington, DC nor the Montgomery County tax led to a significant change in the daily store volume measured as either the number of transactions (column 1) or the total expenditure (column 2). The taxes also did not change the average basket size, i.e., the number of items per transaction (column 3).

Table A4—Effect of Hypothetical Tax versus Bonus Policy on Likelihood of Using Reusable Bags

	(1)
Tax (versus bonus)	0.286
	(0.025)
White	−0.110
	(0.028)
Female	0.050
	(0.025)
Age	−0.003
	(0.004)
Age squared	0.000
	(0.000)
≥ High school	0.045
	(0.034)
Income < \$50k	0.026
	(0.032)
Dependant variable mean	0.194
Observations	1,294

Notes: Robust standard errors are in parentheses. Outcome variable: indicator for if respondent answered "definitely" when asked if the \$0.05 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. Dependent variable mean for bonus-framing. All regressions control for store county and respondent characteristics including sex, race, age, education, and income.

D. *Survey Measure of Policy Effectiveness*

To investigate the presence of 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 \$0.05 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.[37] Participants were instructed to give one of the following five responses: definitely, quite a bit, somewhat, very little, or not at all. Table A4 presents results of the following linear probability model:

$$Y = \theta_0 + \theta_1 Tax + \lambda X + \varepsilon,$$

where Y is the probability that the survey participant gave a response of "definitely;" *Tax* is an indicator variable that takes the value of one if the participant was asked about 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. Of the customers who were asked about the influence of the bonus program, 19.4 percent responded that the policy would definitely influence their decision. This average is

[37] 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.

Table A5—Effect of Hypothetical Tax versus Fee on Likelihood of Using Reusable Bags

	(1)
Tax (versus fee)	0.025
	(0.081)
White	0.080
	(0.095)
Female	0.183
	(0.086)
Age	−0.029
	(0.026)
Age squared	0.000
	(0.000)
$\geq$ High school	0.032
	(0.093)
Income $<$ \$50k	0.034
	(0.085)
Dependant variable mean	0.356
Observations	147

Notes: Robust standard errors are in parentheses. Outcome variable: indicator for if respondent answered "definitely" when asked if the \$0.05 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. Dependent variable mean for bonus-framing. All regressions control for store county and respondent characteristics including sex, race, age, education, and income.

significantly lower—28.6 percentage points lower—than the proportion of customers who responded similarly when asked about the tax policy.[38]

E. *Tax Aversion*

Recent evidence from the lab and field suggests that individuals are more likely to avoid taxes than other costs of the same amount, i.e., they are tax-averse (Li, Linn, and Muehlegger 2014; Sussman and Olivola 2011). If customers treat taxes differently than other types of incentives, this could generate the differential responses to the tax and bonus policies. Since there were no policies that charged a fee for a disposable bag (rather than a tax), I rely on data from a randomized experiment using an online platform, Amazon Mechanical Turk, to test for tax aversion in this context. The survey questions mirror the questions asked in the in-store survey described in Appendix Section D, in which participants were asked perceived responses to a bonus versus a tax. In this survey, participants were randomly assigned to answer how they believed they would respond to a store-imposed fee or a government-imposed tax. Table A5 presents these results using the same specifications and controls as in Table A4. While this analysis should be viewed as merely suggestive due to the

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

hypothetical nature of the questions, the results show differences in the responses of participants in the "tax" group compared to the "fee" group.

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