
Evaluating the Ban:
Philadelphia's
Plastic
Bag Ban
and Changes in Bag
Usage in the City

Study conducted by:

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Executive Summary

In Philadelphia, an estimated 1 billion single-use disposable plastic bags are used annually, contributing to carbon emissions, plastic waste, and litter. These bags are typically used only for a few minutes before ending up in landfills, on streets, and in waterways. Municipal single-stream recycling processes are unable to recycle plastic bags and the soft material causes equipment jamming at recycling centers, leading to dangerous and costly repairs that account for 150 hours of lost staff time and \$300,000 in city costs.¹ Paper bags, while easier to recycle than plastic, require four times the energy to produce and may involve the use of environmentally harmful chemicals and fertilizers.

In response to these environmental impacts, the Philadelphia City Council passed Bill 190610 in 2019, which banned retail establishments from distributing single-use plastic bags and paper bags not made of at least 40% recycled material. The ban went into effect on July 1st, 2021, after being delayed due to the COVID-19 pandemic. Businesses had 90 days to comply and a nine-month grace period before facing financial penalties of \$150 or more. As commissioned by the bill, a study was conducted between June 2021 and August 2022 to assess the effects of the ban during its first year of implementation.

To assess the effectiveness of the ban, the research team compared plastic bag usage in grocery stores in Philadelphia ("Philadelphia" sample) with usage in surrounding suburbs ("Suburbs" sample). By collecting data from the suburbs, the team established a counterfactual of bag usage in the absence of the ban and compared it to the observed behavior in Philadelphia. The study aimed to measure changes in plastic bag usage and determine if businesses and consumers substituted other types of bags or stopped using bags altogether in response to the ban.

The results of the study showed a significant decrease in plastic bag usage in the city after the ban was implemented. Prior to the ban, 64% of shoppers used at least one plastic bag when shopping at sample grocery stores in the city. This proportion dropped to only 4.1% of shoppers after October 1st 2021. This decrease was offset by an increase in the usage of paper and reusable bags. The percentage of shoppers who used paper bags nearly tripled from 17.7% to 45.5%, and the usage of reusable bags almost doubles from 21.8% to 41.7%. The decrease in plastic bag usage was larger in magnitude than the increase in paper bag usage, leading to an overall reduction in the quantity of disposable bags used in the city. Extrapolating the results from our sample, we estimate that the ban led to the elimination of over 200 million plastic bags in the city. This is roughly equivalent to filling Philadelphia City Hall with plastic bags every eight months.

¹<https://www.phila.gov/programs/plastic-bag-ban/frequently-asked-questions/>

Key Findings

The Philadelphia plastic bag ban significantly reduced plastic bag use and increased paper and reusable bag use in the city. It led to a significant decrease in the likelihood of consumers using plastic bags at grocery stores in our sample (Figure 1), a change that occurred in the first three months of the ban and persisted through the first year of implementation. The likelihood of consumers using paper bags, any reusable bags, or no bag at all also increased significantly. The composition of bags used per shopping trip changed as a result (Figure 2). Based on the results from our sample, the estimated number of disposable bags consumed in the city decreased overall (Figure 3), even after accounting for the increase in the number of paper bags used.

FIGURE 1: Changes in Likelihood of Philadelphia Consumers Using Bags After the Ban

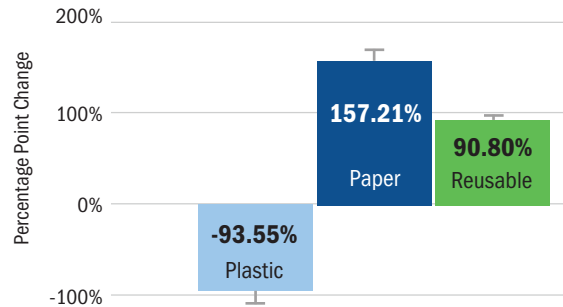


FIGURE 2: Change in Composition of Bags Used in Philadelphia After the Ban

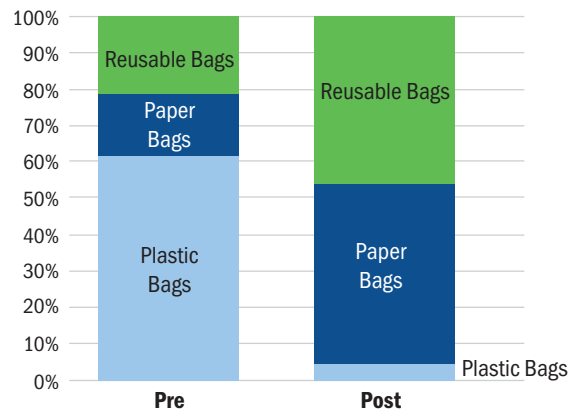
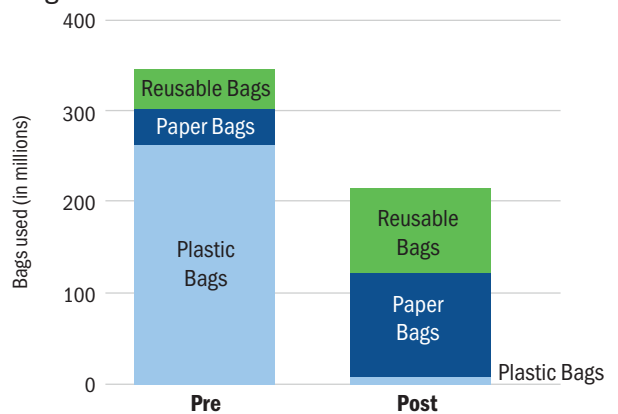


FIGURE 3: Estimated Change in Total Number of Bags Used



Background

Every year, 100 billion plastic bags are used in the US, but only 10% of them are recycled. As a result, these bags often end up littering city streets, landfills, and waterways. In response to this problem, many states in the US have enacted regulations on the use of plastic bags. These regulations have been rapidly implemented in the past 20 years, and now one in six people in the US live in a jurisdiction that has a state or local government regulation on plastic bags (Wagner, 2017).

In recent years, some of these policies have been evaluated for their effectiveness. For example, in California, a plastic bag ban combined with a five-cent paper bag fee reduced the number of plastic bags used by 35 percentage points (Taylor and Villas-Boas 2016). However, a similar ban in Chicago led to greater environmental pollution as consumers and businesses substituted thin plastic bags for thicker ones that were not covered by the ban (Homonoff et al., 2022). In response, Chicago policymakers changed the ban to a 7-cent tax on all paper and plastic bags. In Washington D.C., a 5-cent fee on plastic and paper bags resulted in a 42% decrease in disposable bag use (Homonoff, 2018).

In 2019, the City of Philadelphia passed an ordinance banning all single-use plastic bags made through a blown-film extrusion process and paper bags with less than 40% recycled content. The implementation of this policy was staggered, with businesses given 90 days to comply before facing warnings and an additional six months to become compliant before facing penalties (see Figure 4). Businesses had 90 days to comply and a nine-month grace period before facing financial penalties of up to \$150 or more. If businesses repeatedly violated the ordinance, the City could ask a judge to impose additional penalties. Postings were distributed to businesses in the City to inform customers and business owners of the ban and mandated to be posted by July 31st (see Appendix Figure 1). These signs told customers that the establishment will no longer be providing single-use plastic bags and non-recycled content paper bags as of Oct 1, 2021.

FIGURE 4: Timeline of the Implementation of the Philadelphia Plastic Bag Ban



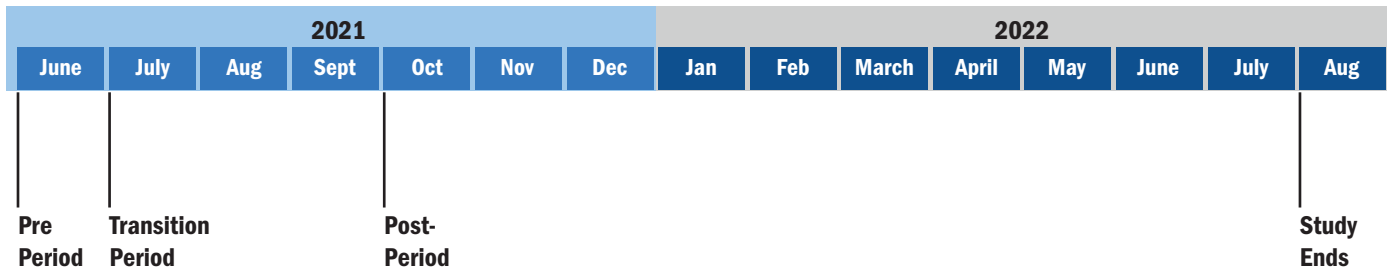
Methodology and Data

The key purpose of the study was to understand the impact that the Philadelphia plastic bag ban had on consumer behavior. In order to evaluate the impact of the policy, one has to predict what bag usage would have looked like in the absence of the policy (the counterfactual) and compare that behavior to actual bag use. We used a difference-in-difference approach to estimate the effect of the ban by comparing bag usage in grocery stores in Philadelphia and its suburbs before and after the ban was implemented from June 2021 to August 2022.² The plastic bag ban was a city-wide policy that did not regulate the distribution of such bags outside the city limits, providing a clear boundary between the regulated and unregulated areas. While we cannot observe the behavior of the same people both with and without the regulation, we can do our best to estimate a counterfactual by employing a combination of comparisons across time (before and after the policy) and location (in regulated and unregulated stores). Using the two comparisons together allows us to account for differences in bag usage due to reasons other than the regulation. This research approach also accounts for the possibility that consumers might change their shopping behavior by increasing their purchases at stores that could still offer plastic bags outside of the city.

Prior to data collection, we selected a sample of 10 “treatment” grocery stores that would be affected by the ban, along with 7 “control” locations in the city’s suburbs (outside the reach of the ban). These locations were chosen to ensure a representative sample of Philadelphians based on census tract-level demographic data. From June 2021 to August 2022, we observed bag use at these grocery stores, collecting data on the number and type of bags used per consumer. Pre-period “baseline” data collection was conducted in June 2021 and post-period data collection began in July 2021 and ended in August 2022 (see Figure 5). We define the period between July 1, 2021 and October 1, 2021 as a “Transition period” to account for residual plastic bag distribution from stores before warnings began to be imposed October 1st. We collected a unique individual level data set on approximately 9,000 shoppers using over 21,000 bags. We categorized single-use disposable plastic bags from the store as “plastic bags,” any bags comprised of paper pulp as “paper bags,” and any other bags that are reusable or being reused (e.g., a plastic bag brought in from a different store) as “reusable”.

²The difference-in-difference approach has been widely used to study previous policy changes, and bag regulations in particular. See Homonoff et al. (2022) for an overview of the difference-in-difference design approach in assessing disposable bag regulations in other cities and municipalities.

FIGURE 5: Timeline of the Data Collection Periods for Evaluating the Ban Study



We then estimated the effect of the ban on two groups of outcomes: indicators for using any disposable or reusable bags (or no bags at all), as well as the number of bags used per consumer for each type of bag. Specifically, we estimated the following model:

$$\text{Outcome}_{ist} = \beta_0 + \beta_1 \text{Philadelphia} \times \text{Post}_{st} + \beta_2 \text{Philadelphia}_s + \beta_3 \text{Post}_t + \epsilon_{ist}$$

For individual i , store s , and time period t . *Philadelphia* is an indicator variable for shopping in Philadelphia and *Post* is an indicator for shopping after the implementation of the ban (the post period). *Philadelphia* × *Post* is an interaction of *Philadelphia* and *Post* i.e. an indicator variable for shopping in Philadelphia during the post period. The coefficient of interest, β_1 , measures the effect of the tax on bag use in Philadelphia, relative to bag use in the suburbs. Standard errors are clustered at the store level.

Results

RESULT 1:

The ban led to a large decrease in the likelihood of using a plastic bag, with consumers switching to using paper bags, reusable bags, or no bags at all.

Before the ban went into effect, roughly 64% of consumers in Philadelphia used at least one plastic bag, 17.7% used at least one paper bag, 21.9% used at least one reusable bag and 4.9% of consumers used no bag at all (see Table 1). Table 2 presents the main results on the effect of the ban on bag use and our estimate of β_1 using data collected through August 2022, just over one year after the ban was implemented. The ban led to a 52.6 percentage point reduction in the likelihood of a consumer using a plastic bag ($p < 0.01$). In addition, the likelihood of consumers using a paper bag, reusable bag, or forgoing a bag entirely increased by 21.45 percentage points, 17.6 percentage points, and 8.6 percentage points respectively. Taken together, the ban led to a large decrease in the proportion of consumers using a plastic bag, with consumers mainly switching to either paper bags or reusable bags.

Table 1: Observed Bag Use for Philadelphia and Suburban Stores, before July 1, 2021 and after October 1, 2021

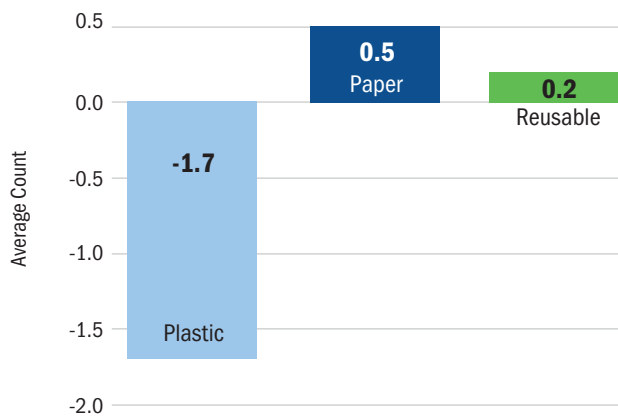
	Pre		Post	
	Philadelphia	Suburbs	Philadelphia	Suburbs
Proportion using any plastic bag	63.5%	88.3%	4.14%	76.5%
Proportion using any paper bag	17.7%	1.1%	45.5%	8.9%
Proportion using any reusable bags	21.9%	6.7%	41.7%	10.2%
Proportion using no bags	4.9%	5.8%	14.3%	7.6%
Number of plastic bags used per consumer	2.01	2.99	0.08	2.61
Number of paper bags used per consumer	0.28	0.02	0.85	0.21
Number of reusable bags used per consumer	0.31	0.14	0.68	0.17

RESULT 2:

The ban led to a decrease in the number of plastic bags used and an increase in the number of paper and reusable bags used per customer.

An estimated average of 2 plastic bags were used for each shopping trip before the ban, more than the number of paper or reusable bags used per shopping trip on average (Table 1). After the ban went into effect, the number of reusable and paper bags used per customer increased and the number of plastic bags used decreased (Figure 6).

FIGURE 6: Change in the Number of Bags Used in Philadelphia After the Ban



After the ban went into effect, the number of reusable and paper bags used per customer increased and the number of plastic bags used decreased

Table 2: Effect of Bag Ban on Various Measures of Bag Use from June 2021 to July 2022

Variables	Likelihood of Use				Number of Bags Used per Consumer		
	(1) Plastic	(2) Paper	(3) Reusable	(4) No Bag	(5) Plastic	(6) Paper	(7) Reusable
Philadelphia X Post	-0.526*** (0.16)	0.215 (0.140)	0.176** (0.020)	0.086* (1.80)	-1.694*** (0.53)	0.396 (0.280)	0.352*** (0.121)
Post	-0.119 (0.092)	0.079 (0.079)	0.036** (0.012)	0.086* (0.048)	-0.381 (0.329)	0.192 (0.189)	0.039 (0.021)
Control Mean	0.883	0.011	0.067	0.059	2.987	0.020	0.139
Observations	8703	8703	8703	8703	8703	8703	8703

Notes: *** p < 0.01, ** p < 0.05, *p<0.1 Standard errors clustered at the store level in parentheses.

RESULT 3:

It took three months for plastic bag usage to decrease in the city, and remained steady near zero for the remainder of the study. The likelihood of using reusable bags gradually increased over the first year of the ban's implementation. Paper bag usage peaked 6 months after the ban was implemented before receding slightly.

To understand whether the impact of the ban changed over time, we estimated the ban's effect at five different periods: Jun 2021, Jul-Sept 2021, Oct - Dec 2021, Jan - Mar 2022, and Apr - Aug 2022. These time frames correspond to: 1) the month before the plastic bag ban was initiated, 2) the interval before warnings were issued as businesses adjusted to the regulation, and 3) the post period split into three time intervals. Figures 7-9 display the measures of bag use over time for plastic bags, paper bags, and reusable bags, respectively. During the first year of the ban's implementation, the reduction in the likelihood of plastic bag usage in the city largely occurred after October 1st, 2021, where the likelihood fell from 92% to 14%, and then fell further to <1% by January 1st, 2022. (Figure 7). In contrast, the likelihood of consumers using paper bags increased gradually over time, from 18% before the ban to 66% between January and March 1st, 2022 (Figure 8). The likelihood of using reusable bags increased from 13.1% before the ban, to 39% between October and December, to 41% between April 1st and August 1st, 2022 (Figure 9).

FIGURE 7: Likelihood of Consumers Using Plastic Bags Over Time

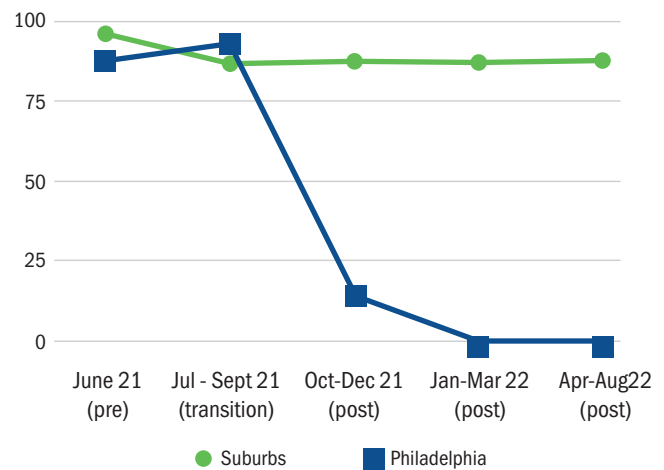


FIGURE 8: Likelihood of Consumers Using Paper Bags Over Time

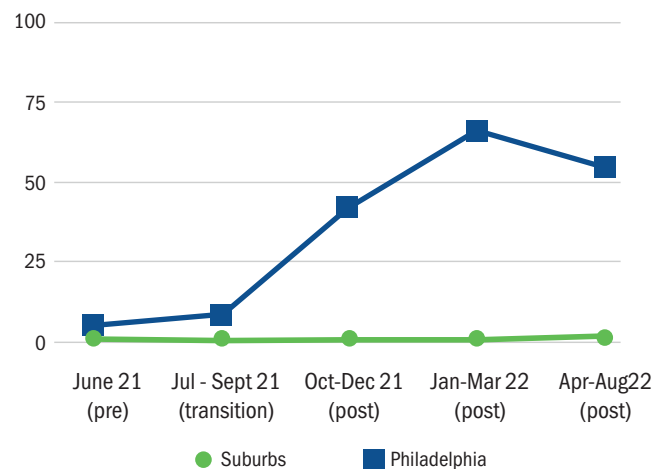
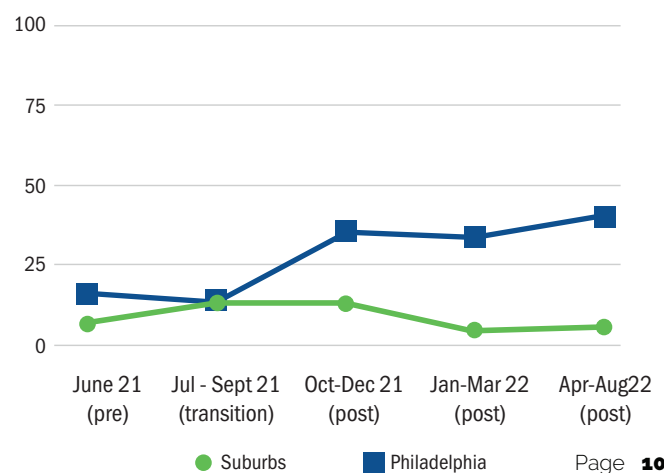


FIGURE 9: Likelihood of Consumers Using Reusable Bags Over Time



Summary and Conclusion

The City of Philadelphia implemented a ban on plastic bags and non-recycled paper bags on July 1st, 2021 with the purpose of reducing the amount of waste and litter generated in the city. This report analyzes the effect of the ban on the quantity of bags used in grocery stores in the city during the first year of its implementation. We find that the Philadelphia plastic bag ban had a large effect on bag use in Philadelphia after its initial year of implementation. During the study period, the proportion of consumers using a plastic bag dropped by 94% at grocery stores in our sample after an initial adjustment period. The proportion of consumers using a reusable bag almost doubled from 21.8% to 41.7%. The proportion of consumers using a paper bag increased by 27.8 percentage points from a baseline of 17.7%.

The results of the study showed a significant decrease in plastic bag usage in the city after the ban was implemented. The decrease in plastic bag usage was greater than the increase in paper bag usage, leading to a reduction in the overall quantity of disposable bags used. Extrapolating the results from our sample to the population of Philadelphia, we estimate that the ban led to the prevention of over 200 million disposable plastic bags from being distributed in the city in its first year, which is enough bags to fill City Hall every 8 months.

Appendix

Appendix Figure 1: Signage Posted in Retail Establishments Retail establishments were required to post clear and visible signage at all points of sale by July 31st, 2021. These signs tell customers that the establishment no longer provides single-use plastic bags and non-recycled content paper bags as of the date the prohibition begins. Signs were available in multiple languages. The sign says: "beginning October 1st, Philadelphia retail establishments are prohibited from providing single-use plastic and paper bags for carryout or delivery".



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