The Rise and Fall of Single-Use Plastic Tax: The Effects on Sales and Prices*

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Abstract

We study the impact of a tax on single-use plastic tableware introduced in Israel in November 2021 and repealed 15 months later on prices and sales. Following the tax's implementation, prices increased by 45%, leading to a 24% decline in sales. After the repeal, prices fell, and sales rebounded. However, prices remained 18% higher, and sales stayed 19% below pre-tax levels. Our analysis suggests that 15% of the post-repeal decline in sales can be attributed to changes in consumption patterns, with the remainder driven by higher prices. The shift in consumption behavior was more pronounced among less price-sensitive consumers.

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1 Introduction

Plastic pollution has become one of the most pressing global environmental issues, causing damage to ecosystems, human health, and economic productivity, with annual global losses estimated between $300 and $600 billion (Fletcher et al., 2023).[1] Both industrial activities and households contribute to plastic pollution, with single-use plastic products being the primary source of the latter. Discarded after a single use, these products generate waste that imposes substantial environmental and social costs that persist for centuries (Abate & Elofsson, 2024; Herberz, Barlow, & Finkbeiner, 2020).[2] In response to this growing concern, policymakers are adopting various strategies, including enhanced recycling practices, taxes, and outright bans. Among these approaches, taxation has emerged as a pivotal tool for addressing the negative externalities associated with single-use plastic products (Fletcher et al., 2023; Homonoff, 2018).[3] For policymakers, taxes serve two goals: they encourage consumers to adopt more environmentally sustainable habits and at the same time generate revenues that can be used to accomplish government objectives (O'Connell & Smith, 2024).

Taxation has long been used as a policy instrument to influence consumer behavior and correct market failures. While the literature on the use of taxes to promote social welfare focuses on public health issues—such as consumption of tobacco, alcohol, and sugary beverages (Allcott, Lockwood, & Taubinsky, 2019; Chaloupka, 2000)—there is growing interest

[1] Other studies place the total annual losses even higher, exceeding USD 1.5 trillion (Landrigan et al., 2023).

[2] The global shift from reusable to single-use containers has dramatically increased plastic consumption, with plastics' share of municipal solid waste rising from less than 1% in 1960 to over 10% by 2005 in high- and middle-income countries (Geyer, Jambeck, & Law, 2017). Plastic pollution harms nearly every aspect of the environment, from oceans and soil to drinking water, air, and even human and animal health (Nielsen, Hasselbalch, Holmberg, & Stripple, 2020).

[3] The most widely targeted single-use plastics are bags. Directive 2015/720 of the European Union regulates lightweight plastic bags. Countries such as Italy, Denmark, Germany, Ireland, and Israel introduced taxes to curb their use (Convery, McDonnell, & Ferreira, 2007), and several U.S. states, including California, New Jersey, and Vermont implemented bans on single-use plastic bags. Also, countries such as India and Rwanda have also enacted strict prohibitions on plastic bags. Additional measures target single-use plastic products more generally. Directive 2019/904 of The European Union sets reduction targets for single-use plastic items. Countries such as Estonia, Greece, Italy, Latvia, Spain tax single-use plastic products, while France and Kenya prohibit their usage.

in using taxation to also address environmental challenges, such as plastic pollution. Nevertheless, we are unaware of studies that investigate the impact of taxes on non-zero-price plastic products.[4]

In this paper, we address this gap in the literature and study the impact of an excise tax on single-use plastic tableware products introduced in Israel on November 1, 2021.[5] The tax was repealed 15 months later following general elections and a change in government. These tax changes provide a unique opportunity to study how prices and sales evolved after the imposition of the tax and after it was repealed. We can therefore study not only the effectiveness of the tax while it was in effect but also whether the tax induced lasting behavioral changes, shaping consumption habits even after it was removed.

We use monthly data from approximately 1,500 stores across Israel between 2019 and 2023, covering nearly 5,000 products. For each store, the data include monthly total revenue, the number of units sold for each product, and the socioeconomic status of the store's location, classified as low, medium, or high. Using these data, we apply a dynamic difference-in-differences (DiD) method to estimate how prices and sales changed following the implementation of the tax and after it was repealed. The treatment group consists of single-use plastic tableware products subject to the new tax, while the control group includes non-taxed products from related disposable supplies categories, such as aluminum foil and serving trays.

We find that after the introduction of the tax, the prices of single-use plastic tableware products increased by an average of 45% per unit compared to the prices of products in the control group. This increase remained stable throughout the tax period. At the same time, sales (the number of units sold) of single-use plastic tableware plastic products declined by approximately 24%, reflecting inelastic demand for single-use plastic products. After the tax

[4]Existing studies examine the impact of taxing zero-priced plastic products, such as single-use plastic bags (Homonoff, 2018; Homonoff, Kao, Selman, & Seybolt, 2022).

[5]The tax imposed a levy of 11 NIS per kilogram on the production and import of single-use plastic products including plates, bowls, cups, straws, knives, forks, tablespoons, and spoons. A separate tax of 3.3 NIS per kilogram was applied to hot drink cups made of paper with an inner plastic layer.

repeal, prices dropped sharply but remained, on average, 18% higher than pre-tax levels. Also, sales remained roughly 19% lower than before the tax was introduced.

We also examine how the tax and its removal affected prices and sales by socioeconomic status: low, medium, and high. This distinction is particularly relevant since individuals in the low socioeconomic status group are known for their high use of single-use plastic products,[6] while consumption patterns in the medium and high groups are more aligned with the OECD average. The socioeconomic analysis reveals notable differences between socioeconomic groups. While average price changes were somewhat similar across groups—48% in the low, 45% in the medium, and 43% in the high socioeconomic groups—sales patterns differed significantly. In the low socioeconomic group, sales decreased by 34%, with the decline becoming smaller as socioeconomic status increased: 25% in the medium and 16% in the high socioeconomic groups. After the tax repeal, prices remained approximately 18% higher than pre-tax levels in all groups. Correspondingly, sales in all groups were lower than before the tax was imposed, with a 23% decrease in the low socioeconomic group, and 19% and 16% decreases in the medium and high groups, respectively.

Our findings that sales remained significantly below their pre-tax levels, give rise to the question of whether the high post-repeal prices are the only explanation for the post-repeal sales reductions, or whether a change in consumption patterns of single-use plastic products also drives the decrease. To explore this issue, we estimate for the entire sample and separately for each group, the sales of single-use plastic products controlling for price, while instrumenting for price endogeneity using prices of the same product at other stores. This approach serves two purposes. First, by focusing on the coefficient of the post-repeal dummy variable, we can assess what fraction of the post-repeal sales can be attributed to a potential change in consumption patterns in the entire sample and in each group. Second,

[6]According to a survey conducted by Kantar (2020), the ultra-Orthodox Jews, who make up the majority of the low socioeconomic status group, account for 27% of plastic consumption in Israel, although their share of the Israeli population is about 10%.

we directly estimate the price elasticity of demand for single-use plastic products across the entire sample and within specific socioeconomic groups.

Our analysis reveals substantial variation across socioeconomic groups. We find that 25% and 16% of the decline in sales in the medium and high socioeconomic groups, respectively, is likely driven by a behavioral change in consumption patterns. In contrast, in the low socioeconomic group, the entire drop in sales is likely due to the higher prices in the post-repeal period, suggesting no change in consumption behavior. With regards to the estimates of demand elasticity, in the medium and high socioeconomic groups, we find that demand elasticity is inelastic at -0.85 and -0.67, respectively, while in the low socioeconomic group, demand is elastic (-1.26). These findings are consistent with our regression findings mentioned above regarding the changes in prices and sales.

Our paper contributes to the growing literature on plastic product regulation. Empirical studies on plastic-related taxes have primarily examined single-use plastic bags, which are typically provided free of charge before taxation. Single-use plastic bags are also highly substitutable with alternatives such as reusable bags and paper bags. This contrasts sharply with the potential effects of tax policies on other plastic products, such as cutlery and plates, which not only have non-zero baseline prices but also face limited substitutability. Existing studies on plastic bag taxation show significant short-term effectiveness (Asmuni, Hussin, Khalili, & Zain, 2015; Homonoff et al., 2022). For example, studies report short-run reductions in bag usage ranging from 40% to 80% following taxes of $0.05 to $0.10 (Cabrera, Caffera, & Cid, 2021; Homonoff, 2018). However, evidence on long-term effects is mixed: Dikgang, Leiman, and Visser (2012) found that the sharp decline in bag usage in South Africa was not sustained, whereas Ireland's plastic bag tax resulted in a lasting reduction (Convery et al., 2007). Our study leverages a unique setting in which the tax was both introduced and later repealed, allowing us to study long-term consequences of taxation and identify potential shifts in consumption patterns that are not solely driven by price changes.

Our findings also contribute to the literature on habit formation and behavioral change. Previous research has examined how behavior, such as smoking, soft drinks, alcohol consumption, or gym attendance, changes over time, often when taxes or prices change. Previous research shows that while immediate price increases of alcohol and soda effectively reduce consumption, long-term behavior changes are often slower and may require ongoing policy interventions to sustain reduced consumption (Bíró, 2015; J. M. Fletcher, Frisvold, & Tefft, 2015; Gehrsitz, Saffer, & Grossman, 2021; Griffith, O'Connell, & Smith, 2019; Powell & Leider, 2020). Similarly, research on tobacco taxes suggests that consumption habits can be shaped over time, with some populations showing more resilience to price increases than others (Chaloupka, 2000). Notably, we are unaware of studies that examine whether environmental taxes, such as those on plastic products, can induce lasting changes in consumption patterns. This distinction is important because, unlike 'sin goods,' which generate externalities but are also directly harmful to the individual who consumes the good, environmental impacts are almost exclusively externalities. Thus, our paper provides novel insights into the lasting impact of tax policy on the consumption of plastic products, particularly among consumers who belong to higher socioeconomic groups.

2 Data and Descriptive Statistics

Our dataset was obtained from *StoreNext*, a private company specializing in the collection and analysis of supermarket checkout data in Israel. *StoreNext* has access to over 2,600 points of sale, capturing more than 80% of real-time sales data in the Israeli consumer market.

The sample we received covers 1,475 stores and 4,997 distinct products sold from 2019 to 2023, resulting in approximately 6.84 million observations.[7] The dataset is structured

[7]To prevent identification of specific stores or chains, *StoreNext* excludes some stores from the sample. The raw data initially contained 9.23 million observations. We excluded observations with missing data or negative revenue values. Negative revenue may result from a high volume of returned products. We also exclude food items (e.g., butter) and hygiene products.

such that each observation represents the sales of a specific product (identified by a barcode) in a given month at a specific store. It includes monthly information on the number of items sold, total revenues from each product, and the store and month of the transaction. Additionally, the data contains store-level characteristics, such as store type (e.g., discount store, convenience store, grocery store, etc.) and the socioeconomic status of the store's locality, classified as low, medium, or high.[8] We also have detailed product information, such as category (e.g., single-use tableware items, napkins, aluminum foil), subcategory (e.g., single-use plates, premium napkins, narrow aluminum foil), brand, supplier, and the number of units per package.

We examine two outcome variables: sales and price. To obtain the sales variable, we calculate the total number of units sold by multiplying the number of items (packages) sold in each store and month by the number of units per package. To obtain the price variable, we derive the price per unit by dividing the total revenue by the total number of units sold.

The treatment group comprises all products subject to the tax, totaling 3,555 unique products (barcodes) and approximately 3.62 million observations. While the law clearly defines which products are taxed, the *StoreNext* data does not explicitly identify them. To address this, we relied on product characteristics—specifically, category and name—to distinguish between single-use tableware products affected by the tax and those that are not. Products not subject to the tax, such as those made of wood, bamboo or biodegradable plastic, were excluded from the analysis as they serve as direct substitutes for the taxed items.[9] Overall, the treatment group comprises single-use plastic tableware items affected by the tax regulation, including cups, plates, bowls, straws, and cutlery.

Identifying a suitable control group requires careful consideration to ensure that it follows

[8]The socioeconomic status of the store's location is based on data from the Central Bureau of Statistics, which defines 10 socioeconomic clusters by geographic location. In our data, low corresponds to clusters 1–3, medium to clusters 4–7, and high to clusters 8–10.

[9]Out of approximately 3.75 million observations in the single-use tableware category, we excluded about 128,000 observations corresponding to non-taxed products.

similar trends to the treatment group during the pre-treatment period while remaining unaffected by the intervention. To this end, we include in the control group disposable products used for food preparation and storage, rather than products intended for food consumption. To address potential concerns about indirect effects that could distort the results, we excluded single-use tableware items made from biodegradable plastic or non-plastic materials, such as bamboo or palm leaves, which could serve as substitutes for the treated plastic products. Thus, the control group includes approximately 3.21 million observations, representing 1,442 products from related disposable food supplies categories, such as cling film, disposable tablecloths, aluminum foil, and baking accessories (e.g., baking molds, roasting bags, and baking paper), which were not subject to the tax.

FIGURE 1

Figure 1 presents the average unit price and monthly unit sales for treatment and control group products over the sample period. The figure shows that, before the tax was imposed, the sales and price patterns in the control group closely mirror those of the treatment group, with both exhibiting seasonal demand variations. This strong correlation suggests that the control group is a reliable basis for comparison, supporting our estimation strategy and the validity of the parallel trends assumption.

After the tax was implemented, the pricing and sales patterns of the treatment and control groups diverged. As shown in Figure 1a, the average price of treatment group products increased by 45% following the tax. When the tax was repealed, prices remained 17% higher than their pre-tax levels and continued to exceed those of the control group products, which remained relatively stable throughout the sample period. Figure 1b illustrates a sharp decline of nearly 35% in the sales of treatment group products immediately after the tax was implemented, a trend which persisted until the repealed. During the post-tax period, sales recovered but remained 6% below pre-tax levels, even after the repeal. The figure also

shows a spike in sales of treatment group products just *before* the tax was enacted, likely attributed to stockpiling.[10]

The observed patterns are consistent across socioeconomic status of the store's location. *StoreNext* classifies each store's socioeconomic status based on its location and data from the Central Bureau of Statistics, which defines 10 socioeconomic clusters by geographic location. *StoreNext* use these clusters to define three groups: low (clusters 1–3), medium (clusters 4–7), and high (clusters 8–10).

Table 1 provides description of the data by socio-economics groups. The table reveals that 22% of observations (and 18% of stores) are from the low socioeconomic group, 50% of observations (and 50% of stores) from the medium socioeconomic group, and 28% from the high socioeconomic group.

TABLE 1

Table 1 further presents the average price per unit before, during, and after the tax for the treatment products (Panel B) and the control products (Panel C). During the tax period, the price increase among treatment products was largest in the low socioeconomic group, followed by the medium group, and smallest in the high group. Following the tax repeal, prices declined across all socioeconomic groups; however, the relative price differences between groups persisted. For the control products, prices remained stable across time periods and socioeconomic groups, validating our research design.

3 Estimation and Results

We implement a dynamic difference-in-differences (DiD) framework to estimate the impact of the tax and its repeal on prices and sales. We compare changes in the prices and sales

[10] Appendix Table A1 presents the patterns depicted in Figure 1 for prices and sales quantities, using average percentages for the pre-tax, during-tax, and post-tax periods.

of treated and control products following the tax introduction and its subsequent repeal, relative to their pre-tax period. Specifically, we estimate the following model:

$$\ln(y_{ist}) = \sum_{\tau=t;\tau\neq t_0}^{T} \beta_\tau \cdot T_i \cdot \delta_t + \eta_s + \gamma_i + \delta_t + \epsilon_{is\tau}, \tag{1}$$

where T_i is a binary variable equal to 1 for observations in the treatment group and 0 for those in the control group. The dependent variable $y_{it\tau}$, represents either the unit price, $\ln(unit\ price_{ist})$, or the number of units sold, $\ln(units\ sold_{ist})$, for product i in store s during month t. The terms η_s, γ_i, and δ_t represent fixed effects for store, product, and month, respectively. These fixed effects control for systematic variations associated with specific stores, product characteristics, and seasonal fluctuations, thereby mitigating confounding factors such as general market trends, changes in consumer behavior, and geographical differences across market.

The main parameters of interest are the β_τs coefficients, which capture the effect of the tax in month t on the treatment group relative to the control group, compared to the baseline period, t_0, defined as July 2021. A positive (negative) β_τ during the tax regime indicates an increase (decrease) in the average price (sales) of single-use plastic tableware items compared to control products, relative to July 2021. Similarly, a positive (negative) β_τ following the tax repeal suggests that prices (sales) remained higher (lower) compared to the pre-tax period. The months following the tax repeal are particularly interesting, as they provide insight into whether the tax induced lasting changes in consumption habits. We explore this aspect in Section 3.2.

The β_τs coefficients also allow us to validate our identification strategy. Specifically, we expect β_τ to be close to zero before the tax regime, indicating no significant differences in price or sales between single-use plastic items and control products relative to the baseline period. As will be shown in the next section, examining the coefficients for the months prior

to the tax imposition ($\tau < t_{Tax}$) confirms this expectation.

FIGURE 2

3.1 The Effects of the Tax on Price and Sales

Figure 2 presents the coefficients estimated using Eq. (1), along with their confidence intervals, capturing the monthly impact of the tax on prices and sales for both the treatment and the control group over time.

Figure 2a shows that prices for treatment group products increased by approximately 45% immediately after tax was implemented and remained stable throughout the period it was in effect. Following the tax repeal, prices gradually declined rather than dropping sharply, likely due to the inventory products being subject to the tax. By December 2023, the price gap had narrowed to around 11%. Correspondingly, Figure 2b shows a sharp drop in sales of over 40% relative to the control group, which later moderated to around 20%-30%. The initial 40% decline in sales near the tax's effective date may be attributed to stockpiling in anticipation of the tax. Presumably, as households' pre-tax inventory was depleted, sales gradually began to recover. Following the tax repeal, prices remained above pre-tax levels, and while sales increased relative to the tax period, they remained below pre-tax levels.

Figure (2) also shows a strong alignment in the price and sales patterns between the treatment and control groups before the tax was imposed, supporting the parallel trends assumption and strengthening our research strategy.

FIGURE 3

To explore the heterogeneous responses to the tax, we estimated Eq. (1) separately for each socioeconomic group: low, medium, and high. Fig. 3 shows the monthly impact of the tax and repeal on price levels and sales across socioeconomic groups. The figure reveals that the price and sales trends were very similar across groups in the pre-tax period.

A closer examination of the tax's impact on prices, shown in Fig. 3a, reveals an inverse relationship between socioeconomic status and the magnitude of the price increase: the lower the socioeconomic status, the greater the price increase. Specifically, average prices rose by 48% in the low socioeconomic group, compared to 45% and 43% in the medium and high socioeconomic groups, respectively. This price gap persisted throughout the tax period until its repeal. Following the repeal, prices in the low group decreased at a slightly faster rate, leading to price convergence across all groups, ultimately stabilizing at an average of 18% *higher* than pre-tax levels.

The impact of the tax on sales of single-use plastic products is shown in Fig. 3b. The initial effect of the tax was more pronounced in the low socioeconomic group, with a sharper decline in sales compared to the medium and high groups. However, as shown in the figure, sales in the low socioeconomic group began to recover within a few months of the tax's introduction. The average sales change over the entire period further illustrates the inverse relationship between socioeconomic status and the magnitude of the tax impact: during the tax period, sales in the low socioeconomic group decreased by an average of 34%, compared to 25% in the medium group and 16% in the high group. Given that price increases were roughly similar across groups, these patterns suggest that price sensitivity increases as socioeconomic status decreases.

Media coverage before the introduction of the tax highlighted stockpiling effects, particularly in the low socioeconomic group, with a focus on the ultra-Orthodox community. The argument was that, in anticipation of the upcoming tax, consumers were purchasing larger quantities of products that would soon be taxed. Indeed, Fig. 3b shows a spike in sales of taxed products in the low socioeconomic group in October 2021, just before the tax took effect, followed by a sharp decline immediately after its implementation, in contrast to the control group. Appendix Table A2 shows that the results hold when excluding the two months before and after the tax was imposed, mitigating these concerns.

Fig. 3b also shows that sales in all groups recovered in the post-tax period. Interestingly, despite prices remaining 18% above pre-tax levels across all groups, the extent of the sales decline varied by socioeconomic status. In the low socioeconomic group, sales were 23% below pre-tax levels, compared to a 19% in the medium group and a 16% in the high group. These differences raise the question of whether the tax induced a change in habitual consumption patterns that was successfully embedded in one group but not in the others. The following section explores this question.

3.2 Shaping Consumption Patterns

The setting of imposing and repealing the tax provides an opportunity to study consumption behavior and habit formation after the tax was lifted. As shown in Figure 2b, after the tax repeal, sales remained below pre-tax levels. However, this evidence alone is insufficient to indicate a change in consumption habits, as sustained higher prices (see Figure 2a) can also explain the reduction in sales.

In this section we aim to capture sales patterns that extend beyond price effects alone. Specifically, to disentangle the two factors, we estimate the following demand equation:

$$\begin{aligned}\ln(\textit{units sold}_{ist}) =& \eta \ln(\textit{unit price}_{ist}) + \beta_1 \times \textit{Period1}_t \times T_i + \beta_2 \times \textit{Period2}_t \times T_i \\ &+ \lambda_s + \gamma_i + \delta_t + \epsilon_{ist},\end{aligned} \tag{2}$$

where the dependent variable represents the number of units sold for product i in store s during month t. The variable $\textit{Period1}_t$ represents the time periods during the tax period, while $\textit{Period2}_t$ denotes the time after the tax was repealed. All other variables are as specified in Eq.(1). However, unlike Eq.(1), this specification controls for price. Since the price in store s is likely endogenous due to the simultaneous relationship between price and quantity, Eq. (2) cannot be estimated directly. To overcome the endogeneity problem, we adopt an

instrumental variable (IV) approach. Specifically, we instrument the price, $\ln\left(unit\ price_{ist}\right)$, with the average price of product i in month t across all stores other than store s, denoted as $\ln(unit\ price_{i(-s)t})$.

The underlying assumption is that the average price in other stores (-s), is correlated with the price in store s, but does not directly affect the number of units sold in store s.[11] This assumption is supported by the wide geographical dispersion of the stores and the fact that demand is relatively localized. Indeed, the first-stage analysis, which examines the relationship between $\ln(unit\ price_{ist})$ and $\ln(unit\ price_{i(-s)t})$, shows a high correlation between the average price in other stores and the price in store s.[12]

The main coefficient of interest in Eq. (2) is β_2, which arguably captures a change in consumption patterns in the post-repeal period compared to the pre-tax period. If the decline in sales after the repeal is solely driven by price changes, we would expect β_2, to be close to zero. Conversely, an economically and statistically significant β_2 suggests a change in consumption patterns after the repeal, beyond the impact of the price.

Table 2 presents the IV estimates of Eq. (2). The analysis for the entire sample, shown in Column (1), reveals a 3% reduction in sales compared to the pre-tax period, even after accounting for price effects. This finding suggests that the decrease in single-use plastic sales following the repeal is not only a response to higher prices but also a reflection of a shift in consumption habits, suggesting a lasting behavioral impact of the tax. As the overall post-repeal drop in sales is 19%, we can claim that the change in consumption patterns (3%) accounts for about 15% of the total change.

TABLE 2

[11] In a separate analysis, we use the average price across different store types as an instrument. The results are qualitatively similar.

[12] Appendix Figure B1 shows a scatter plot of the balance and reduced form relationships, residualizing by baseline controls. The balance coefficient is insignificant, while the effect on $log(sales)$ is large and significant. The first stage coefficients and the F-stat also appear on this figure. All estimates indicate that the IV is suitable for the analysis.

In Columns (2), (3), and (4), we present group-specific analyses for the low, medium and high socioeconomic groups, respectively. The estimates suggest that the change in consumption habits occurred in the medium and high groups, where sales declined by 4% beyond the impact of price increases in both groups. This reduction accounts for a quarter of the total sales decline observed in the high socioeconomic group and a fifth of the decrease in the medium group. In contrast, in the low socioeconomic group, no such change is observed, and the entire sales reduction following the tax repeal can be attributed to the price increase.

The table also reports the estimated coefficients for $\ln(unit\ price_{ist})$, which capture the price elasticity of demand across the different subsamples. Consistent with our previous results, the estimates show that price elasticity increases as socioeconomic status decreases. In the high socioeconomic group, a 1% increase in price leads to an average decrease of 0.67% in sales, while in the medium group, a 1% price increase results in a 0.85% decrease in sales. At the same time, the same price increase leads to a 1.26% reduction in sales in the low socioeconomic group, indicating that consumers in the low group exhibit significantly higher price sensitivity to the price of single-use plastic products.

4 Concluding Remarks

This study examines the effects of introducing and subsequently repealing an excise tax on single-use plastic tableware products. Our findings demonstrate that the tax significantly affected both prices and sales. During the tax period, the prices of taxed products increased by an average of 45%, and sales declined by 24%. Using the most recent data available on total plastic consumption in Israel for 2020, we estimate that this reduction corresponds to a savings of over 16 tons of plastic per year. These results suggest that taxing single-use plastics can be an effective strategy for reducing plastic consumption.

The tax repeal offers a unique opportunity to examine long-term behavioral changes in

consumption. We find that following the repeal, prices remained elevated compared to pre-tax levels, while sales increased relative to the tax period but remained 19% lower than their pre-tax levels. When we decompose the sales reduction into a price and a behavioral change, we find that about 15% of the change in sales can be attributed to a change in consumption patterns, whereas 85% is likely driven by the higher post-repeal price.

Our analysis also reveals significant socioeconomic differences in behavioral responses, with the magnitude of behavioral change increasing with socioeconomic status. Among individuals in the high socioeconomic group, the tax led to a substantial shift in consumption, with 25% of the post-repeal sales reduction attributed to behavioral changes rather than solely to higher prices. In the medium socioeconomic group, 21% of the post-repeal sales reduction can similarly be attributed to behavioral changes. In contrast, for the low socioeconomic group, which exhibits greater price sensitivity, we find no evidence of behavioral change. Instead, the entire post-repeal reduction in sales is fully explained by the persistence of higher prices. These findings align with previous studies suggesting that awareness of environmental risks among the ultra-Orthodox population, who comprise the majority of the low socioeconomic group, is relatively low (Feldman, 2024).

This study offers valuable insights into the potential benefits of taxation as a tool for shaping consumption behavior patterns and raises important questions for further exploration. Disentangling behavioral responses from price effects is critical for policymakers, as it provides key insights into the effectiveness and implications of behavior-oriented taxes, which are widely implemented worldwide—such as the commonly used "sin taxes" on alcohol, tobacco, and sugary drinks. Our findings contribute to this discussion by emphasizing the relationship between habit formation tendencies and price sensitivity. Future research could expand on these results, further exploring this connection.

Additionally, while our analysis highlights the potential of taxes to influence behavior, it also underscores the need for a deeper understanding of their long-term impact. For

instance, could extending the duration of the tax amplify its effects on behavioral change? Furthermore, how might a prolonged tax impact price-sensitive consumers, such as those in the low socioeconomic group—a key consumer group of single-use plastic items—where no significant behavioral shifts were observed? Addressing these questions could further inform the design of effective, targeted policies aimed at reducing the use of environmentally harmful products and fostering sustainable consumption habits.

References

Abate, T. G., & Elofsson, K. (2024). Environmental taxation of plastic bags and substitutes: Balancing marine pollution and climate change. *Journal of Environmental Management*, *359*, 120868.

Allcott, H., Lockwood, B. B., & Taubinsky, D. (2019). Regressive sin taxes, with an application to the optimal soda tax. *The Quarterly Journal of Economics*, *134*(3), 1557–1626.

Asmuni, S., Hussin, N. B., Khalili, J. M., & Zain, Z. M. (2015). Public participation and effectiveness of the no plastic bag day program in malaysia. *Procedia-Social and Behavioral Sciences*, *168*, 328–340.

Bíró, A. (2015). Did the junk food tax make the hungarians eat healthier? *Food Policy*, *54*, 107–115.

Cabrera, J. M., Caffera, M., & Cid, A. (2021). Modest and incomplete incentives may work: Pricing plastic bags in uruguay. *Journal of Environmental Economics and Management*, *110*, 102525.

Chaloupka, F. (2000). The economics of smoking. *Handbook of Health Economics*.

Convery, F., McDonnell, S., & Ferreira, S. (2007). The most popular tax in europe? lessons from the irish plastic bags levy. *Environmental and Resource Economics*, *38*, 1–11.

Dikgang, J., Leiman, A., & Visser, M. (2012). Elasticity of demand, price and time: lessons from south africa's plastic-bag levy. *Applied Economics*, *44*(26), 3339–3342.

Eliyahu, E. (2021). Taxation on single-use plastic utensils. *Knesset - Research and Information Center*.

Feldman, S. U. P. I. K. Y. K. P. R. A.-N. D., Y. (2024). Barriers to pro-environmental behavior and the effectiveness of behavioral interventions. *Israel Democracy Institute*.

Fletcher, March, A. L. A., Roberts, K., Shirian, Y., i Canals, L. M., Cairns, A., ... others (2023). *Turning off the tap: How the world can end plastic pollution and create a circular economy*. United Nations Environment Programme.

Fletcher, J. M., Frisvold, D. E., & Tefft, N. (2015). Non-linear effects of soda taxes on consumption and weight outcomes. *Health Economics*, *24*(5), 566–582.

Gehrsitz, M., Saffer, H., & Grossman, M. (2021). The effect of changes in alcohol tax differentials on alcohol consumption. *Journal of Public Economics*, *204*, 104520.

Geyer, R., Jambeck, J. R., & Law, K. L. (2017). Production, use, and fate of all plastics ever made. *Science advances*, *3*(7), e1700782.

Griffith, R., O'Connell, M., & Smith, K. (2019). Tax design in the alcohol market. *Journal of Public Economics*, *172*, 20–35.

Herberz, T., Barlow, C. Y., & Finkbeiner, M. (2020). Sustainability assessment of a single-use plastics ban. *Sustainability*, *12*(9), 3746.

Homonoff, T. (2018). Can small incentives have large effects? the impact of taxes versus bonuses on disposable bag use. *American Economic Journal: Economic Policy*, *10*(4), 177–210.

Homonoff, T., Kao, L.-S., Selman, J., & Seybolt, C. (2022). Skipping the bag: the intended and unintended consequences of disposable bag regulation. *Journal of Policy Analysis and Management*, *41*(1), 226–251.

Kantar. (2020). *Plastic consumption in israel.* Retrieved from https://www.gov.il/BlobFolder/reports/consumption_of_disposable_utensils/he/news_files_2021_consumption-of-disposable-utensils.pdf (Accessed: 2024-12-08)

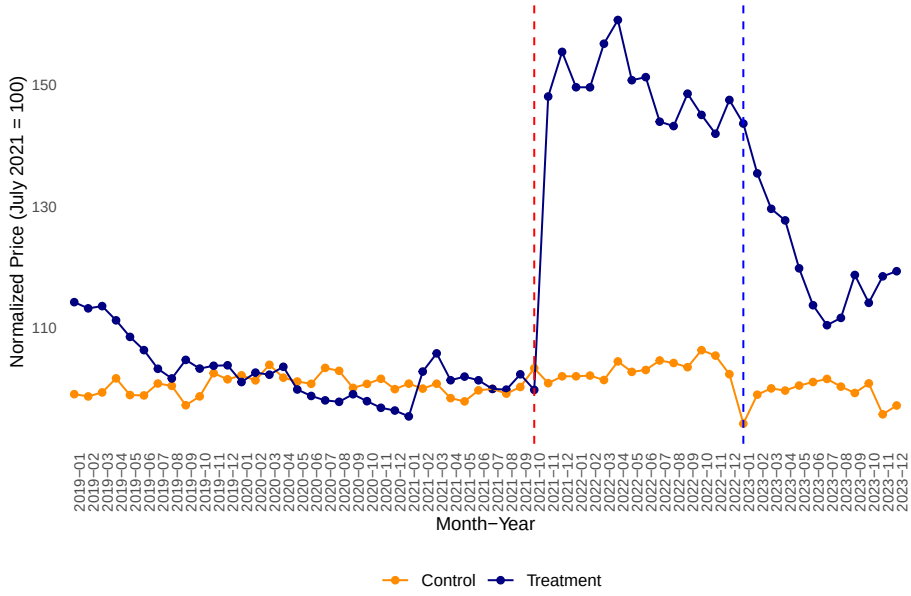
Landrigan, P. J., Raps, H., Cropper, M., Bald, C., Brunner, M., Canonizado, E. M., ... others (2023). The minderoo-monaco commission on plastics and human health. *Annals of Global Health*, *89*(1).

Nielsen, T. D., Hasselbalch, J., Holmberg, K., & Stripple, J. (2020). Politics and the plastic crisis: A review throughout the plastic life cycle. *Wiley Interdisciplinary Reviews: Energy and Environment*, *9*(1), e360.

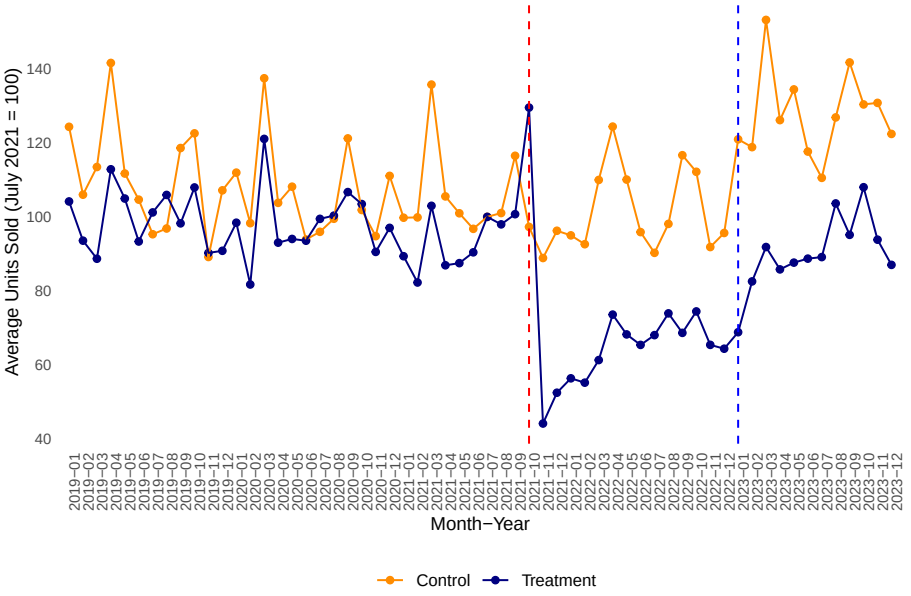
O'Connell, M., & Smith, K. (2024). Optimal sin taxation and market power. *American Economic Journal: Applied Economics*, *16*(4), 34–70.

Powell, L. M., & Leider, J. (2020). Evaluation of changes in beverage prices and volume sold following the implementation and repeal of a sweetened beverage tax in cook county, illinois. *JAMA network open*, *3*(12), e2031083–e2031083.

Figures



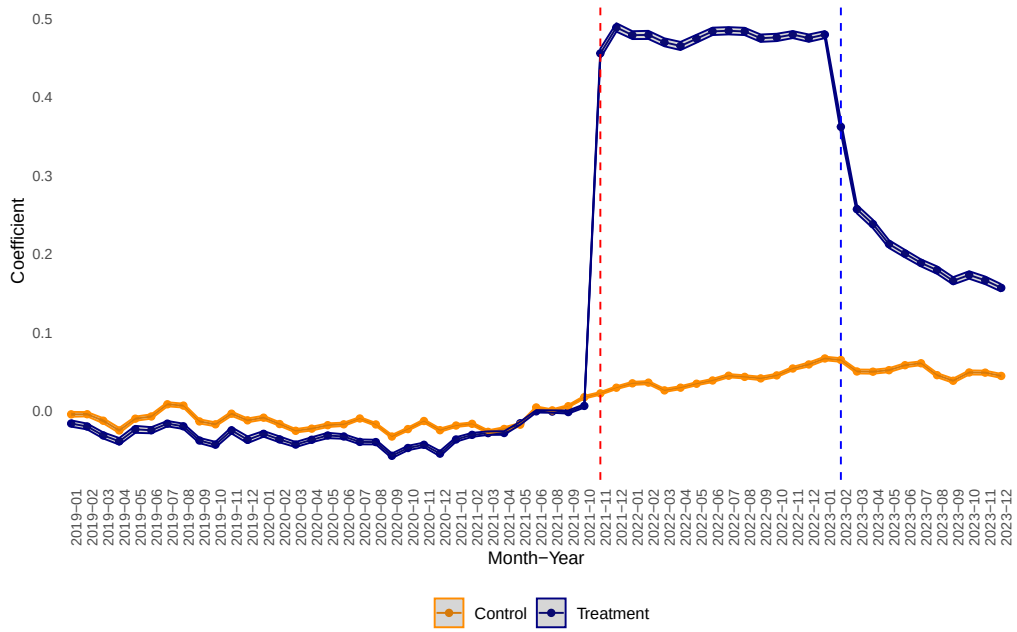
(a) Prices



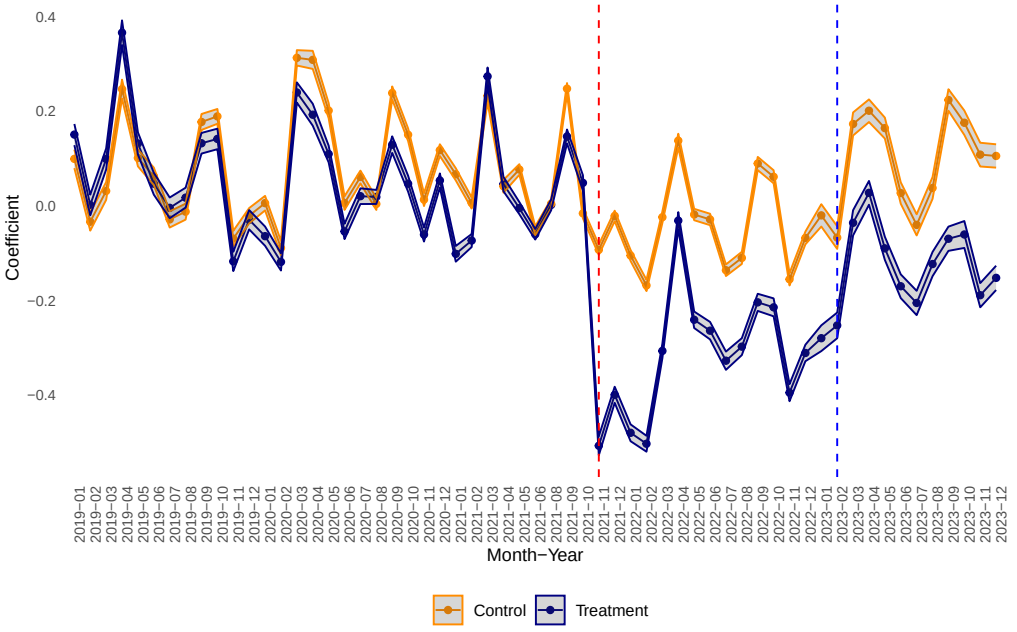
(b) Sales

Figure 1: Average price and sales of single-use plastic tableware products (treatment group) and of non-taxed products (control group) over time

Notes: The average price and sales (number of units) for each group are normalized to 100 in July 2021.



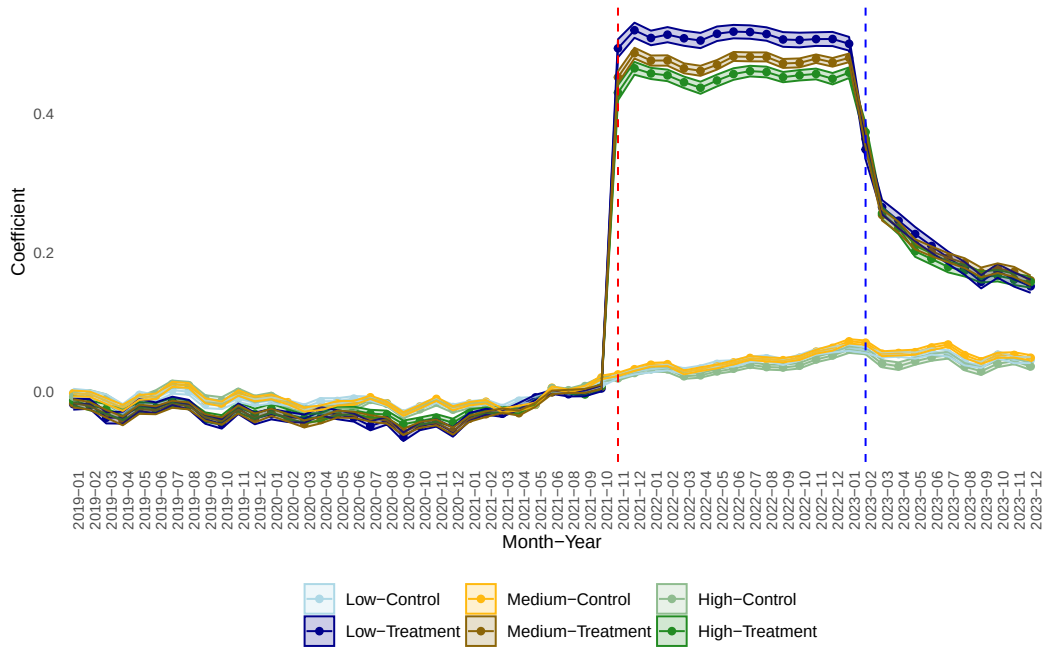
(a) Prices



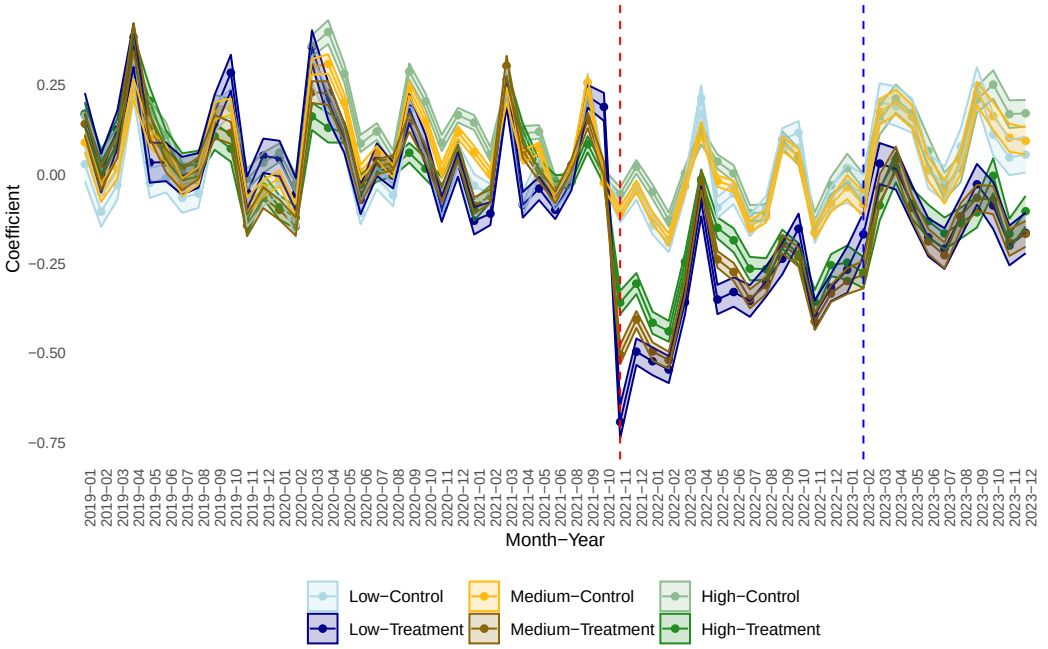
(b) Sales

Figure 2: The Impact of the Tax on Prices and Sales of Single-Use Plastic Products Over Time.

Notes: The figures show the evolution of the coefficients of the average price and sales of products in the treatment and control products, before, during the tax period and after it was repealed, as estimated using Eq. 1. The results compare trends for taxed disposable plastic tableware products (treatment group) to untaxed products (control group) over the sample period.



(a) Prices



(b) Sales

Figure 3: The Impact of the Tax on Prices and Sales of Single-Use Plastic Products Across Socioeconomic Groups Over Time.

Notes: See notes of Fig. 2.

Tables

Table 1: Number of Observations, Stores, and Average Price by Socioeconomic Group.

	Socioeconomic Group			
	Low	Medium	High	All
Panel A: General Information				
Number of Observations	1,487,981	3,444,796	1,903,219	6,835,996
Percentage of Total Observations	22%	50%	28%	100%
Number of Stores	271	733	471	1,475
Percentage of Total Stores	18%	50%	32%	100%
Panel B: Treatment Products				
Average Price per Unit				
Before Tax	0.53	0.59	0.54	0.56
Tax Period	0.83	0.85	0.75	0.82
After Tax Repeal	0.66	0.69	0.60	0.66
Panel C: Control Products				
Average Price per Unit				
Before Tax	7.81	7.58	7.58	7.63
Tax Period	7.87	7.81	7.69	7.79
After Tax Repeal	7.75	7.54	7.42	7.55

Note: The price per unit was calculated at the product, store, and month level.

Table 2: The Impact of the Tax and Its Repeal on Price and Sales Using an IV Model.

	Dependent Variable: *ln(unit sold)*			
	(1)	(2)	(3)	(4)
	Full Sample	Low	Medium	High
ln(price)	-0.92***	-1.26***	-0.85***	-0.67***
	(0.02)	(0.04)	(0.02)	(0.02)
$T_i \times Period1$ (β_1)	0.17***	0.27***	0.14***	0.13***
	(0.01)	(0.02)	(0.01)	(0.01)
$T_i \times Period2$ (β_2)	-0.03***	-0.00	-0.04***	-0.04**
	(0.01)	(0.01)	(0.01)	(0.01)
Store FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes
Month and Year FE	Yes	Yes	Yes	Yes
N	6,814,518	1,482,117	3,433,924	1,898,477
Adj. R^2	0.83	0.83	0.84	0.83

Notes: The table reports estimates from the IV model in Eq.(2), presented in Section 3.2. The binary variable T_i equals 1 for treatment group products and 0 for control group products. $Period1$ denotes the period when the tax was in effect, while $Period2$ refers to the period after its repeal. $^{**}p < 0.05, ^{***}p < 0.01$.

A Single-use plastic products in Israel

The use of single-use plastic products has substantially increased waste volumes over the years, and plastic waste significantly pollutes oceans and open spaces. Specifically, single-use plastic accounts for 19% of public waste volume and approximately 90% of the pollution along Israel's beaches and sea. Plastic waste not only causes environmental damage but also has notable health impacts. Before decomposing, much of it breaks down into microplastics, polluting the environment. This situation harms ecosystems and poses severe public health risks due to exposure to microplastic particles dispersed in water and soil. Beyond these damages, the plastic production process itself is highly polluting, as it is primarily oil-based and emits vast amounts of greenhouse gases. In recent years, as awareness of the harm caused by single-use plastics has grown, a global trend toward regulatory policies to reduce plastic consumption has emerged to lessen the environmental impact associated with these products.

In Israel, the consumption of single-use plastic products is widespread. Estimates suggest that average per capita consumption is five times higher than the EU average (Eliyahu, 2021). According to a report by Kantar for the Ministry of Environmental Protection (Kantar, 2020), single-use plastic consumption in Israel doubled between 2010 and 2020, with household expenditure on these products amounting to approximately 1.3 billion NIS annually as of 2020. The report indicates that single-use plastic is used daily across all population sectors, underscoring that convenience often outweighs environmental and health considerations or that the public may lack awareness of the damages associated with single-use plastics. Additionally, single-use plastic prices do not reflect their significant external costs, supporting the argument for regulatory interventions like taxes to internalize these costs and curb consumption.

B Static Difference-in-Difference Model

B.1 Econometric Strategy

$$\ln(y_{ist}) = \beta_1 \times \text{Period1}_t \times T_i + \beta_2 \times \text{Period2}_t \times T_i + \eta_s + \gamma_i + \delta_t + \epsilon_{ist} \tag{3}$$

The variable *Period1* is a binary variable taking the value 1 for observations between November 2021 (the month the tax was implemented) and January 2023 (the last month the tax was in effect), and 0 otherwise. *Period2* takes the value 1 for observations from February 2023 (when the tax was repealed) to December 2023, and 0 for other periods.

The terms η_s, γ_i, and δ_t represent fixed effects for store, product, and month, respectively, which control for time-based variations in prices and consumption arising from differences across products and stores. The coefficients β_1 and β_2 on the interaction of *Period1* and *Period2* with *Treatment* are of primary interest, as they measure the impact of the tax implementation and repeal, respectively. In both cases, the estimates are relative to the baseline period, i.e., the period before the tax implementation.

B.2 Results

Table A2 presents the results from estimating Eq. 1, which examines the effect of the tax and its repeal on price levels and consumption volumes of single-use plastic items. Column (1) shows the impact on prices, while Column (2) displays the impact on consumption volumes. According to this table, during the period when the tax was in effect (*Period1*), the average price of products in the treatment group increased by approximately 45% compared to the prices of products in the control group. Simultaneously, during this period, consumption of products in the treatment group declined by about 24% relative to the control group. Additionally, the table indicates that in the period following the tax repeal (*Period2*), the average price remained about 18% higher than in the pre-tax period, while

average consumption volumes remained about 19% lower compared to the period before the tax imposition.

Analysis by Socioeconomic Status. We examined the impact of the tax imposition and repeal on price levels and sales volumes of single-use plastic products across socioeconomic groups by implementing Eq.3 separately for the low, medium and high socioeconomic groups. The results are presented in Table A3.

The results in Table A3 indicate that during the period when the tax was in effect (*Period1*), the average price increase relative to control group prices was about 48% in the in the low socioeconomic group, 45% in the medium group, and 43% in the high group.. During the period following the tax repeal (*Period2*), price levels remained 18% higher than in the pre-tax period across all groups. While price changes were relatively similar across socioeconomic groups, consumption responses varied, with lower-income consumers displaying greater sensitivity to price changes. Specifically, during the tax period, consumption in the low socioeconomic group decreased by approximately 34%, compared to a 25% decrease in the medium group and a 16% decrease in the high group.

C Appendix Tables

Table A1: Average Price per Unit and Average Number of Units Sold by Periods.

Panel A.	Average Price per Unit		
	Before Tax	Tax Period	After Tax Repeal
Treatment Group	0.56	0.82	0.66
Percentage Change Relative to Pre-Tax Period		45.4%	17.0%
Control Group	7.63	7.79	7.55
Percentage Change Relative to Pre-Tax Period		3.0%	-0.2%
Panel B.	Average Number of Units Sold		
	Before Tax	Tax Period	After Tax Repeal
Treatment Group	5,467.84	3,569.76	5,123.42
Percentage Change Relative to Pre-Tax Period		-34.7%	-6.3%
Control Group	730.09	694.94	870.90
Percentage Change Relative to Pre-Tax Period		-4.8%	19.3%

Note: The price per unit and the number of units sold were calculated at the product, store, and month level.

Table A2: The Effect of Tax Introduction and Repeal on Price Levels and Sales Volumes

	Dependent Variable:			
	ln(price)		ln(units sold)	
	(1)	(2)	(3)	(4)
	Full	Stockpiling	Full	Stockpiling
$T \times$ Period 1	0.45***	0.45***	-0.24***	-0.22***
	(0.002)	(0.002)	(0.01)	(0.01)
$T \times$ Period 2	0.18***	0.15***	-0.19***	-0.19***
	(0.002)	(0.002)	(0.01)	(0.01)
Store FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes
Month and Year FE	Yes	Yes	Yes	Yes
N	6,835,996	5,954,494	6,835,996	5,954,494
R^2	0.99	0.99	0.82	0.82

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Standard errors are clustered at the store level. The Stockpiling sample excludes the two months before and after both the tax imposition (November 2021) and the tax repeal (February 2023).

Table A3: The impact of the implementation and repeal of the tax on price levels and consumption volumes by socioeconomic status

	Dependent Variable					
	ln(price)			*ln(units sold)*		
	(1)	(2)	(3)	(4)	(5)	(6)
Socioeconomic Status	Low	Medium	High	Low	Medium	High
$T \times$ Period 1	0.48***	0.45***	0.43***	-0.34***	-0.25***	-0.16***
	(0.00)	(0.00)	(0.00)	(0.02)	(0.01)	(0.01)
$T \times$ Period 2	0.18***	0.17***	0.18***	-0.23***	-0.19***	-0.16***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
Store FE	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Month and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	1,487,981	3,444,796	1,903,219	1,487,981	3,444,796	1,903,219
Adj R^2	0.99	0.99	0.99	0.82	0.83	0.83

D Appendix Figures

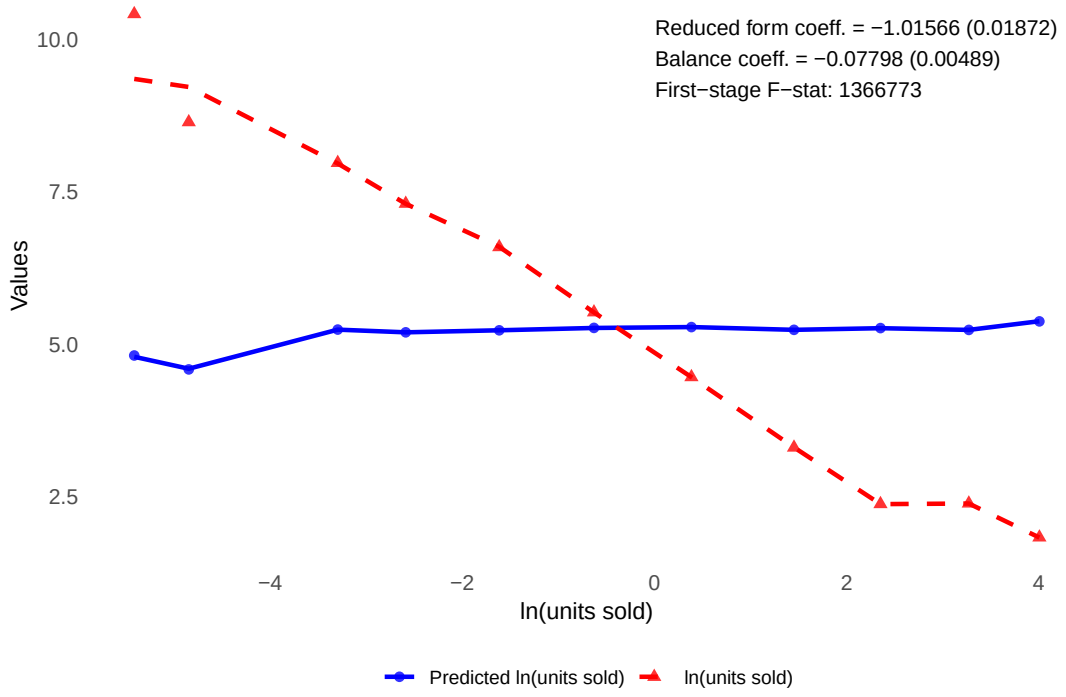


Figure B1: Instrument Validity and Balance Test

Notes: The solid blue line represents the balance regression, while the dashed red line represents the reduced-form regression