THE IMPACT OF A SODA TAX ON AGGREGATE CONSUMER BEHAVIOR

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Executive Doctorate of Business Administration

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by
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ABSTRACT

In January of 2017, Philadelphia became the second American jurisdiction to implement a targeted “soda tax”, which added a new tax of 1.5 cents per ounce to sweetened beverages. Revenue from the tax was intended to be used for pre-k education and the rebuilding of parks and recreation centers (Terruso, 2017). As obesity in the United States and around the world continues to be of concern, leaders from across disciplines will be looking to find out if and how consumers change behavior as a result of such taxes. Many communities across the US are currently considering or in the process of implementing adding a similar tax yet existing research is limited and finds conflicting results. The following paper demonstrates the impact of the tax in two different ways. First, transactional data from a convenience store chain was used to review beverage transactional sales before and after the tax. Sales were recorded in Philadelphia, stores immediately outside the border, and remaining stores in the geographical area. Secondly, purchase behavior of consumers in the Philadelphia market before and after the soda tax was implemented was analyzed. This allowed the ability to understand the geographic buying patterns of individuals before and after the tax, as well as any demographic differences in the behavior change. These two studies provide a deeper look into the soda tax impact than exists in the current literature due to the number of locations captured, duration of studies, and consumer-level transactional data.

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CHAPTER 1. INTRODUCTION

Sugar sweetened beverages (SSB) are a popular choice among consumers, with US carbonated soft drinks reaching over 36 billion in sales in 2016 (Mintel, 2017). A number of research studies demonstrate the health risks of consuming drinks formulated with sugar, including obesity and diabetes (e.g., Ludwig, Peterson, & Gortmaker, 2001; Schulze, M. B., et al., 2004).

Around the world, policy makers are considering and implementing taxes specifically aimed at SSB's. Some focus on the health benefits of reducing SSB consumption, while others highlight the resulting revenue that would be raised for local (often health-related) causes. Berkeley, California became the first jurisdiction in the US to launch a targeted SSB tax, beginning the tax in March 2015. During 2016 SSB taxation progressed, with Philadelphia, PA, Boulder, CO, three California cities (San Francisco, Oakland and Albany) and Cook County, Illinois passing similar measures. Other countries with SSB taxes in place include France, Hungary, Ireland, the U.K., and Mexico.

As more and more communities consider and implement the SSB tax, multiple disciplines can benefit from gaining a greater understanding of the impact. Marketers can utilize the research to project sales, and make pricing, inventory, and shelf management decisions for geographies with an upcoming tax. Data will be valuable to the healthcare industry, as a further way to understand the caloric results and impact to health conditions (i.e., obesity and diabetes). Policy makers can better understand the impact to consumption and revenue to inform taxing decisions for their own jurisdictions. Existing studies show mixed results in SSB consumption following tax implementation. However, countries vary widely in their consumption of SSB's and obesity rates (Jou &

Techakehakij, 2012), and the previous research published about the US, focused on Berkeley, CA, is not representative of the average American community (Silver et al., 2017). This paper analyzes SSB consumption in the Philadelphia market, leveraging total store transactions at a convenience chain. Additionally, the potential exists that the beverage format (packaged, self-serve, foodservice) differs in impact from the tax. Previous studies have not examined this in depth, presenting an opportunity for this study to explore.

CHAPTER 2. LITERATURE REVIEW

Most of the research analyzing the SSB tax appears in the healthcare and economics literature, and generally falls into one or more of three categories: theory and recommendations for building a new tax, beverage consumption and pricing changes resulting from the tax, and health outcomes from the tax.

In 2009, Brownell et al. initially proposed SSB taxation through an excise tax of 1 cent per ounce, with the goal of reducing consumption and using the funds raised towards improving health outcomes (Brownell et al., 2009). In 2011, a model utilizing beverage consumption, historic trends, and the estimated price elasticity demands of SSB's demonstrated a 24% reduction in SSB consumption based upon a one cent per ounce tax increase. Additionally, this research projected daily per capita intake of SSB calories from 190-200 to 145-150 calories, and tax revenue of $79 billion over five years if implemented nationwide (Andreyeva, Chaloupka and Brownell, 2011). These recommendations helped prompt discussions in jurisdictions within the US and around the world.

As communities began launching SSB taxes, studies cover results in a number of countries. However, initial SSB consumption varies widely by country (Jou & Techakehakij, 2012). Combined with cultural and income differences, results of a tax may not be consistent.

Berkeley, California was the first jurisdiction in the United States to pass a targeted SSB tax and started implementing the tax in March 2015. Retailers in Berkeley passed 43% of the tax along to consumers via increased prices at the shelf (Cawley and Frisvold, 2017). Using consumer interviews before and after the tax, Falbe et al. find a

21% decrease of SSB consumption in Berkeley, compared to an increase of 4% in the comparison cities. Water consumption shows an increase of 63% in Berkeley versus 19% in the comparison cities. (Oakland and San Francisco were identified as the comparison cities due to their location near Berkeley and similarity of environment.)

A review of the Berkeley tax by Silver et al. combines transactional data with consumer interviews further after the tax implementation. A review of scanner data from three grocery stores (representing two chains) verified that prices rose following the tax. Six control stores were selected from the Bay area. Grocery store transactions after the implementation (March 2015 -February 2016) show a SSB decline of 9.6% versus control store growth of 6.9%. Conversely, sales of untaxed beverages increased 3.5% in Berkeley stores, compared to a .5% increase in control stores. Conflictingly, telephone surveys by the same researchers did not show a significant change in Berkeley consumer consumption of SSB's (Silver et al., 2017).

An additional study conducted in the US by Sharpe and Staelin (2010) considers the impact of a tax within the context of a bundle (i.e., a meal, fries and drink for one total price). The results show that a SSB would be successful in reducing consumption of the sweetened beverages, and would be valuable more so for the health care revenue raised instead (Sharpe and Staelin, 2010).

The launch of the Mexican SSB tax took place across the country at once, so no perfect control group exists. Colchero et al. (2017) uses consumer panel data to demonstrate an average SSB decrease of 7.6%. Untaxed beverages for the same time period increased by 2.1%. Separately, research in France demonstrates a decrease of

6.7% of regular cola purchases and 6.1% for low calorie cola in the two years following the tax launch.

Research also demonstrates that the impact of the SSB tax can also be connected ultimately to health outcomes. A meta-analysis performed by Escobar et al. in 2013 shows that the majority of studies (six out of nine), and all of the articles from the US, demonstrate a measureable change in health outcomes upon SSB taxation or price increase. These health outcomes can include a change in diet, body mass index, weight loss, and obesity. The researchers ultimately conclude that the SSB tax may reduce obesity and that "context-specific cost-effectiveness studies" are needed to make policy decisions (Escobar et al., 2013).

Analyzing income levels specifically, Finkelstein et al. (2010) interestingly finds that middle income households were most likely to see a change in weight as a result of the tax. Higher income households are less influenced by pricing, and lower income households may "purchase more generic, bulk, or sale items or by switching to non-taxed items that are equally high in calories," (Finkelstein et al., 2010).

Although early, initial results from Philadelphia are surfacing. First, findings confirm that, on average, merchants are passing the tax to consumers (Seiler, Tuchman, and Yao, 2019). Distribution was also impacted, with a documented reduction of taxed beverages and increase of untaxed beverages available for purchase (Cawley et al., 2018). A before and after telephone survey deployed to residents of the city about their beverage consumption. Within the first two months after the tax launched, daily consumption in Philadelphia of regular soda was 40% lower and bottled water was 58% higher than comparison cities (Zhong et al., 2018). One year after the tax was enacted, a decline of

51% was recorded by Roberto et al. (2019). Taxed beverage sales in Philadelphia decreased 51% post-tax. Sales measured in Pennsylvania border zip codes increased by 308.2 million ounces, offsetting the decrease in Philadelphia by 24% (Roberto et al., 2019). This trend continued over time, with a SSB decline of 46% in the taxed area in the 21 months post-tax (Seiler, et al., 2019). No significant increase to untaxed beverages was measured but researchers noted high cross-shopping outside of Philadelphia (Seiler, et al., 2019).

CHAPTER 3. STUDY ONE: SODA TAX SALES RESULTS

The SSB tax in Philadelphia began on January 1, 2017. The following section reviews the impact of this change. Units were measured instead of sales dollars, as dollars would have been influenced by the price changes taken by the retailer and therefore would not be a fair comparison. Average sales per store are used instead of totals to better account for stores that opened and closed during the analysis period. Three categories of stores are analyzed: Philadelphia, Border Stores (those immediately surrounding the city of Philadelphia), and All Other (remaining stores in the chain in the Mid-Atlantic area).

This research study reviews store-level transactions before and after the tax was enacted. The following hypotheses are tested using a before and after methodology:

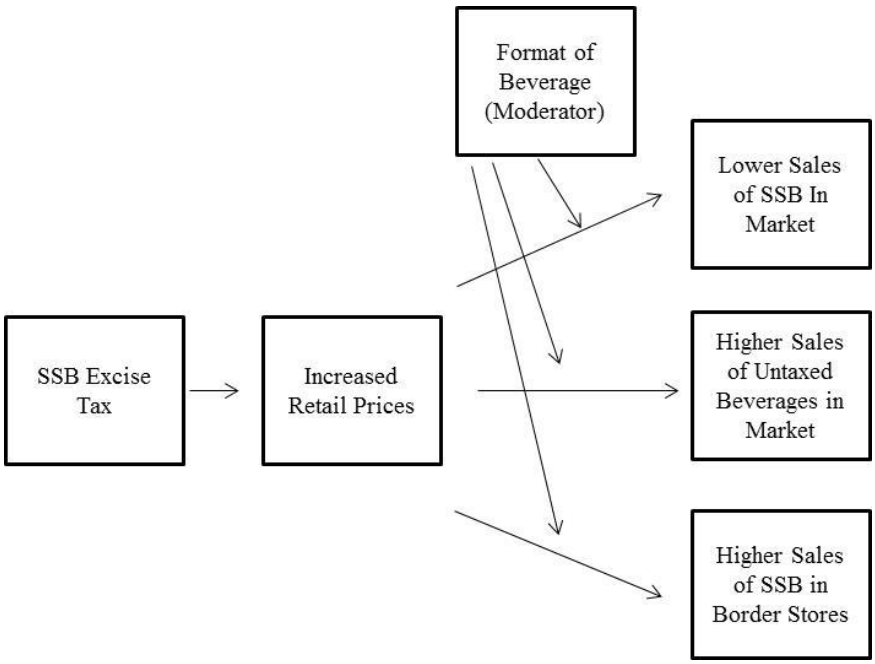
H1: The SSB tax reduces consumer purchases of SSB in the taxed market.

H2: The SSB tax increases consumer purchases of SSB in stores surrounding the taxed market.

H3: The SSB tax impacts consumer purchases of SSB differently by format. Packaged beverages and self-serve beverages will decline at a greater rate than foodservice beverages.

H4: The SSB tax increases consumer purchases of untaxed beverages in the taxed market.

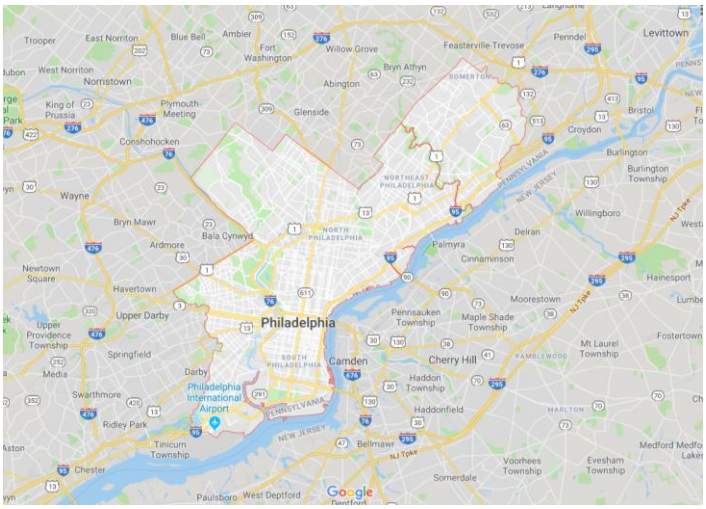
The model would be as follows:



Description of Data

The study utilizes transactional data from a convenience retail chain with stores in and around Philadelphia. Stores are categorized by location, including Philadelphia, Philadelphia border stores, and all other stores in the Mid-Atlantic. Philadelphia stores were in the city limits, as depicted in Figure 1. Border stores were located just outside the perimeter of the city on the Pennsylvania side. Remaining stores included those found in Pennsylvania (excluding Philadelphia and Border), New Jersey, Virginia, and Maryland. Beverage units are grouped by format, consisting of packaged, self-serve (i.e., fountain beverages), and foodservice (i.e., smoothies prepared by employees.) Additionally, beverages are split between taxed and untaxed. Data captures monthly volume from 1/1/16 through the end of 2017.

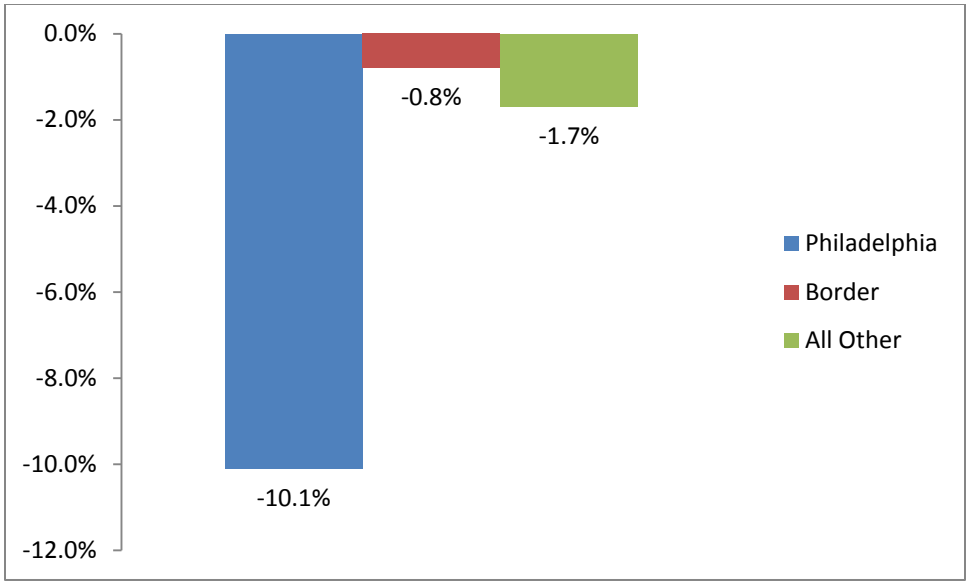
Figure 1: Map of Philadelphia



Discussion of Results

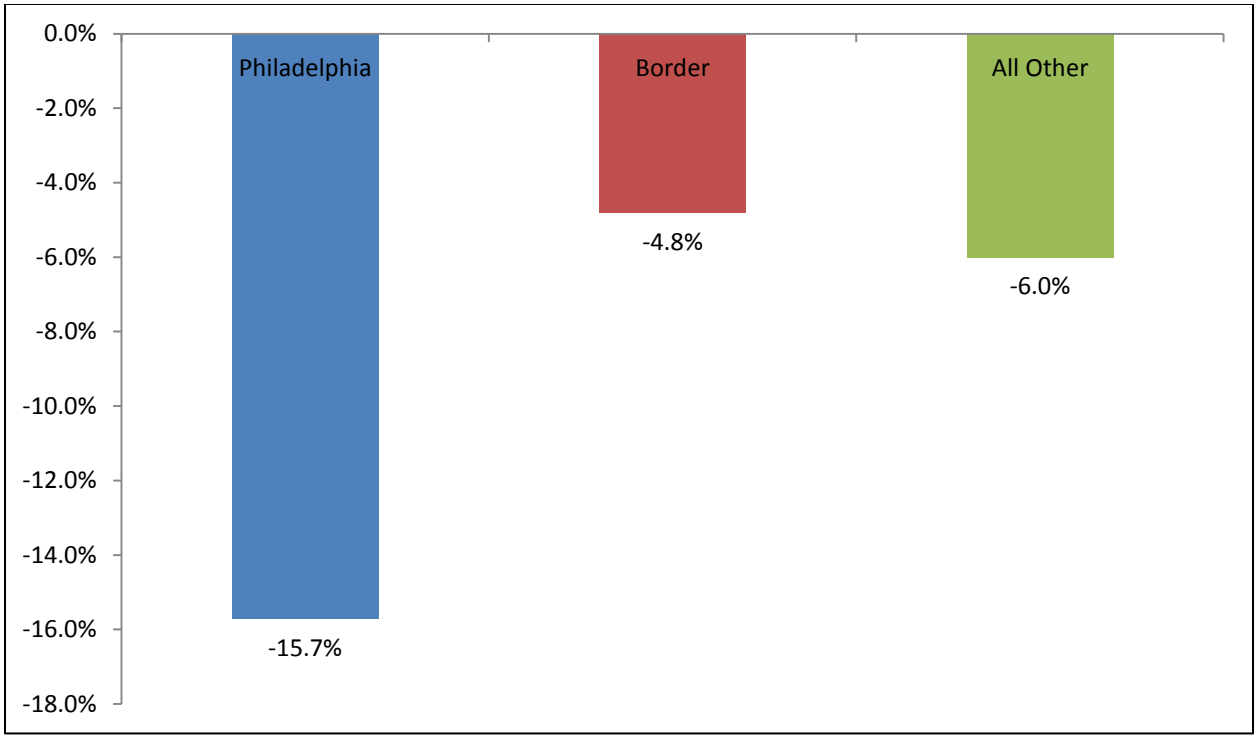
Figure 2 captures the year over year change in taxed beverage unit sales per store. In the twelve months following the tax implementation, total taxed beverages declined 10.1%, supporting the first hypothesis that the tax would reduce SSB purchases in the taxed market. Unit sales in border stores outside of Philadelphia decreased .08%. While declining, this performance outpaced the remaining stores in the chain, down 1.7%. This suggests support for hypothesis two, that the tax increases consumer purchases of SSB in stores surrounding the taxed market. This data suggests that consumers bought more taxed beverages when they were in stores located just outside of the city due to the tax.

Figure 2: Taxed Beverage Unit Sales Per Store, 2017 vs. 2016



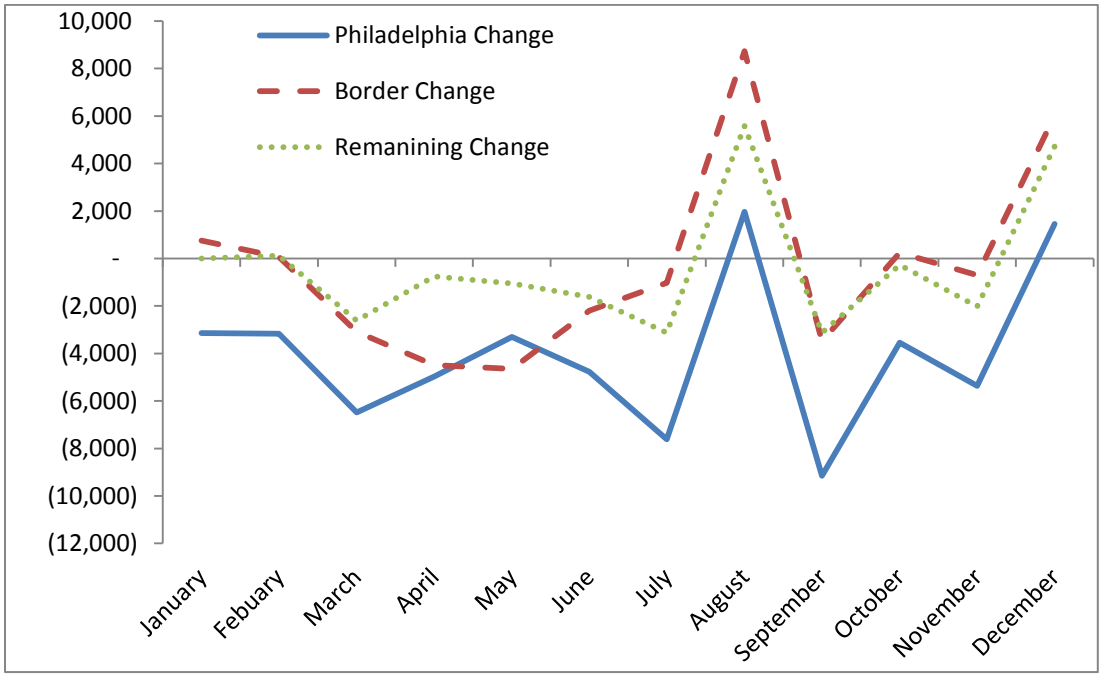
Interestingly, results varied by the format of beverage (packaged, self-serve, and full-serve). Packaged beverages were the largest driver of the change, down 15.7% from the prior year. Figure 3 represents the year over year taxed packaged beverage unit sales per store. While sales in both the border stores and the rest of the chain declined, border stores experienced the lowest decline of the three categories of store. It is possible that taxed packaged beverages declined the most due to a greater awareness by consumers. Much of the media attention concerning the tax highlighted bottled beverages. It is also possible that consumers are less price sensitive when purchasing a full-serve or self-serve beverage. Additionally, it may be easiest for consumers to view the prices of the packaged beverages versus the other two formats. Lower price visibility may have been a contributing factor.

Figure 3: Taxed Packaged Beverage Unit Sales Per Store, 2017 vs. 2016



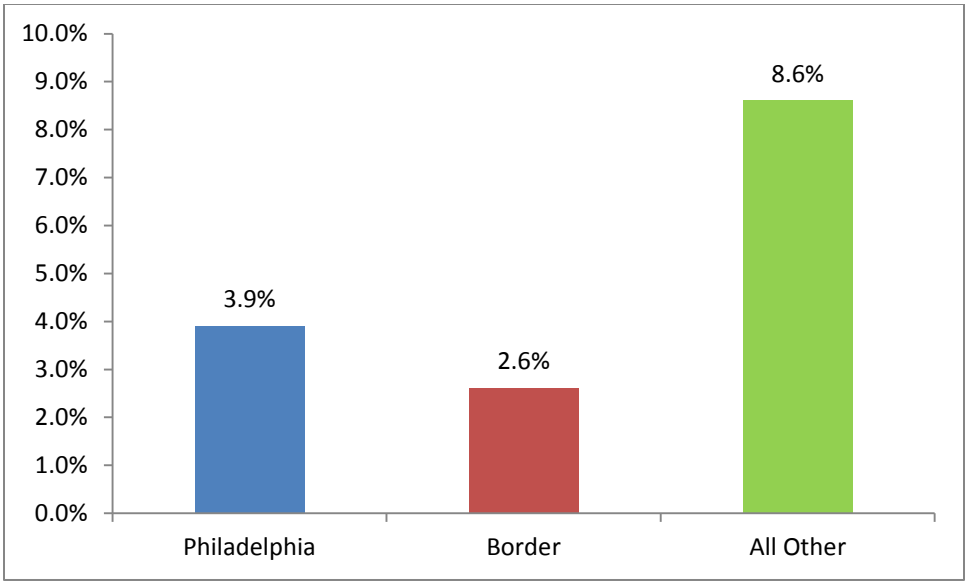
One question prompted by the review of a soda tax is how long the change continues. Do consumers change behavior initially but later return to original habits? Figure 4 demonstrates the difference in purchases before and after the tax was implemented, over the course of a year. While a similar pattern can be observed, likely due promotional activity and seasonality, Philadelphia stores experienced the greatest decline. Additionally, it is important to note that the decline continues throughout the majority of the year. An increase can be seen in December, however, likely caused by promotional activity.

Figure 4: Taxed Packaged Beverage Unit Sales Average Per Store Change, 2017 vs. 2016



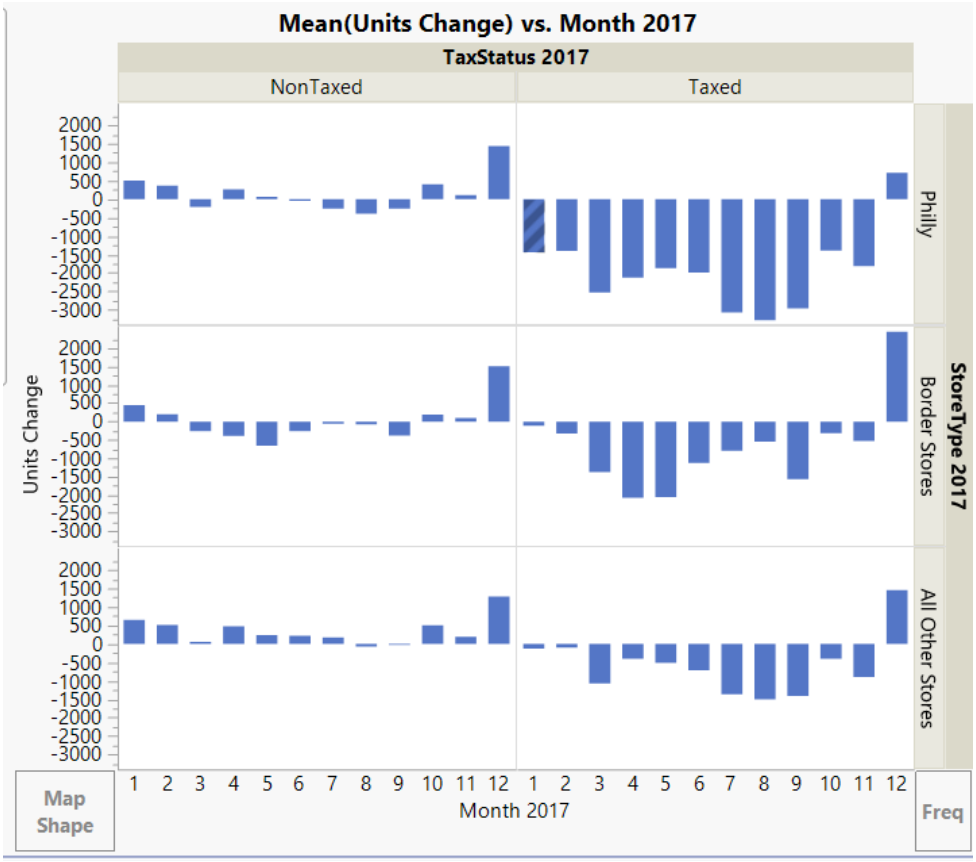
Lastly, the data in Figure 5 demonstrates the growth of non-taxed beverages across the three categories of stores. The growth in Philadelphia of 3.9% is less than that of the rest of the chain (+8.6%), and does not make up for the total loss in taxed beverage sales (down 10%). This demonstrates that consumers did not evenly swap nontaxed beverages for taxed beverages, suggesting support for hypothesis four.

Figure 5: Non-Taxed Beverage Unit Sales Per Store, 2017 vs. 2016



Additionally, an analysis of total unit change was run (Figure 6). This suggests again that Philadelphia stores witnessed the greatest taxed beverage decline of the three sets of stores. The increase in non-taxed beverages was not enough to make up the difference.

Figure 6: Total Mean Unit Change by Month



A regression was run and model created to explain the unit variation (Figure 7). The model demonstrated that the tax had a strong impact, explaining 11% of the variance.

Figure 7: Regression and Model

Summary of Fit

RSquare	0.110084
RSquare Adj	0.109765
Root Mean Square Error	2256.334
Mean of Response	-169.098
Observations (or Sum Wgts)	44693

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	16	2.8136e+10	1.7585e+9	345.4063
Error	44676	2.2745e+11	5091042.5	Prob > F
C. Total	44692	2.5558e+11		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	161.63717	63.59103	2.54	0.0110*
StoreType 2017[Border Stores-Philly]	-134.8372	116.5996	-1.16	0.2475
StoreType 2017[All Other Stores-Border Stores]	320.81839	98.99766	3.24	0.0012*
TaxStatus 2017[Taxed-NonTaxed]	-2090.702	89.6477	-23.32	<.0001*
Month 2017[1]	384.34862	35.38704	10.86	<.0001*
Month 2017[2]	326.50692	35.46066	9.21	<.0001*
Month 2017[3]	-398.0584	35.46069	-11.23	<.0001*
Month 2017[4]	116.92477	35.41728	3.30	0.0010*
Month 2017[5]	-42.22019	35.44324	-1.19	0.2336
Month 2017[6]	-131.8464	35.34826	-3.73	0.0002*
Month 2017[7]	-485.2016	35.40427	-13.70	<.0001*
Month 2017[8]	-668.4709	35.42591	-18.87	<.0001*
Month 2017[9]	-611.8761	35.4652	-17.25	<.0001*
Month 2017[10]	181.85709	35.35255	5.14	<.0001*
Month 2017[11]	-212.903	35.40448	-6.01	<.0001*
StoreType 2017[Border Stores-Philly]*TaxStatus 2017[Taxed-NonTaxed]	1374.0667	164.2077	8.37	<.0001*
StoreType 2017[All Other Stores-Border Stores]*TaxStatus 2017[Taxed-NonTaxed]	-219.5305	139.367	-1.58	0.1152

CHAPTER 4. RESEARCH CONTRIBUTION

The Berkeley studies are important as the first analyses of the SSB tax in the US. However, they are limited in a few ways that this study builds upon. First, Philadelphia is a more representative market of the US than Berkeley, as Berkeley residents consume only 34% of the national average of SSB's (Silver et al., 2017). This limits the ability to use these results in projecting the results from other communities. Secondly, some of the research utilizes surveys, while consumers may answer surveys differently than how they actually behave (Gaba and Winkler, 1992). Actual transactions give a more accurate view of behavior. Finally, data from the research between the studies conflicts, which presents an opportunity to revisit.

This study is one of the first to analyze the impact of the Philadelphia SSB tax. Philadelphia is a larger market than Berkeley. Utilizing transactional data, it provides insight into consumer purchase behavior. It is also the first to review changes in SSB purchases by format (packaged, self-serve, foodservice).

CHAPTER 5. LIMITATIONS

This study is limited in a few ways. First, customers of the selected convenience store chain may not be fully representative of the market. Changes may differ by type of retailer (grocery, mass merchandiser, drug store, etc.) and by remaining convenience stores. Secondly, transactional data does not allow for the viewing of which individuals drove the change. However, by sharing this data from a convenience store with a significant presence in the market area of Philadelphia over an extended time frame, this study deepens the current understanding of consumer response to an SSB tax.

CHAPTER 6. STUDY TWO: A REVIEW OF CONSUMER SODA TAX TRENDS

To gain a deeper insight into the impact of a soda tax, a second set of data was analyzed from the same retailer, capturing transactions made through the retailer's loyalty program. The loyalty program is optional and free for the company's customers to join. Members then receive benefits such as coupon promotions in return for providing both transactional and profile data to the company. The majority of members choose to provide demographics (age and gender). By leveraging loyalty data, trends can be seen at the consumer level, allowing for a view of individual trends over time.

This dataset provides insight to the following hypotheses:

- After the SSB tax was enacted, consumers will buy less SSB's.
- After the SSB tax was enacted, consumers bought a lower percent of SSB's in the taxed area vs. non-taxed stores.
- After the SSB tax was enacted, consumers bought a higher amount of non-taxed beverages in the taxed area.
- Younger consumers had a greater drop in SSB purchases in the taxed stores than older consumers.

Description of Data

The second dataset comes from the retailer's loyalty program from January 1, 2016 through May 31, 2017. It captures detail on members who purchased a taxed beverage in Philadelphia in 2016. In order to remain in the data set, however, members must have also made a purchase (not limited to beverages) in the post-period. This is to reduce the likelihood that the sales difference would be caused by customers that stopped

using the loyalty program or this chain. This resulted in a sample of 22,035 members. Consumer data incorporates the demographics age and gender for customers when available (these were optional fields for the customer to provide). Transactional data recorded all purchase made by these members in this time period and was not restricted to beverages. This allows for a comparison to members' overall purchase trends, isolating beverage changes. Transaction detail included the item purchased, time of purchase, store location, as well as basket data (the other items purchased at the same time).

Figure 8 demonstrates the purchase patterns in the five months after the tax was enacted as compared to the preceding five months. Consumer purchase patterns outside of the beverage category were consistent, buying 8.4% less of remaining items in Philadelphia and 8.5% less outside of the city. However, a substantial change can be seen within the beverage category. Consumers in the loyalty program purchased 27% less SSB's in Philadelphia after the tax went into effect. While untaxed beverages declined (-5%), it was not high enough to demonstrate that consumers swapped a sugary beverage for an untaxed beverage.

Figure 8: Loyalty Purchases Before and After Tax

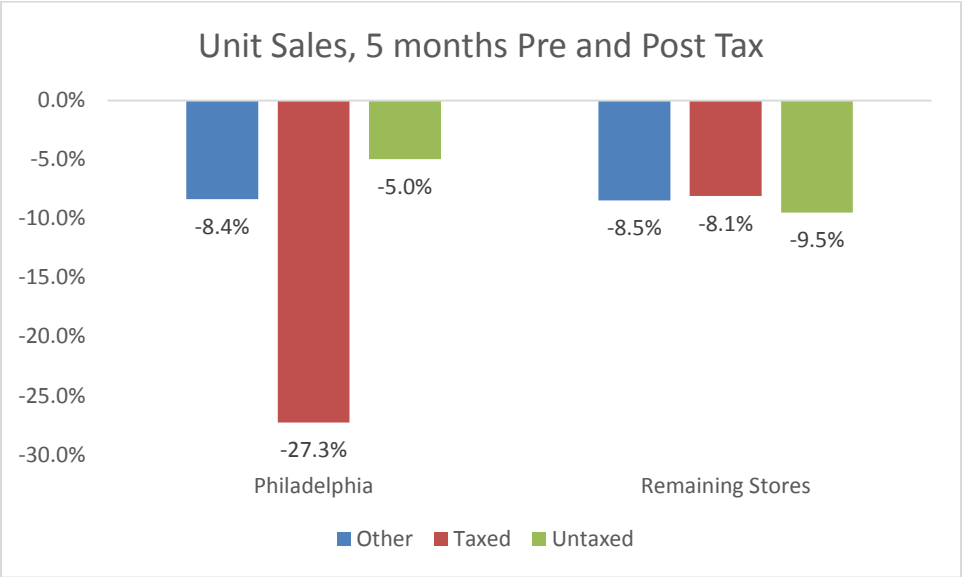
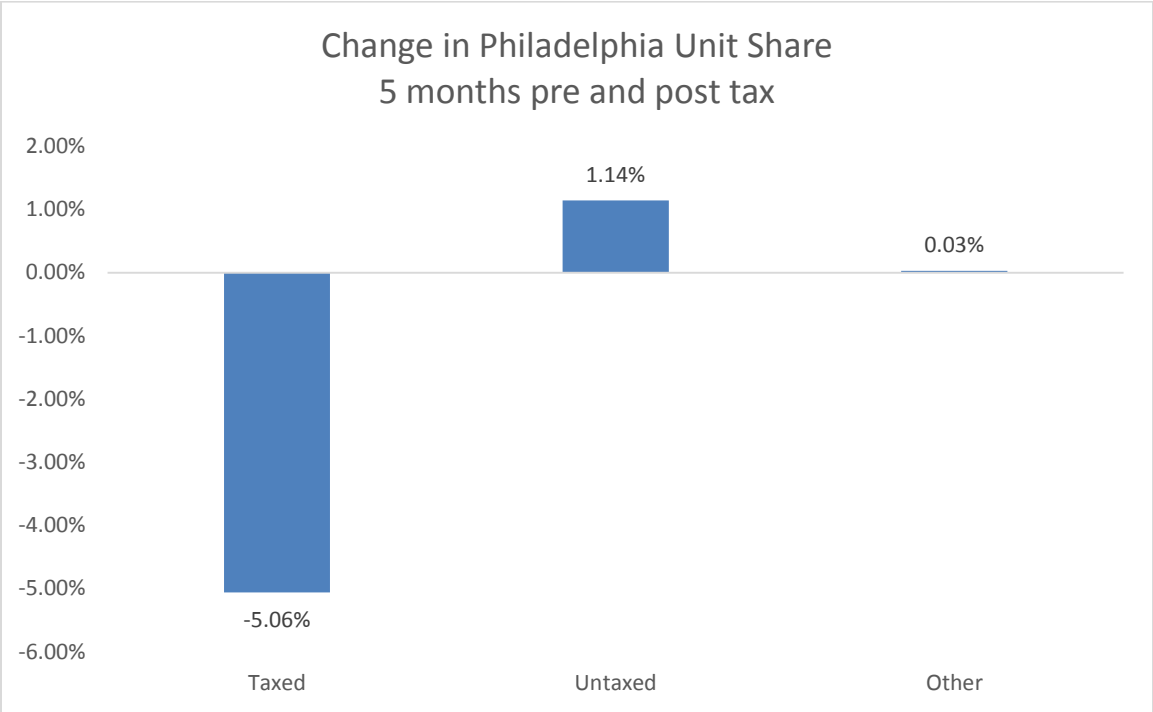


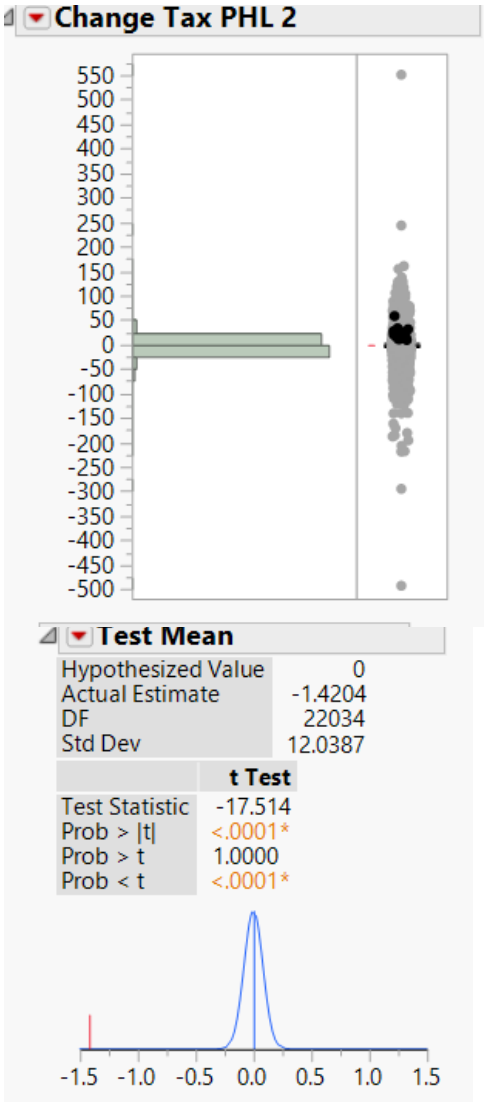
Figure 9 demonstrates consumer buying behavior by geography in the five months after the tax compared to the previous five months. This view provides the ability to view where members purchased their remaining beverages once the tax was enacted. Outside of the beverage category, purchase change by geography was flat, demonstrating that members did not shift overall where they bought items from this retailer. However, they did shift locations to buy beverages. 5% less of their total SSB's were purchased in Philadelphia. Untaxed beverages in Philadelphia increased slightly, up 1%. While the original intention of the tax was to reduce SSB consumption, this data suggests that consumers will travel outside of the taxed area to purchase SSB's.

Figure 9: Loyalty Purchases Market Share



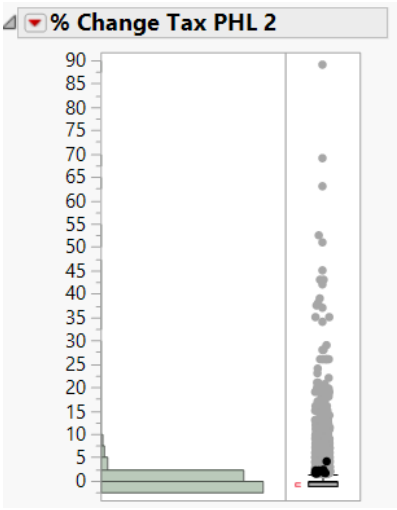
On average, each member bought 5.2 units of taxed beverages in Philadelphia before the tax and 3.8 after. (This can be compared to a decline from 15.2 to 13.0 in total taxed beverages in the region.) This equates to an average of 1.4 less taxed beverages over five months after the tax in Philadelphia. A distribution plot in Figure 10 reflects that a few consumers are extreme outliers in purchase behavior before and after tax, with a couple varying wildly (over 500 unit change). A t test was run against an expected mean of 0 and reflects statistical significance.

Figure 10: Change in Total Taxed Units, by Member, Philadelphia



A similar distribution and t test was run on the dataset, using percent change in place of unit change, shown in Figure 11. On average, each member purchased 7% less SSB's in the five months after the tax than before, with a median decline of 20%. The t test again reflects statistical significance.

Figure 11: Percent Change in Total Taxed Units, by Member, Philadelphia



Quantiles

100.0%	maximum	89
99.5%		11
97.5%		4
90.0%		0.6666666667
75.0%	quartile	0
50.0%	median	-0.2
25.0%	quartile	-1
10.0%		-1
2.5%		-1
0.5%		-1
0.0%	minimum	-1

Summary Statistics

Mean	-0.073102
Std Dev	2.1247479
Std Err Mean	0.0143137
Upper 95% Mean	-0.045046
Lower 95% Mean	-0.101158
N	22035

Test Mean

Hypothesized Value	0
Actual Estimate	-0.0731
DF	22034
Std Dev	2.12475

	t Test
Test Statistic	-5.1071
Prob > |t|	<.0001*
Prob > t	1.0000
Prob < t	<.0001*

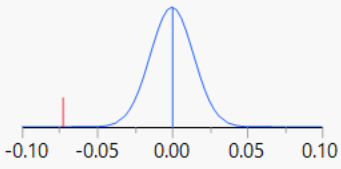
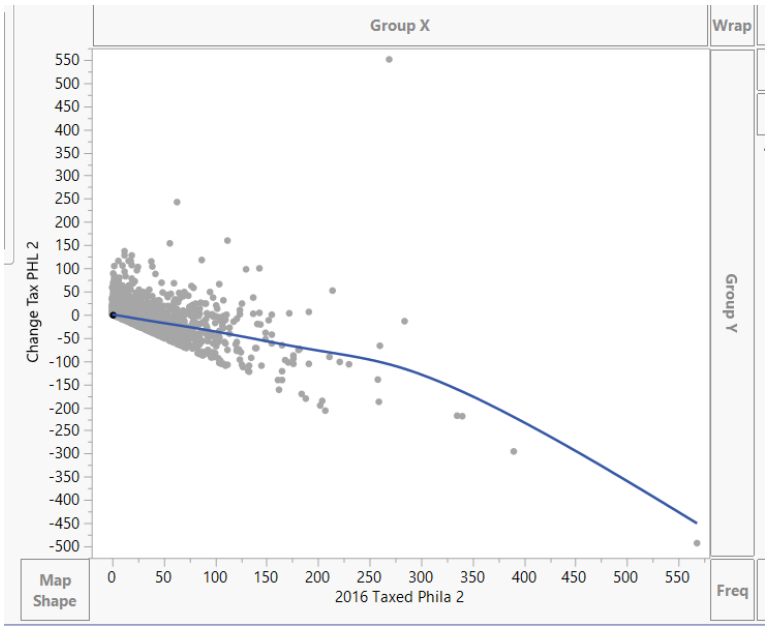


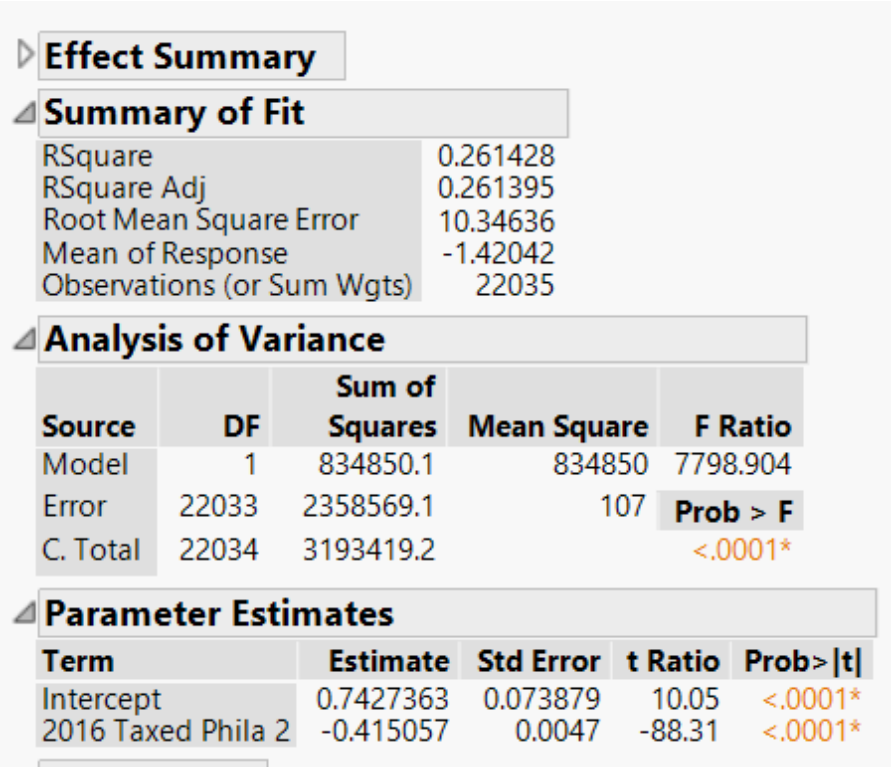
Figure 12 plots members onto a chart by their starting quantity and change post-tax. A higher change is associated with higher quantities purchased before the tax was enacted.

Figure 12: Change in Total Taxed Units, by Member Volume, Philadelphia



A regression model, as depicted in Figure 13, was created to predict the change in taxed beverages in Philadelphia using pre-tax taxed beverage volume, with 26% of the variation explained.

Figure 13: Regression Model Predicting Change in Taxed Philadelphia Beverages



Effect Summary

Summary of Fit

RSquare	0.261428
RSquare Adj	0.261395
Root Mean Square Error	10.34636
Mean of Response	-1.42042
Observations (or Sum Wgts)	22035

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	834850.1	834850	7798.904
Error	22033	2358569.1	107	Prob > F
C. Total	22034	3193419.2		<.0001*

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	0.7427363	0.073879	10.05	<.0001*
2016 Taxed Phila 2	-0.415057	0.0047	-88.31	<.0001*

More men buy more SSB's than women within the loyalty program (10,164 females vs. 11,186 males). Since members are not required to provide this information, the data was unknown for remaining buyers. Figure 14 demonstrates buying changes in the five months before and after the tax, split by gender. Both genders followed the overall pattern of post-tax decline with greater quantities; however, their slopes were not equal. On average, males saw a greater decline (down 1.7 units per person vs. females at 1.0 units per person).

Figure 14: Changes in Purchases by Gender

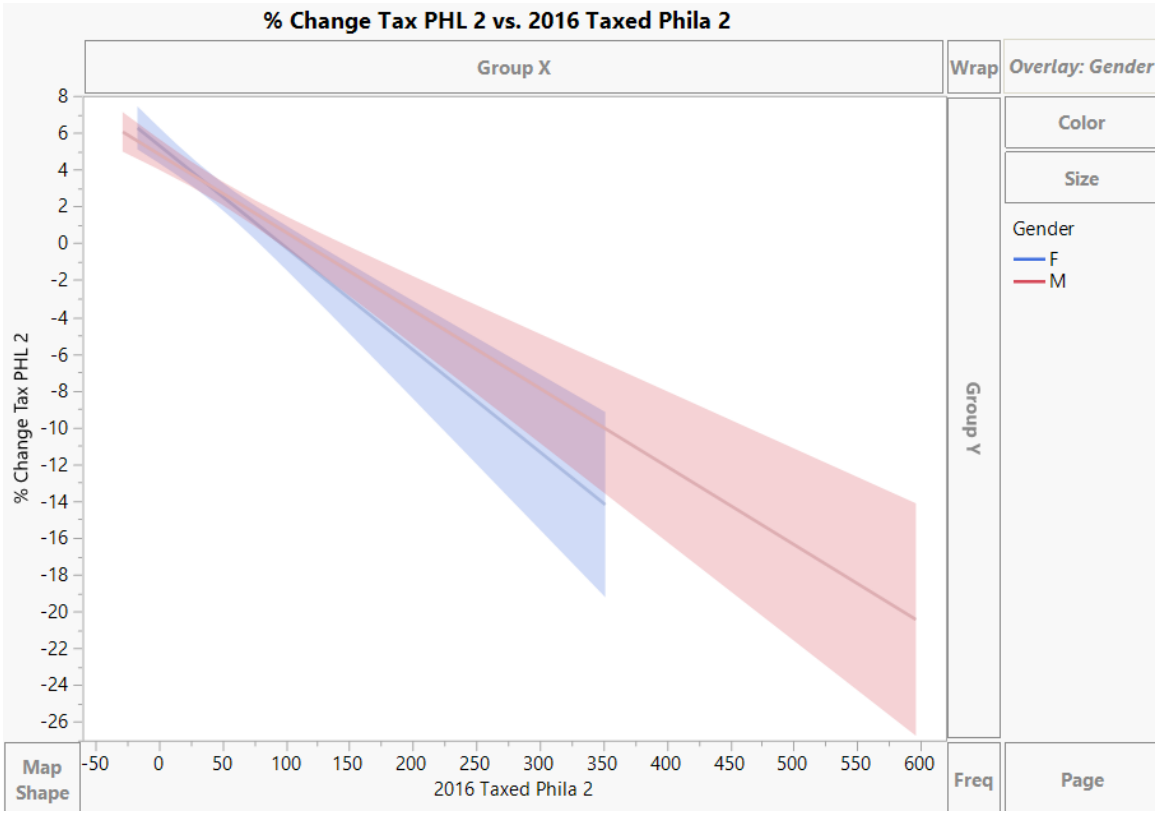
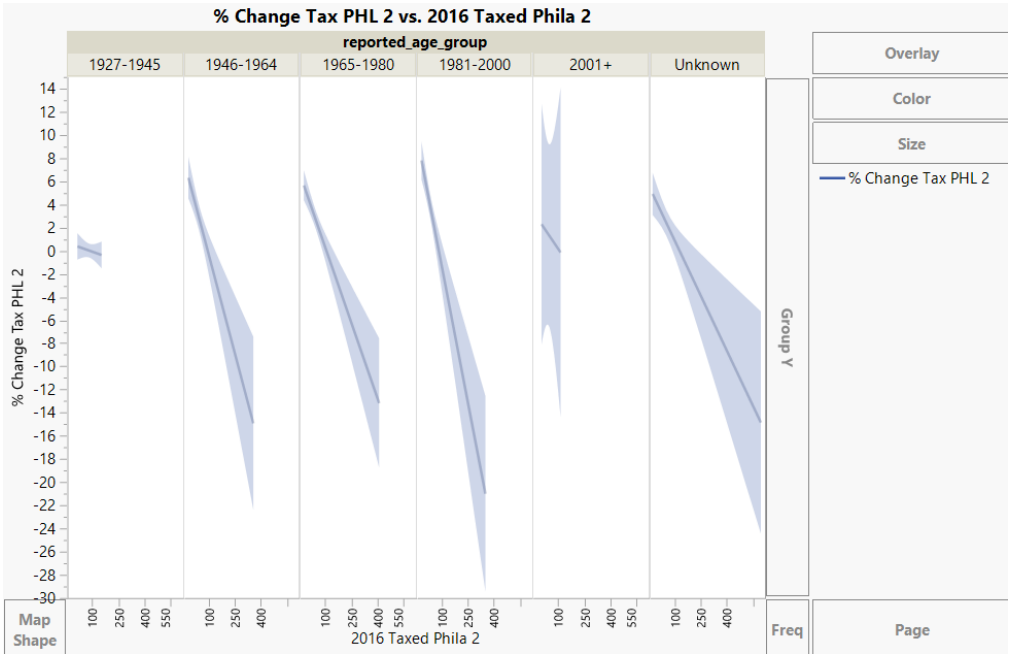


Figure 15 demonstrates buying changes in the five months before and after the tax, broken out by age. First, this data reflects that millennials (defined here as born between 1981 and 2000) are the largest segment of SSB buyers within the loyalty program. Additionally, this group drove the highest decline of SSB's in Philadelphia than any of the other age groupings. The chart also continues to reflect the overall pattern of decline by quantity.

Figure 15: Purchase Taxed Beverage Changes by Age, Philadelphia



154 2,961 5,470 8,886 192 4,205

CHAPTER 7: RESEARCH CONTRIBUTION

Analyzing purchases made through a retail loyalty program provide a deeper look into consumer behavior following the soda tax as it allows for the tracking of individual purchases over time. First, the dataset confirms that members do buy less SSB's following the implantation of a soda tax. However, when reviewed at a unit level, individual consumers may not experience as much of a unit reduction to experience positive health outcomes. Further studies would be needed at a consumer level encompassing multiple outlets for purchase.

Additionally, the data suggests that consumers are willing to travel outside of the taxed area to buy sugary beverages. This impact should be considered as communities consider similar taxes. The findings also suggest that as consumers purchase higher quantities of SSB's before a tax, they are more likely to be impacted by a soda tax. Since the majority of loyalty members provide demographic characteristics in their loyalty profile, this analysis also provides a unique look into purchases split by age and gender. Males and millennials make up the largest segments of purchasers in this dataset, and all groups reflect a greater decline by initial volume purchased.

CHAPTER 8: LIMITATIONS

Limitations exist for the second dataset as well. First, not all transactions at the retailer are captured through the loyalty program as customers may shop without participating in the program. It is possible that a certain type of consumer participates in loyalty and that these characteristics may also influence their behavior. At the same time, there is a higher proportion of loyalty transactions within the city of Philadelphia than in the average store in the chain. Secondly, trends in the loyalty program may be influenced by additional variables, such as rewards and promotions. The dataset captures five months, and a longer time period would be valuable to review trends over time. Additionally, a consumer may choose to sometimes shop with their loyalty program and not use it at other times. This would mean that not all of their purchases are being recorded. Finally, this dataset contains records from only one retailer – if a consumer shifts buying among retailers, these trends would not be captured here.

Given the current state of research on SSB taxation, utilizing both datasets of this convenience retailer provides valuable data to better understand true soda tax impact.

CHAPTER 9. CONCLUSION

Taxes on sugary beverages are being hotly debated in communities around the world. Decisions are being made based on a current literature stream that is limited and conflicting. The implications of such a tax are important to many constituents, in addition to the policy makers who must make or defend these decisions. Marketers can use this data for inventory, shelving, pricing, and promotional decisions. Economists will value the results of a taxation strategy, and health care professionals can use the data around understanding tax implications on diabetes and obesity.

The study of transactional data at a convenience store chain verifies that taxed beverage sales did in fact decline; however, non-taxed beverages did not make up for the total decline of taxed beverages. A second study using loyalty data broadens current understanding by tracking of purchase behavior of individuals over time. Purchase pattern changes can then be viewed by demographic characteristics. The current literature does not provide such a view, as it is typically based on transactions. Consumer data to this point has been based on survey methodology as opposed to actual recording of purchases. Together, these studies paint a picture of the soda tax impact that is unique to the current literature and important to both researchers and practitioners across disciplines.

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APPENDIX

Table 1: List of Soda Taxation Studies

Location	Tax	Implementation Date	Measurement	Study Timing	Results	Source
France	83 cents per liter	1/1/12	ECORYS data	1/12 – 12/13	Decrease of 6.7% for regular cola and 6.1% for low calorie cola	European Commission, 2014
Mexico	1 peso per liter	1/1/14	Store purchase data from 6,645 households	1/12 – 12/15	SSB purchases decreased 5.5% in 2014 and 9.7% in 2015, yielding an average reduction of 7.6%, untaxed beverages increased 2.1%. (Note: this study includes revisions to Colchero et al., 2016)	Colchero et al., 2017
Mexico	1 peso per liter	1/1/14	Purchases as reported by 6,253 households in Nielson Mexico's Consumer Panel Services	1/1/12 – 12/31/14	SSB purchases decreased 6%, untaxed beverages were 4% higher than what would be expected without the tax	Colchero et al., 2016
Mexico	1 peso per liter	1/1/14	Two estimations – synthetic control and intervention analysis using data from Mexico's Consumer Price Index Program	1/10 – 1/15	Prices rose by more than the amount of the tax; mean weight of adults falls 1 – 2% of mean BMI with SSB tax	Grogger 2017
Berkeley, CA, USA	1 penny per ounce	3/1/15	Questionnaire to 990 participants before the tax and 1689 after the tax; targeted two large low-income neighborhoods with the highest proportions of African American and Hispanic residents	Baseline 7/14 ; Follow-up 4/15 – 8/15	SSB consumption decreased 21% and increased in comparison cities (Oakland and San Francisco) by 4%. Water consumption increased 63% versus 19% increase in comparison cities	Falbe et al., 2016
Berkeley, CA, USA	1 penny per ounce	3/1/15	Scanner data from three grocery stores representing two chains	Prices collected 12/14, 6/15, 3/16	67% of the tax was passed through to consumers	Silver et al., 2017
Berkeley, CA, USA	1 penny per ounce	3/1/15	Scanner data from three grocery stores representing two chains	Scanner data from 1/1/13 – 2/29/16	SSB sales dropped 9.6% in relation to the predicted sales in the absence of the tax; sales of untaxed beverages rose 3.5%	Silver et al., 2017
Berkeley, CA, USA	1 penny per ounce	3/1/15	Telephone survey of 957 adult Berkeley residents	Baseline 11/14-12/14; Follow-up 11/15-12/15	No significant change in self-reported SSB consumption	Silver et al., 2017

Table 1, continued

Berkeley, CA, USA	1 penny per ounce	3/1/15	In-person pricing survey of 31 Berkeley stores (supermarkets, grocery stores, pharmacies, convenience stores, and gas stations)	Surveys completed 12/22/14 and 6/1/15	Retailers in Berkeley passed 43% of the tax along to consumers via increased prices at the shelf	Cawley and Frisvold, 2017
Philadelphia, PA, USA	$.015 per ounce	1/1/17	Telephone survey of 899 Philadelphia residents	Surveys completed 12/16, 1/17 and 2/17	Soda consumption was 40% lower and bottled water was 58% higher than comparison cities	Zhong et al., 2018
Philadelphia, PA, USA	$.015 per ounce	1/1/17	Data collection of pricing and distribution in Philadelphia	2016 and 2017	On average, merchants are passing the full tax to consumers and there was a documented reduction of taxed beverages and increase of untaxed beverages available for purchase	Cawley et al., 2018
Philadelphia, PA, USA	$.015 per ounce	1/1/17	IRI transactions	January 2015 through September 2018	The tax pass-through rate was 97%, driving 40% price increase. Sales in Philadelphia decreased by 46% post-tax. No significant increase to untaxed beverages but high cross-shopping outside of Philadelphia.	Seiler, Tuchman, and Yao, 2018
Philadelphia, PA, USA	$.015 per ounce	1/1/17	IRI transactions	2016 and 2017	Taxed beverage sales in Philadelphia decreased 51% post-tax. Sales in Pennsylvania border zip codes increased by 308.2 million ounces, offsetting the decrease in Philadelphia by 24%	Roberto et al., 2019