

Distributing Recycling Bins with Lids:

Philadelphia Behavioral
Science Research
Protocol

August 2017 - May 2018

Testing the Effect of Lidded Recycling
Bins on Recycling Volume to Prevent
Litter

The goal of this project is to address the litter problem in Philadelphia by examining whether recycling bin distribution has an effect on recycling volume, and whether use of lids can reduce litter. The project aims to make recycling more accessible by increasing the number of recycling bins with lids in neighborhoods.

As part of the City of Philadelphia's broader emphasis on reducing litter and waste, the primary goal of this intervention was to **promote recycling and divert recyclable materials that might otherwise be placed with rubbish.**

Executive Summary

From August 2017 to May 2018, the City's GovLabPHL team worked in partnership with the Zero Waste and Litter Cabinet and researchers from local academic institutions to test the effect of lidded recycling bins on recycling volume and on preventing litter. This experiment examines how recycling bin distribution with lids influences 1) tonnage (weight) of recycling from residences and 2) littering in the neighborhood. Recycling bins with lids were distributed at two recreation centers in Port Richmond and two in Brewerytown with the intention of influencing recycling volume and litter on two recycling routes in each neighborhood. Sanitation workers were asked to complete surveys to record lid use data and the litter index was used to preliminarily measure the effect of the treatments on litter rates.

The study found that the results varied by neighborhood. The methodology for analysis included a difference-in-difference design, estimated via Ordinary Least Squares (OLS). There were significant differences between the data results for the two routes in Brewerytown, therefore leading to inconclusive results. However, analysis of

data from the two routes in Port Richmond showed a likely increase of recycling volume due to the increase of recycling bins. Preliminary analysis does not find evidence that bin distribution affected litter rates. A further geospatial analysis will also be completed.

Qualitative data collected from conversations with residents who received lidded recycling bins noted that they would be more likely to use lids if the lids were attached. Residents also reported that they use the lids inside their home or in their backyard.

The Zero Waste and Litter Cabinet intends to use the outcomes from this experiment to craft policy and regulation on increasing recycling bin distribution locations through a strategic partnership with the Streets Department and the Department of Parks and Recreation, implementing city-wide composting, and on piloting larger recycling bins with lids.

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Background

In December of 2016 Mayor Kenney announced his goal of zero waste by 2035. One major component of achieving this ambitious target is to reduce the amount of litter that Philadelphia generates. While the City of Philadelphia has developed many programs to keep litter off of the streets, litter continues to be a seemingly intractable problem that requires more collaborative and data driven solutions.

In 2017, the Streets Department spent approximately \$45 million in disposal fees for landfill and recycling. However, due to the fact that recycling is less expensive than disposal through a landfill, the City saved \$5 million in disposal fees. In 2017, the Streets Department distributed approximately 40,000 recycling bins without lids to residents for a total of \$200,000 in costs.

The Zero Waste and Litter Cabinet, and the Kenney Administration, is committed to using data and evidence to drive decision making. The Zero Waste and Litter Cabinet partnered with GovLabPHL, a multi-agency intergovernmental team led by the Mayor's Policy Office to support the use of evidence-based practices through research and evaluation. The city, in collaboration with area academic institutions, designed this research project with the main objective to examine whether the distribution of recycling bins with lids had an effect on the volume of residential recycled materials collected by the City.

This experiment examined how recycling bin distribution influenced 1) tonnage of recycling from residences and 2) littering in the neighborhood. Recycling bins were distributed along 4 recycling routes – two in Port Richmond and two in Brewerytown. Volunteers handed out flyers to residences on April 22, 2017 and bins were distributed at local recreation centers on April 29, 2017.

Relevant Literature

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Partner Organizations

This project involved the cooperation and expertise of multiple private and public partners.

City of Philadelphia Partners

Mayor's Policy Office and GovLabPHL

Zero Waste and Litter Cabinet (departments involved from the cabinet listed below)

- Managing Director's Office
- Mayor's Office
- Department of Health
- Department of Commerce
- Streets and Sanitation Department
- Office of Sustainability
- Philly 311

Research Institutions

University of Pennsylvania

Temple University

Swarthmore College

Non-profit Organizations

Keep Philadelphia Beautiful



Study Design



Study Design

This project was resource-intensive, as it involved flyering on selected routes, obtaining and distributing recycling bins with lids, and then obtaining and analyzing data on recycling tonnages for select routes. Given these resource constraints, we lacked a sufficient sample size to randomize. This project is thus an observational study analyzed using "difference-in-difference" analysis, and so falls under the category of quasi-experimental designs rather than pure randomized control trials (RCT).

Subjects

Recycling bins were distributed along four recycling routes – two in Port Richmond and two in Brewerytown. In Port Richmond, bins were distributed on recycling routes 604 (5F [Port Richmond] Friday) and 607 (5F [Port Richmond] Friday). In Brewerytown, bins were distributed on recycling routes 404 (3C [Brewerytown] Wednesday) and 602 (3C [Brewerytown] Friday). Residences were handed flyers by volunteers on April 22, 2017 and bins were distributed at local recreation centers on April 29, 2017.

Assignment to Treatment

Due to resource constraints, we did not have the sample size necessary for a randomized experiment. Instead, local academics serving on the subcommittee reviewed maps of the two targeted neighborhoods and data on prior recycling tonnages collected by route to identify two routes in each of the two targeted neighborhoods which 1) were effective targets for the intervention while 2) being similar in length and prior tonnage to neighboring routes and 3) reducing the rate of likely spillovers from treated to untreated routes. Particular attention was paid to ensuring the routes that would be treated were geographically proximal to one another and the site that would be used to distribute bins. Assignment to treatment took place at the level of the recycling route.



Control/Treatment

Researchers designated recycling routes in the two relevant neighborhoods as either treatment or control, with households on the treatment routes being targeted for flyering announcing the recycling bin distribution while untargeted routes were not. In 3C (Brewerytown), the treated routes were 404 and 602 while the control routes were 201, 202, 203, 204, 205, 206, 401, 402, 403, 405, 601, 603, 604, 605, 607, and 606. In 5F (Port Richmond), the treated recycling routes were 604 and 607 while the control routes were 201, 202, 203, 204, 205, 401, 402, 403, 404, 405, 406, 501, 502, 503, 504, 505, 506, 601, 602, 603, 605, and 606.

We also identified whether rubbish collection routes overlapped perfectly with the treated recycling routes (3C [Brewerytown]: 403 and 607; 5F [Port Richmond]: 606), overlapped partially with the treated recycling routes (3C [Brewerytown]: 401 and 405; 5F [Port Richmond]: 601, 602, 604, and 605), or did not overlap with the selected recycling routes at all (3C [Brewerytown]: 201, 202, 203, 204, 205, 206, 207, 402,

404, 406, 407, 601, 602, 603, 604, 605, and 606; 5F [Port Richmond]: 201, 202, 203, 204, 205, 206, 207, 208, 501, 502, 503, 504, 505, 506, 603, and 607).

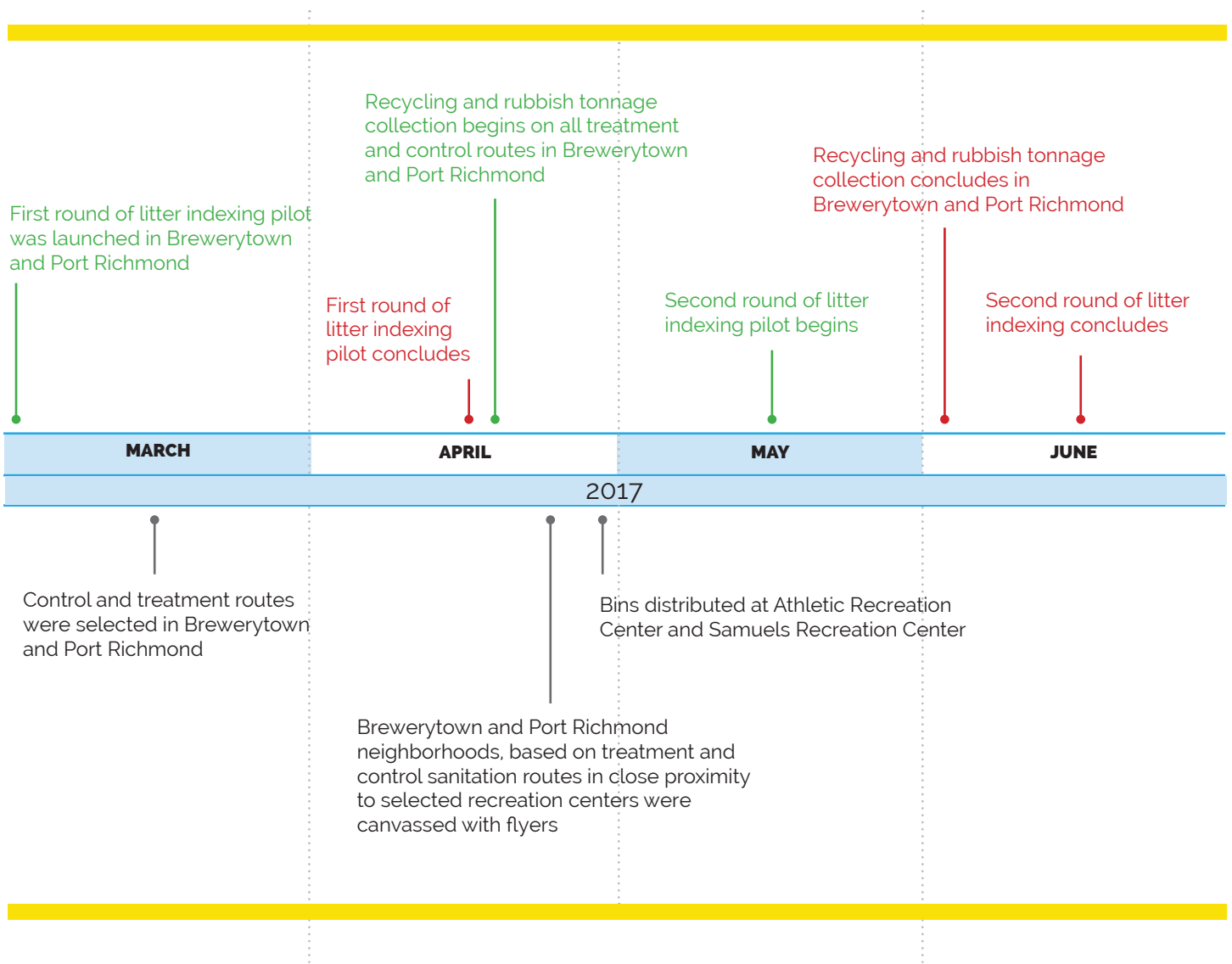
Procedure

Those who picked up a bin received one with a lid, a flyer about recycling rewards, and a flyer on the ins and outs of recycling. To collect a bin, residents provided their address and phone number, which was used by the city to follow up with them about the lidded bins. Sanitation workers were also briefed on the introduction of the recycling bin lids on their routes and asked to ensure that lids stayed with the bins. Their feedback on how the lidded bins affected their routes was also captured via a survey at the end of the experiment period.

Weekly tonnage of recycling and trash was collected for the year preceding the start of the experiment and until June following the distribution. The four routes served as the treatment group and all other routes in the neighborhoods served as controls. The litter index for the neighborhood was also collected before the distribution (March 1, 2017 – April 15, 2017) and after the distribution (June 2017).

Project Timeline

All areas had an initial litter index measure collected from March 1, 2017 to April 15, 2017. From April 15, 2017 to May 1, 2017, baseline measures were collected. The first experimental manipulation window began at most sites on May 1, 2017, with other sites starting their manipulations shortly thereafter.



Qualitative data collected from conversations with residents who received lidded recycling bins noted that they **would be more likely to use lids if the lids were attached.**

Financial Considerations

The only cost incurred during this project was that of bin distribution which cost approximately \$14,000. This fee came from the Streets Department budget which allocates funding every year for purchasing residential recycling bins. These bins cost \$5 per unit and as part of this experiment, we also purchased lids for an extra \$2 per unit for a grand total of \$7 per bin for 2,000 bins for the total of \$14,000. Labor and transportation were not taken into account since these bins were delivered during normal work hours.

The return on investment (ROI) of distribution of bins in relation to amount of disposal fees saved was a major impetus for wanting to conduct this experiment. However, this increase in recycling bin distribution needs to be considered along with storage and staff time to distribute the bins in a decentralized manner such as using Parks and Recreation facilities as we did in this experiment. And even though the ROI on recycling in regards to bins is impressive, the Streets Department is still very mindful of bins being used by residents for uses other than recycling (storage, moving materials) and is implementing stricter oversight to ensure that a household can only receive two recycling bins per year. The Streets Department has piloted a program to record each household receiving a bin in an effort to limit each household to two bins. The pilot took place when we did this study and it helped the Streets Department to further develop this program.

Outcomes

As part of the City of Philadelphia's broader emphasis on reducing litter and waste, the primary goal of this intervention was to promote recycling and divert recyclable materials that might otherwise be placed with rubbish. As a result, our primary measures are the tonnage of the treatment and control routes for both recycling and rubbish collection and litter.

Data Variables and Collection

The Streets Department routinely collects data on the tonnage of recycling and rubbish trucks' hauls after collection. In some cases, trucks need to offload their rubbish or recycling multiple times, in which case we measured the total tonnage from the route. The Streets Department conveyed the data to the Zero Waste and Litter Cabinet in the form of Microsoft Word Documents, and local academic partners and research assistants worked to put the results into a fully compiled data format. This data export process was resource-intensive, as the data was originally stored in separate Microsoft Word documents by route and week, requiring significant effort on the part of City officials as well as academic researchers to obtain, reformat, and verify the data.

By bringing lidded recycling bins into the neighborhoods and reducing the difficulty of obtaining them, **we hypothesized that we would increase the tonnage in recycling and decrease the amount of litter.**

Although the Streets Department worked diligently with the Cabinet to supply the data, their data storage systems are set up to aggregate the tonnage numbers from each route into total tonnages for the entire district. Once tonnage weights are calculated on each tonnage sheet for a district's daily routes (see appendix A), these numbers are aggregated into a spreadsheet for the entire district. Then, the dump tickets and these sheets are filed away. This collection was not difficult for real time data during the experiment. However, to go back and filter out specific routes for the historic data proved very difficult and took much work and coordination between the Streets Department and the Cabinet.

For the analysis of litter rates, the Streets Department provided the Mayor's Office with the map-based survey results of sanitation districts 3C and 5F from the pre- and post-treatment periods, as well as geo-data of recycling routes. A Social Scientist working in the Mayor's Policy Office used the City's Address Information System (AIS) to geo-code the survey results, and then matched the geocoded survey data to the recycling route geo-data in order to analyze the results by recycling route. 10% of the surveyed locations (339 locations) did not return results from AIS, and must be hand-coded before a final analysis can be performed.

Hypotheses

The animating hypothesis is that the number and size of recycling bins that Philadelphia residents possess may constrain their ability to recycle, and that as a consequence, they may be throwing out recyclable material along with their rubbish. By bringing lidded recycling bins into the neighborhoods and reducing the difficulty of obtaining them, we hypothesized that we would increase the tonnage in recycling and decrease the amount of litter.

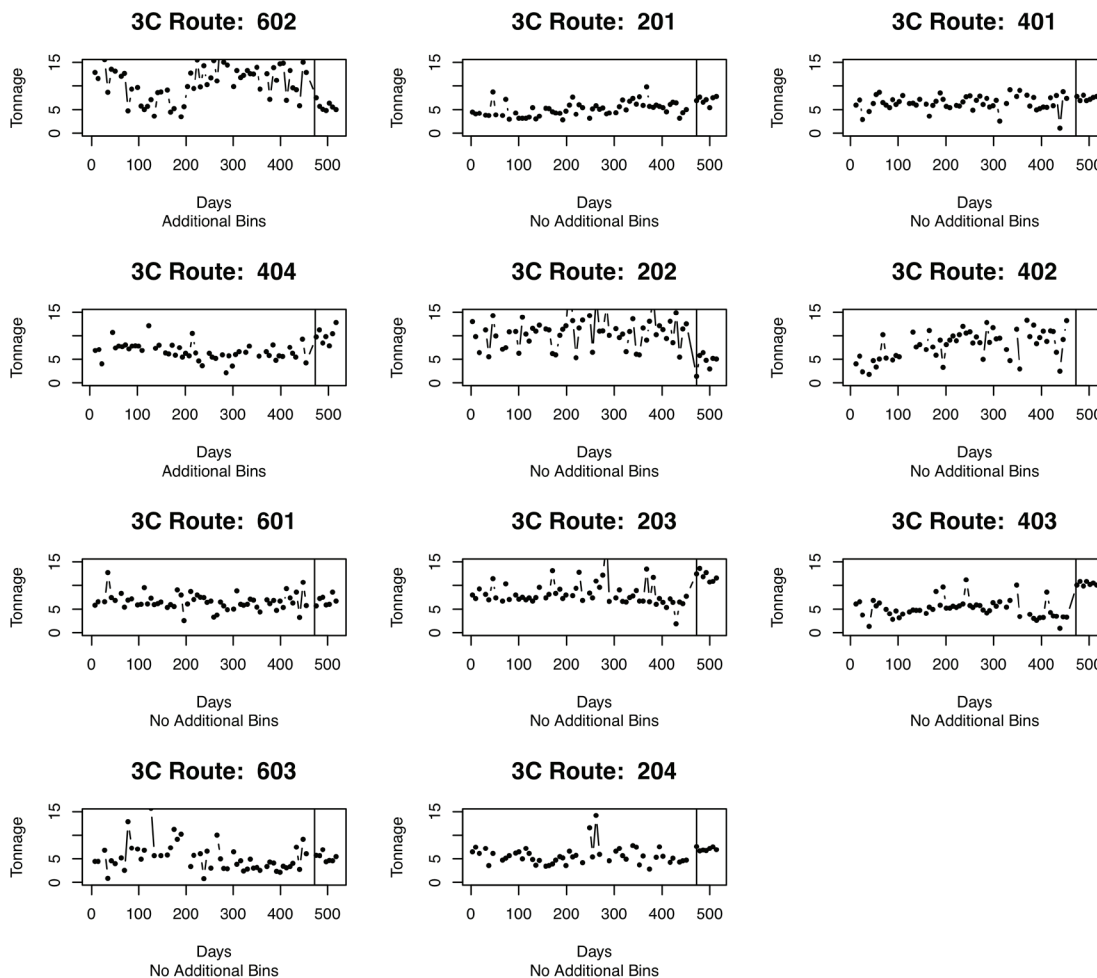
Analysis Plan

We initially summarize the results below using descriptive statistics. For a more formal analysis, because we observe the weights of recycling and rubbish collections for the treated and control routes before and after the distribution of recycling bins, a difference-in-differences analysis is appropriate. In such an analysis, we estimate the change in the outcome in the treatment and control groups before and after the intervention to determine whether the treatment induced a change in the treated group which leads its trajectory to differ from that of the control group (Angrist and Pischke 2009). Specifically, we employ linear models given the continuous nature of the dependent variable, and include several independent variables to isolate the possibly changing levels of recycling for households on the routes where recycling bins were distributed.

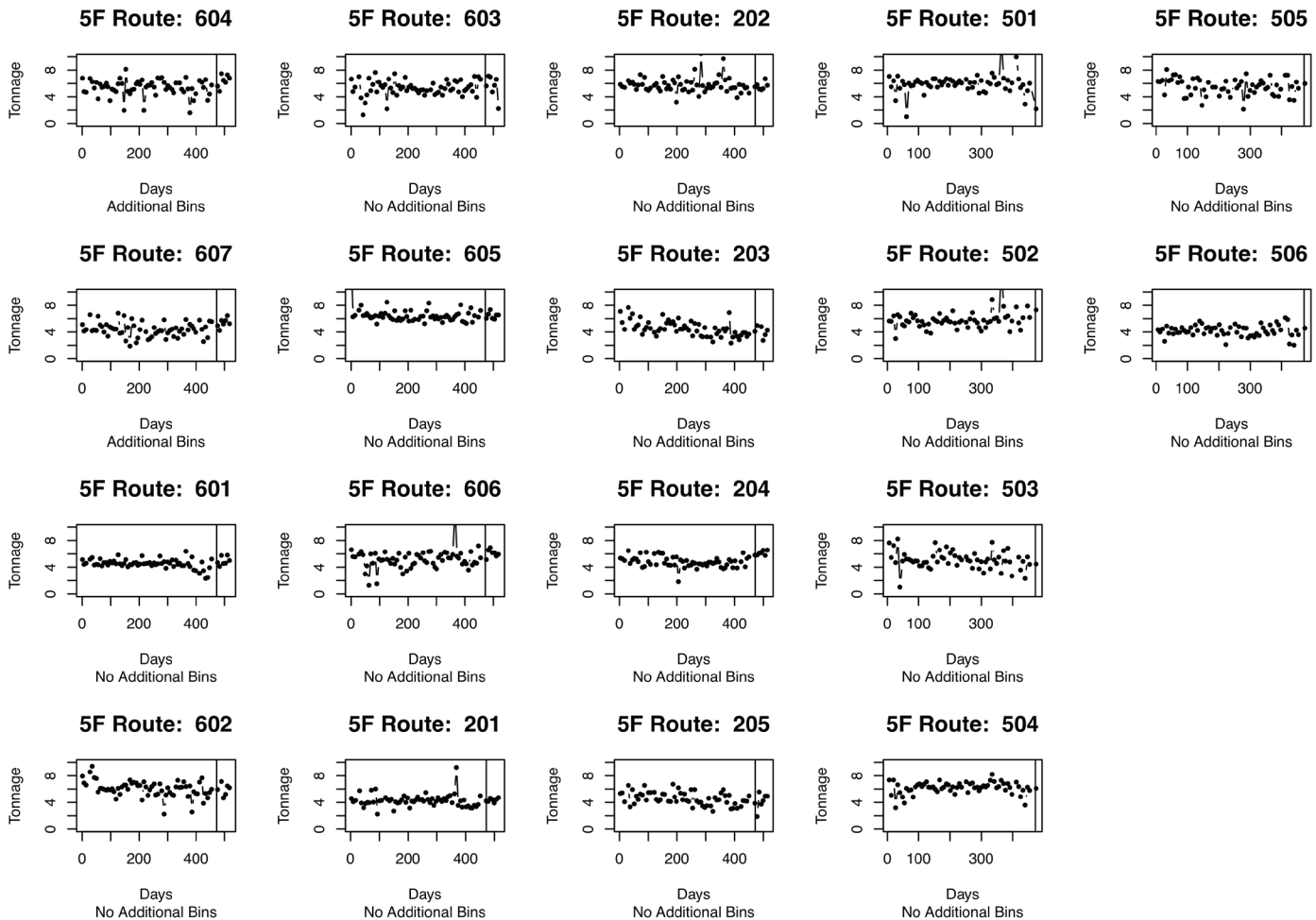
Results

The figure immediately below summarizes the average recycling tonnage for each route in each of the two neighborhoods. The y-axis reports the tonnage for each week and route while the x-axis reports the days since January 1st, 2016. The intervention happened on April 17th, 2017 (approximately day 472 in graphic below).

For the 3C (Brewerytown), ¹ routes, we see that the two treated routes have very different results. Route 602 shows a marked and unexpected drop in recycling tonnage, from an average of 10.5 tons before bin distribution to 5.8 tons afterwards. This drop is sufficiently large that it seems plausible there is an issue with the data and our procedures to match and aggregate tonnage data across routes. Route 404 is the other treated 3C (Brewerytown) route, and it by contrast shows a substantial increase, from 6.3 to 10.1 tons. Overall, there are several 3C (Brewerytown) control routes with sizable changes in their tonnages during the treatment, which reinforces concerns that despite the substantial efforts of City of Philadelphia employees and University of Pennsylvania and Temple University researchers, the data are too highly variable to render a precise estimate of the effect of the bin distribution.



Note that when including the 3C (Brewerytown) data as well as the 5F (Port Richmond) data, the result becomes negative, at -1.8 tons (SE=0.6). This suggests that the effect may not be uniform across different contexts.



For the 5F (Port Richmond) routes, there is less concern about the data, as the figure below makes clear. In these cases, the changes between the pre-intervention and post-intervention period in the control group are more modest, making measurement error less of a concern. Here, we observe that the level of recycling increased in both of the treated routes, 604 and 607. For Route 604, the increase averaged 1.25 tons, while for 607 it averaged 1.0 tons. The increases in the control groups were comparable, as they ranged from 0 (205) to 1.45 (601). However, because it is possible that the trends vary across routes, it is critical that we use statistical models to control for possible trends.

The preliminary results from the 5C bin distribution efforts indicate that recycling tonnages increased after the bin distribution, but whether such increases were larger than we would have expected without the bin distribution remains to be seen. To test this possibility more formally, we employed a difference-in-difference design, estimated via Ordinary Least Squares (OLS). Specifically, we specified an OLS model in which the amount of recycling

Currently, it costs the city approximately **\$16 less per ton** to dispose of recycling rather than landfill-bound trash.

collected by route and day was regressed on a series of independent variables. The unit of observation in these analyses is the route-day. Our models include an indicator variable for whether the tonnage in question was measured before or after the distribution of recycling bins as well as indicators for each route and a multiplicative interaction between whether a route was treated and whether an observation was from the post-treatment period. To account for different possible over-time trajectories by route, we also allowed each route to have its own coefficient for the relationship between the number of days and recycling tonnage.

The results indicate a positive effect of recycling bin distribution of approximately 0.66 tons, with a 95 percent confidence interval ranging from -0.09 to 1.42 tons. The estimate is similar when instead estimated via multilevel models with random, route-specific intercepts. While this result is not statistically significant ($p=0.09$), and while it is somewhat sensitive to model specification and data exclusion, it indicates that the effect of distributing recycling bins on recycling tonnage was likely to have had a positive effect on levels of recycling in Port Richmond. Currently, it costs the city approximately \$16 less per ton to dispose of recycling rather than landfill-bound trash. An increase in recycling of 0.66 tons per route in Port Richmond per week would translate into a savings of approximately \$9,884.16 per year in Port Richmond alone.²

Results from the Survey with the Streets Department

The sanitation worker surveys (see Appendix B for an survey sample) reported some households using lids while others did not and their feedback ranged from indifference of the lids on bins to positive feedback that the lids would help with reducing litter and improper set outs. There were no negative comments such as this would create more work and the only caution was that the lids could crack.

² The City pays \$48 a ton to recycle, and \$64 a ton to landfill. Bins with lids cost \$7 per unit. A 0.66 ton increase per week per route multiplied by 18 routes in Port Richmond multiplied by 52 weeks in a year would be an increase in recycling in Port Richmond of 617.76 tons. Assuming it costs \$16 less per ton to handle recycling versus landfill-bound trash, that's a savings of \$9,884.16 per year in this neighborhood alone.



Ethical Concerns

There are no major ethical concerns related to this project. The University of Pennsylvania and Temple University Institutional Review Boards determined the research does not involve human subjects, and is therefore exempt from further review.

The research protocols did not limit access to trash bins or other means of discarding trash as the number of recycling bins was increased. Our process was also mindful of the added labor burden of sanitation workers managing bins with lids and they were briefed on the introduction of lids on their routes before the experiment began and were surveyed on their experience after the experiment ended.

One situation that we did not foresee occurring, but did occur, is the issue of having left over recycling bins after the time and date of distribution. There were over 750 bins left over at Athletic Recreation Center. The recreation center would have preferred all bins to be distributed or picked up and relocated, but having individuals pick up bins post execution date would impact the experiment. As a compromise, the recreation center continued to distribute bins through the weekend, and documented who picked them up, and on what date. The City picked up the remaining bins the following Monday.

Another consideration is that according to resident feedback at the time of the bin giveaways and in follow up after the experiment, residents were extremely excited to receive lidded bins. Although the use of lids was not always observed on the routes that received them, residents did provide feedback that they use the lids in their homes to keep recycling organized and that if the lids were attached, they would be more likely to use them outside as well.

Recommendations

- Re-establish the relationship between Streets Department and Parks and Recreation for distribution of recycling bins for surrounding community members
- Pilot an investment in larger bins with securely attached lids
- Use lessons learned from this project to inform the possible purchasing of bins for a future City-wide residential composting program

Follow-Up

The Zero Waste and Litter Cabinet and the Streets Department intends to use the outcomes from this experiment to craft policy and regulation in the following three areas:

1. Currently, a majority of recycling bins are distributed at one of the six Sanitation Convenience Centers throughout the City. Although these centers are major resources for Philadelphia residents, residents with limited transportation options have difficulty accessing these centers. By studying the behavior and return on investment of increasing accessibility of recycling bins, we plan to use these data to determine how to allocate these resources. One next step would be to use the results of this experiment to re-establish the relationship between Streets Department and Parks and Recreation for distribution of recycling bins for surrounding community members. This relationship existed when single-stream recycling was first introduced in 2007 but was phased out over time.

2. The Streets Department is currently working on multiple pilots to introduce lidded recycling and trash bins in neighborhoods. These pilots are also considering using larger bins. The results from this experiment will help make the case as to whether the investment in larger bins with attached lids would be a beneficial investment for the City. The resident feedback we received, as expressed in the "other considerations" section is being considered when making these decisions.
3. The Streets Department is currently studying the feasibility of introducing a City-wide residential composting program. Being that the City currently supplies recycling bins for residents but not trash cans, the results of this experiment could be used to justify the future distribution system of city-issued composting bins.

Acknowledgments

The project team would like to thank the following people for their valuable contributions to this experiment - without them, none of this would be possible.

Yuan Huang and **Nandi O'Connor** from the Mayor's Policy Office; **Garry Howell, Faruq Scott, Troy Cooper** and all of the Streets Staff who delivered bins; **Bianca Reid and Becky Oliver** of Streets Department for data collection; **Jamie Miller** and the staff at Samuel Recreation Center; **Oktavia Cherry** and the staff at Athletic Recreation Center; research assistants **Tiger Brown, Justin Iannacone, and Yevgeniy Olkhov**; and 2018 summer policy fellows **Mehra den Braven and Henry Feinstein** for their editorial contributions.

Appendix A

Data collection form for rubbish and recycling tonnage.

Columbia

1/3/2017

RUBBISH						RECYCLING			
3C01		3C02	MONDAY						
WEIGHT	ROUTE	WEIGHT	ROUTE		WEIGHT	ROUTE	WEIGHT	ROUTE	
	201		201			201		203	
	202		202			202		205	
	203		203			204			
	204		204						
	205		206						
			207						
			208						
			WEDNESDAY						
	401		401			402		401	
	402		402			404		403	
	403		403			402		405	
	404		404			404		406	
	405		405						
			406						
			407						
			FRIDAY						
	601		601			601		602	
	602		602			603		605	
	603		603			604		606	
	604		604			607			
	605		605						
	606		606						

Appendix B

Feedback surveys sample and results of sanitation workers/ the Streets department to describe reactions to the recycling bins with lids.

Sanitation Worker Survey

This survey is in regard to the lidded recycling bins that were handed out on your recycling route. As we research the idea of adding lids to bins, we want to collect the feedback of the sanitation workers in the field to learn how these bins affect their jobs. Your feedback is very important to us and we thank you in advance for taking the time to complete this short survey.

1. Did you notice an increase in lidded bins on the route?

- a. Yes b. No

2. On a scale of 1-5, with 1 being the worst and 5 being the best, please rate your experience with removing the lids from the bins during collections

1 2 3 4 5

3. On a scale of 1-5, with 1 being the worst and 5 being the best, please rate your experience with keeping the lids with the bins after collections

1 2 3 4 5

4. Did you receive any feedback about the bins with lids?

- a. Yes b. No

If so, what was the feedback? _____

5. Do you feel that the bins with lids:

- a. Decreased litter and improper set outs
- b. Increased litter and improper set outs
- c. Made no difference

6. Please provide any other feedback below

Appendix B

Feedback surveys sample and results of sanitation workers/ the Streets department to describe reactions to the recycling bins with lids.

Responses to the Survey

1. Did you notice an increase in lidded bins on the route?

Number of Responses

Yes 2 No 6

2. Rate your experience with removing the lids from the bins during collections (5 being best and 1 being worst)

1 0

2 1

3 5

4 0

5 2

3. Rate your experience with keeping the lids with the bins after collections (5 being best and 1 being worst)

1 0

2 0

3 5

4 0

5 2

4. Did you receive any feedback about the bins with lids?

Yes 0 No 8

5. Do you feel that the bins with lids:

a. Decreased litter and improper set outs 2

b. Increased litter and improper set outs 3

c. Made no difference 4

6. Please provide any other feedback below

It should help

Cracked lids