Does "Per Bag Trash Collection Fee" Policy Reduce The Amount of Trash?

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垃圾減量一直是世界各地都很關注的城市議題。臺北市在西元 *2000* 年成為臺灣第一個嘗試利用"隨袋徵收"來收取垃圾清理費用的城市，並主張城市的垃圾減量成績斐然。隨後，新北市也在西元 *2010* 年採取相同的政策。本研究嘗試利用「時間序列下的斷點迴歸設計」*(RDD in Time, RDiT*）來捕捉兩城市"政策"與"政策前後垃圾量"的關係，並且加入未執行該政策的臺中市作為政策效果的比較依據。我們發現垃圾量確實因為政策有顯著的減少，但其貢獻的效果不及政府所公布：臺北市政府在兩年前主張垃圾量跟原先相比，減少了 *60% [7]*，但本研究發現實際上由政策貢獻的百分比約為 *44%*；而新北市政府同樣在兩年前主張垃圾量跟原先相比，減少了 *35% [8]*，但本研究發現實際上由政策貢獻的百分比約為 *15%*。

I. Introduction

Policy analysis is an important application of Economics research. It focuses on figuring out the influence of policies enacted by government, institution or similar groups. With comprehensive policy analysis, administrative organizations may comprehend more correctly on the cause and effect inside the policy, and assess if the policy accomplishes the expected goal.

While most individuals realize the necessity of policy analysis, few are aware of or comprehend the challenges it poses. The sophistication of the target population, which is usually a subset of the entire community, is one of the most difficult aspects of policy analysis. Because of society's diversity, there are numerous potential confounding factors, and it is impossible to include all of them in the study. The difficulty of con-

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ducting artificial experiments exacerbates the dilemma. It is impossible to create two identical situation. Therefore, Economists frequently try to find "natural experiments" in historical data to help overcome this difficulty. Economists also devised strategies to eliminate confounding factors, such as the Randomized Control Trial (RCT), Difference in Difference [6], Regression Discontinuity Design and Synthetic Control.

Large amount of trash produced by households has always been a problem all over the world. Usually, there are three methods for charging "waste removal and disposal fees" in Taiwan: based on water consumption, based on per household quota, and based on garbage volume. And local autonomies have the authority to determined within those policies. Among them, "the collection of water charges" is the most common in Taiwan, but "calculated according to the amount of garbage" is considered to be more in line with the "user charge" spirit. Therefore, more amd more cities, including Taipei City and New Taipei City, not execute "collection with the bag" policy when charging waste removal and disposal fees.

The government of Taipei city introduced the "Per Bag Trash Collection Fee" policy in July, 2000. The policy requires citizens in Taipei to collect garbage in a special plastic bag sold by the local government, and cleaning squadrons will only accepts the official trash bag issued by the Taipei government, obligating citizens to follow the policy. This policy is not only about hoping citizens can reduce waste, but also about motivating them to recycle more.

And later on, with Taipei City government claiming succeed regarding the policy, New Taipei City government decided to follow up the practice in December 25, 2010(Note that this research round on the date as 2011/01).

Both government claimed that the "Per Bag Trash Collection Fee" was very successful in the reduction of trash. In 2020, officials of Taipei City have claimed that this policy has reduced 60% of trash in Taipei City [7], and officials of New Taipei City have claimed that this policy has reduced 35% of trash in New Taipei City [8]. However, the lack of research into the causal relationship between "Per Bag Trash Collection Fee" and the reduction of trash adds a certain level of uncertainty toward the effectiveness of the trash bag policy.

Therefore, this research tries to fill this gap by quantifying the effect of the policy,

then demonstrate the previously mentioned causal relationship, and infer the potential political implications. Also, for the policy to succeed, we do not expect the waste will reduce suddenly. Hence, we will also look at the recycle situation in each city.

Note that the reaserch will not only look at data from Taipei City and New Taipei City, but also from Taichung City, where the policy is not fully conduct (only one, Ishigang District executes the policy), and is the closest city to New Taipei City regarding area and population.

The remainder of this paper is organized as follows. Section 2 is Literature Review. And in Section 3 we introduces our data. Then in Section 4 we have our exploratory data analysis. Later, Section 5 will be we report our empirical models and findings. Finally, in Section 6, we offer some conclusion and Discussions.

II. Literature Review

Sang et al. [1] studied how the citizens view this policy by issuing questionnaires to about a thousand Taipei citizens. Though the focus of the paper is similar to ours, our research focus on the result of the policy rather than the perception, and approached with a more quantitative way.

A work by Chen et al. [2] studied the feasibility of "Per Bag Trash Collection Fee" policy in other cities other than Taipei. The author loosely claimed that the causal relationship between the policy and the declination of trash exists based on directly comparing the amount of trashes before and after the policy implemented. This direct comparison ignore possible confounding factors and thus is not a rigorous prove of the causal relationship. In comparison, this work approached the problem with a more quantitative way and ruled out the confounding factors.

III. Data and Sample

The data that this research use are the monthly detailed trash data of Taipei City since 1986, New Taipei City and Taichung City since 2000. They were collected by Department of Environmental Protection of each city government [3]. This data have cover approximately 250-400 months(data points) and about 10 detail categories.

For the data of Taipei City since 1986, we are interested in "Trash Amount Collected by cleaning squadron" (清潔隊清運量) and "Trash Amount of Each Cleaning

Unit" (區隊垃圾量), as these categories are the amount of trash collected by the cleaning squadron, which should more accurately reflects the policy effect because these two metrics directly represent the amount of trash emitted by households. Note that for the rest of this paper, we will by default use "amount of trash" to represent "amount of trash collected by cleaning squadron".

As for the data of New Taipei City and Taichung City since 2000, we are interested in "Amount of Trash in one day per Capita,kg"(平均每人每日一般廢棄物產生量,公斤) and "General waste recycling rate,%" (一般廢棄物回收率,%), as the first one is directly represent the amount of trash, and the later present whether the policy successfully motivate citizens' willingness of recycling. Note that for the rest of this paper, we will by default use ""amount of trash per capita" to represent "amount of Trash in one day per capita,kg".

A. Limitation of The Data

The data collected is far from ideal. First of all, to conduct any causal inference research, it is better to have data from both control group and treatment group. In addition, the most ideal data is when from both groups prior to the treatment comply with the parallel-trend assumption. However, after consulting with Department of Environmental Protection around Taiwan, only Taipei Government publicly release their trash related data on a monthly basis before 2000, the year in which the policy execute. Furthermore, even for the yearly basis data, the earliest data that other local governments released is from 1997, which is only 3 years ahead of the implementation of per bag trash collection fee policy. This is not enough to conduct a difference-in-difference, synthetic control, or comparing two groups of regression discontinuity. Thus, for our first part of analysis, we based on comparing the within effect of the data from Taipei. As for New Taipei City and Taichung, we are lucky enough to reach out monthly basis data between 2000 and 2020, in which include the time period we need. Also, the data base not only contains the amounts of trash city collected, but also the recycle rate they calculated. This is helpful to the research, however, it is not clear how the rate is caiculated.

B. Data Pre-processing

For convenience, we have conducted some pre-processing on it. Our pre-processing pipeline is listed below:

1) Joining raw data of two different formats into the same format.

2) Removing invalid data points (I.e. missing amount of trash)

3) To compare the outlier effect resulted from Nari Typhoon, this research generated data by removing outlier months caused by Nari Typhoon (2001/09, 2001/10) [4].

4) In order to satisfy the precondition of our empirical method (the fourth section), this researcher extract 3 new groups of data: 1997/07 to 2003/07 for Taipei City, and 2008/01 to 2013/12 for both New Taipei City and Taichung. These are the data of three years before and after the implementation time of the policy (recall that the policy is implemented in 2000/07 in Taipei City, 2011/01 in New Taipei City).

Our pre-processing results in 9 groups of data:

1) **Taipei City/3 year**: contains ±3year of data from 2000/07 of Taipei City

2) **Taipei City/2 year**: contains ±2year of data from 2000/07 of Taipei City

3) **Taipei City/2 year remove**: contains ±2year of data from 2000/07, with the removal of data containmented by Nari Typhoon

4) **New Taipei City/3 year**: contains ±3year of data from 2011/01 of New Taipei City

5) **New Taipei City/2 year**: contains ±2year of data from 2011/01 of New Taipei City

6) **Taichung City/3 year**: contains ±3year of data from 2011/01 of Taichung City

7) **Taichung City/2 year**: contains ±2year of data from 2011/01 of Taichung City

IV. Exploratory Data Analysis

we divide our data into two group for the following analysis: data before the policy implemented (pre-policy), and data after the policy implemented (post-policy).

A. Taipei City

Taipei City executed the policy in July,2000. Hence, we look at the time period of "1998/07 to 2000/06" as 2 years of pre-policy, "2000/07 to 2002/06" as 2 years of post-policy, "1997/07 to 2000/06" as 3 years of pre-policy, and "2000/07 to 2003/06" as 3 years of post-policy.

One may observe from the Table 1 that there exist a large difference in the amount of trash per capita between the two groups(pre & post). When compare the mean of 2 years pre-policy and 2 years post-policy without Typhoon Nari, trash amount per person had reduce 0.01175kg each day, with the drcrease of 35%. From Figure 1, one may also observe an obvious decrease in amount of trash per capita in July, 2000, when Taipei City executed the policy. Note that the peak on the left figure(2001/9-10) is caused by Typhoon Nari. The right is a figure eliminated those two outlier.

Taipei City					
Trash amount per person	$\pm 2y$		$\pm 2y$ remove	$\pm 3y$	
policy	pre	post	post	pre	post
Mean	0.03329	0.02433	0.02154	0.03409	0.02244
Standard Deviation	0.002016	0.010437	0.003087	0.002544.	0.008973
Min	0.02991	0.01886	0.01886	0.02991	0.01496
1st Quantile	0.03174	0.01990	0.01964	0.03214	0.01892
Median	0.03263	0.02088	0.02085	0.03349	0.02027
3rd Quantile	0.0347	0.02234	0.02171	0.03573	0.02161
Max	0.03711	0.06612	0.03181	0.03991	0.06612
Sample Size	24	24	22	36	36

Table 1—: Summary Statistics of Trash Amount per Person (kg) in Taipei City

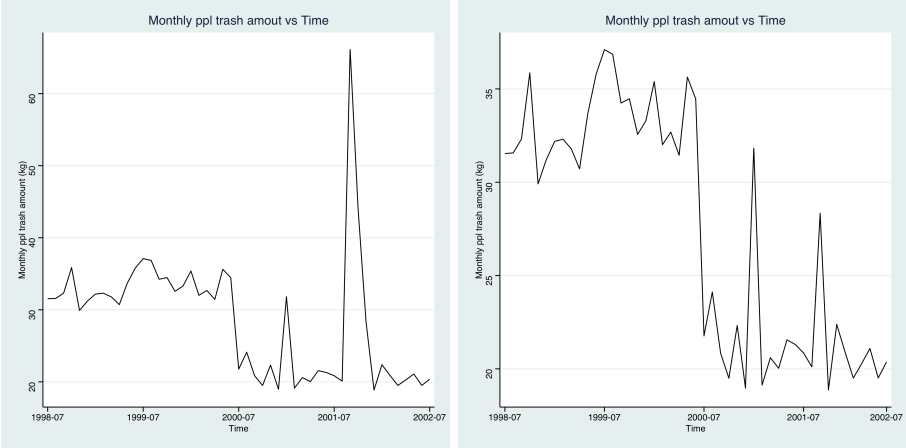


Figure 1. : Trash amount per person verses month. Left: Before pre-process Right: after pre-process

B. New Taipei City & Taichung City

New Taipei City executed the policy in Jan,2011. Hence, we look at the time period of "2009/01 to 2010/12" as 2 years of pre-policy, "2011/01 to 2012/12" as 2 years of post-policy, "2008/01 to 2010/12" as 3 years of pre-policy, and "2011/01 to 2013/12" as 3 years of post-policy.

One may observe from the Table2 that the difference of amount of trash per capita between the two groups (pre & post) in New Taipei City is obvious. When compare their mean of 2 years pre-policy and 2 years post-policy, daily amount of trash per capita had reduce 0.17kg, with the decrease rate 18%, and in 3 years of pre-and-post comparison, the amount decrease 19%. As for Taichung City, Table 3 shows slightly increase in daily amount of trash per capita during 2008/01 and 2010/12. The mean of amount 2 year after 2010/01 is 0.0262 more than that of 2 year before, with the increase rate of 3.3%. One can also obverse the same tendency in 3 year pre-and-post data.

Figure 2 (a) and (b) show the comparison of trash amount between New Taipei City and Taichung City. One may obverse that the trash amount shows periodicity in a yearly basis. While the trash amount of Taichung City remain almost the same pattern over the years, that of New Taipei City exists a great decrease in 2010/01. This might show that the policy did help reduce trash amount, however, we can't be sure whether it is other factor that makes this difference.

To understand more about decrease amount of trash, the research presents data of general waste recycling rate. One may obverse from Table 2 that the recycle rate increase by 12.38% over 4 years from 2009/01 to 2012/12. As for Taichung City, shown in Table 3, only 2.84% increase over the 4 years. The difference between two cities is significant, and can also be observe in the 3 years per-and-post period. The most obvious raise in New Taipei City is also in 2011/01, the time policy executed.We think that this help partly explain the decrease of trash amount in New Taipei City and might also be an evident of cause and effect between the policy and the reduction.

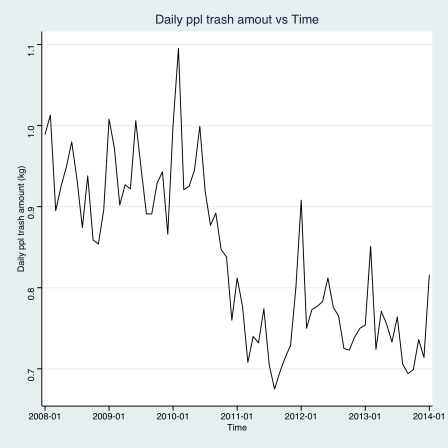
Nevertheless, we still don't know how much impact did the policy contribute to the reduction. There are other factors that can also make differences on the amount of trash, such as the raising awareness on environmental, which leads customers favoring eco-friendly stores or actively participate in recycling. Even with the comparison, showing that other factor might only play a limited role in the trash reduction(given that Taichung City is the closest city to New Taipei City regarding area and population, there are no other important policy we know regarding the issue execute within these years, and we assume that the environmental awareness won't be significant within the cities.), the research still can't be sure on how much impact did the policy contribute to the reduction. Therefore, we introduce empirical method in the following section hoping to seek the answer.

New Taipei City				
policy	pre	post	pre	post
Amount of Trash per Capita(kg)	$\pm 2y$		$\pm 3y$	
Mean	0.9260	0.7560	0.9258	0.7512
Standard Deviation	0.06846834	0.04882042	0.06261803	0.04679018
Min	0.7600	0.6750	0.7600	0.6750
1st Quantile	0.8910	0.7245	0.8910	0.7208
Median	0.9235	0.7500	0.9250	0.7450
3rd Quantile	0.9533	0.7770	0.9547	0.7745
Max	1.0950	0.9080	1.0950	0.9080
Sample Size	24	24	36	36
General waste recycling rate (%)	$\pm 2y$		$\pm 3y$	
Mean	48.29	60.87	44.71	61.45
Standard Deviation	5.605729	1.800349	7.004111	2.155533
Min	38.61	57.03	31.99	57.03
1st Quantile	44.39	59.88	39.31	59.94
Median	47.01	60.68	44.30	61.41
3rd Quantile	50.42	61.59	47.61	63.40
Max	63.48	64.64	63.48	65.53
Sample Size	24	24	36	36

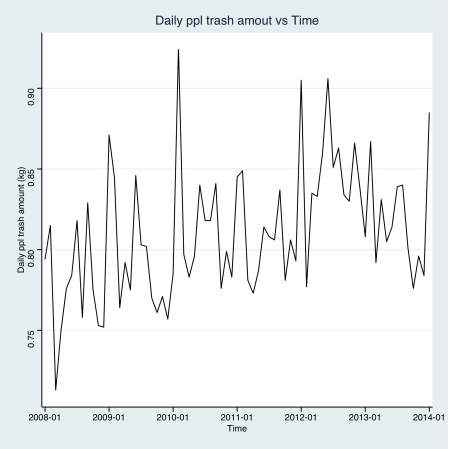
Table 2—: Summary Statistics of Amount of Trash in one day per Capita(kg) & General waste recycling rate(%) in New Taipei City

Taichung City				
policy	pre	post	pre	post
Amount of Trash per Capita(kg)	$\pm 2y$		$\pm 3y$	
Mean	0.7937	0.8199	0.7863	0.8229
Standard Deviation	0.03342354	0.03574067	0.03408709	0.03707743
Min	0.7570	0.7730	0.7130	0.7730
1st Quantile	0.7708	0.7915	0.7632	0.7915
Median	0.7840	0.8110	0.7795	0.8220
3rd Quantile	0.8023	0.8397	0.8023	0.8460
Max	0.8710	0.9050	0.8710	0.9060
Sample Size	24	24	36	36
General waste recycling rate (%)	$\pm 2y$		$\pm 3y$	
Mean	46.98	49.82	45.73	51.11
Standard Deviation	1.145087	2.474014	2.378321	2.507928
Min	44.79	46.63	39.60	46.63
1st Quantile	46.06	48.11	44.62	48.99
Median	47.26	49.10	46.02	51.25
3rd Quantile	47.56	50.27	47.42	53.48
Max	48.88	54.59	48.94	54.70
Sample Size	24	24	36	36

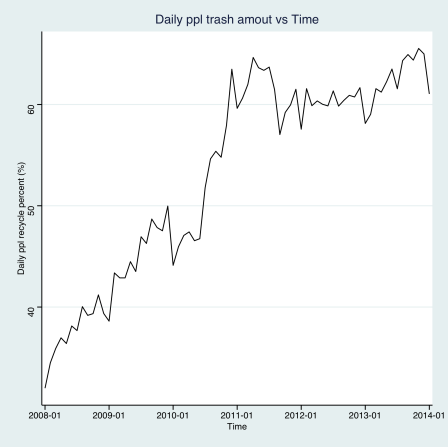
Table 3—: Summary Statistics of Amount of Trash in one day per Capita(kg) & General waste recycling rate(%) in Taichung City



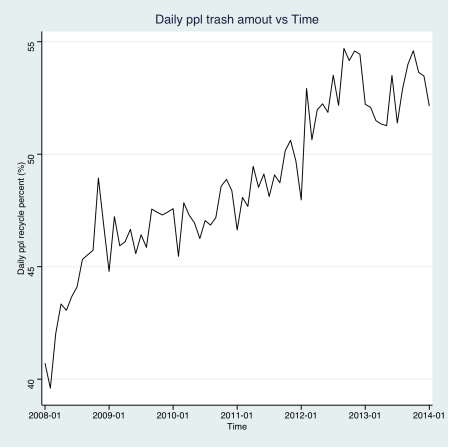
(a) New-Taipei trash amount per person



(b) Taichung trash amount per person



(c) New-Taipei recycle percent



(d) Taichung recycle percent

Figure 2. : Comparison of trash amount and recycle percent between Taichung and New-Taipei

V. Empirical Method & Results

Regression discontinuity design (RDD) is a well-known quasi-experiment method, and has been used extensively in the field of economics to study casual relationship. It can be used when the treatment depends discontinuously on some cutoff of a running variable. For example, suppose that one want to study the effect of going to college, and he or she know that one need to get 1500 in the college admission test in order to be admitted by college. In this case, he or she may pick two groups from all students: one with test score 1501(treatment group), and another with test score 1499(control group). It is reasonable to assume that the ability of these two groups are similar, and the threshold creates a discontinuity which allows us to analyze the causal effect of the treatment. Furthermore, if one view time as the running variable, it becomes another well-known method "RDD in Time" [5], or RDiT.

In this work, we use RDD in Time to examine the treatment effect. We view time (in month) as the running variable, and the policy created a discontinuity on the output (amount of trash). we assume that the city (Taipei) should be similar before and after the cut-point. The equation is given below:

$$\ln(Y_i) = \alpha + \rho D_i + \beta X_i + \eta_i$$

where Y_i is the amount of trash collected by the cleaning squadron per capita, X_i is month, D_i is a dummy variable indicating if X_i is greater then our chosen cutoff, η_i are other confounding factors, and α, ρ, β are coefficients. One might notice that there is a log at our Instead of choosing "total amount of trash" as our outcome variable, we choose "total amount of trash collected by cleaning squadron" because this number can directly reflect the citizen's trash-collecting behavior. Note that they should only use data surrounding the cut-point to satisfy the condition of RDD.

Besides from RDiT, there are several other methods well-known in studying casual relationship. The Difference in Difference [6] method is useful when the two groups we are comparing have some pre-existence but constant difference over time. In our scenario, the two group they are comparing does not have such characteristic. Synthetic control is another useful method to estimate the treatment effect. The main idea of synthetic control is to synthesize the control group from a weighted combination of groups and then compare it with the treatment group. This method is quite suitable for our problem. However, this method usually needs more then twenty groups for a

good synthetic control group, which implies that they need monthly trash data from other cities in Taiwan. As they currently only have data from three cities, they cannot apply this method to our problem.

A. Taipei

The study on Taipei was conducted by running RDiT on both 3 year trash per capita data and a version of the 2 year trash per capita data that removes the outlier data points. Table 4 illustrates the results of the RDiT. "Per Bag Trash Collection Fee" policy did significantly decrease the amount of household trash per capita. The "Per Bag Trash Collection Fee" policy significantly reduced the amount of trash per capita by 35.1% when comparing the amount of trash prior and after the implementation of the policy.

Nari Typhoon is the longest land-staying typhoon in the histroy of Taiwan. It has been estimated that approximately 100,000 tons of trash had been generated directly or indirectly by Nari Typhoon[9]. Hence, the effect of Nari Typhoon on the amount of trash is non-neglectable. In order to cope with the spike amount of trash resulted from Nari Typhoon, this research have generate a tweak version of the 2 year dataset by excluding the 2 months impacted by Nari Typhoon. As showcased in Figure 3, the effect of the "Per Bag Trash Collection Fee" policy increased to 44.2%. This result provides us a glance into the effectiveness of "Per Bag Collection Fee Policy". Numerical results and statistic values can be found at Table 4.

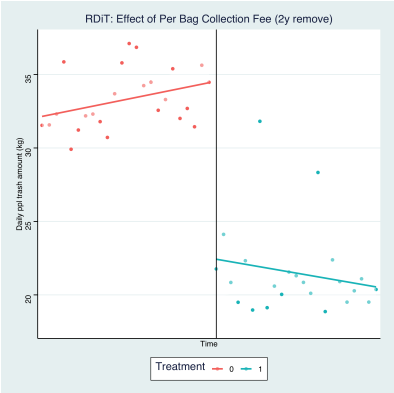
In order to further validate our findings, we ran 3 versions of RDiT with 2 kinds of bandwidth and a tweak version of the original data described in the data pre-processing section. The results provided us with adequate evidence of the effectiveness of "Per Bag Trash Collection Fee" policy as the reduction effect of policy dropped from 41.35% to 32.00% when we extend the bandwidth from ± 2 years to ± 3 years. Since the natural of RDiT is to test whether the treatment variable, in our case the amount of trash per capita, significantly changes right before and right after the cut-point. Therefore, theoretically speaking it is better to minimize the bandwidth as much as possible. The decline of the policy effect combined with the shortening of the bandwidth provided additional supporting evidence for the effectiveness of the "Per Bag Trash Collection Fee" policy.

In additional to validating the results with different bandwidths, this research also

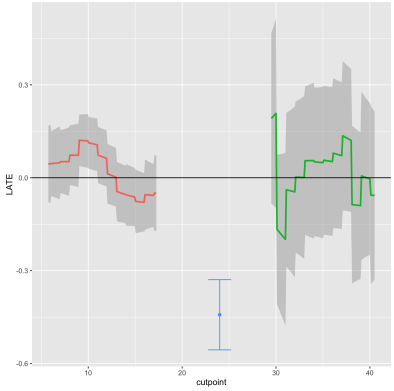
test with different sets of cut-point. It is intuitive to set the cut-point at 2000/07 to test the effect of policy since it was launched on 2000/07. However, the one-time result generated from one cut-point is not robust enough since there are a diverse range of factors that could affect the amount of trash per capita. Therefore, by evaluating the local average treatment effect (LATE) with different sets of cut-point, this research hopes to provide more robustness toward the effectiveness of the "Per Bag Trash Collection Fee" policy. Figure 3 (b) demonstrates the LATE at different cut-points. We may observe that the negative effect is the largest at our natural specified cut-point, while other cut-points does not have such results.

Taipei City			
	2 Year Remove	2 Year	3 Year
Policy Implemented	-0.442421***	-0.413467**	-0.319972**
D	(0.056223)	(0.123237)	(0.095897)
Before Policy	0.003043	0.003043	0.001328
X	(0.002841)	(0.006342)	(0.004094)
After Policy	-0.006674	-0.002593	-0.009324
x_right	(0.004152)	(0.008707)	(0.005069)
Intercept	3.541701***	3.541701***	3.525447***
	(0.040593)	(0.090624)	(0.072689)
Sample Size	22	24	36
R^2	0.8544	0.4477	0.5979
Adjusted R^2	0.8443	0.4109	0.5787
Residual Std. Error	0.09634(df=43)	0.2151(df=45)	0.1941(df=63)
F Statistic	84.13(df=3;43)	12.16(df=3;45)	31.22(df=3;63)

Table 4—: RDiT: Policy Effect of Per Bag Collection Fee (Taipei City)



(a) Taipei 2y-remove rdd



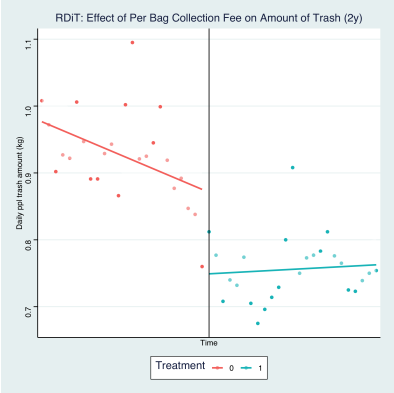
(b) Taipei 2y-remove placebo

Figure 3. : Taipei 2y-remove RDD

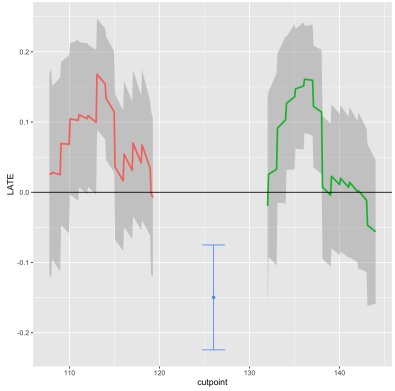
B. New-Taipei

We applied similar methods used above for analyzing Taipei data. Only data ranges and cut-points are different. For New-Taipei data, the policy implementation date is 2011/01, therefore we set it as a natural cut-point. We ran the experiment on both 3 year trash per capita data and 2 year trash per capita data. Both data showed that the policy significantly reduced the amount of trash per capita by 14% when comparing the amount of trash prior and after the implementation of the policy. We also ran the experiment on recycle rate, which shows that the policy have a positive effect on improving the recycle rate by 8%. One can view the visualized result in Figure4(a) and Figure5(a). Numerical result and statistical values can be found at Table5.

Simalar to above, in order to validate our finding, we analyzed the influence of cut-point and bandwidths selection, which is given by Figure 4(b), Figure5(b) and Table5. Those data and plots supported the robustness of our findings.

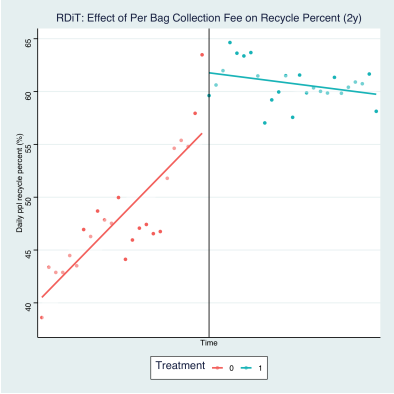


(a) New-Taipei 2y rdd

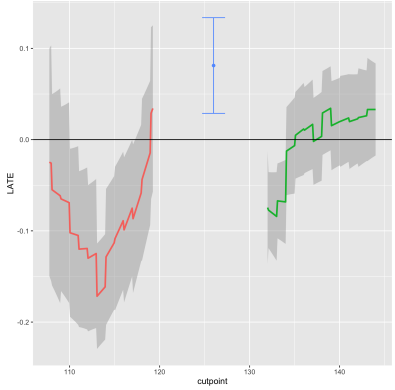


(b) New-Taipei 2y placebo

Figure 4. : New-Taipei Trash RDD



(a) New-Taipei 2y rdd



(b) New-Taipei 2y placebo

Figure 5. : New-Taipei Recycle Rate RDD

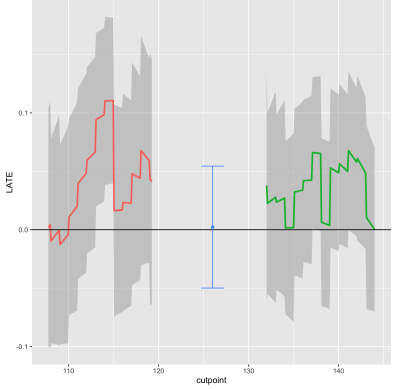
New Taipei City				
	Amount of Trash per Capita		Recycle Rate	
	2 Year	3 Year	2 Year	3 Year
Policy Implemented	-0.149724***	-0.164731***	0.081237**	0.0548676**
D	(0.037092)	(0.029951)	(0.026059)	(0.0199252)
Before Policy	-0.004981*	-0.001900	0.013646***	0.0138626***
X	(0.001909)	(0.001025)	(0.001341)	(0.0006820)
After Policy	0.005796*	0.001545	-0.015009***	-0.0128844***
x_right	(0.002621)	(0.001421)	(0.001841)	(0.0009453)
Intercept	-0.141776***	-0.114465***	4.041586***	4.0450089***
	(0.027276)	(0.021751)	(0.019163)	(0.0144699)
Sample Size	24	36	24	36
R^2	0.7376	0.7373	0.9058	0.9562
Adjusted R^2	0.7201	0.7259	0.8996	0.9543
Residual Std. Error	0.06474(df=45)	0.0639(df=69)	0.04548(df=45)	0.04251(df=69)
F Statistic	42.16(df=3;45)	64.56(df=3;69)	144.3(df=3;45)	502.7(df=3;69)

Table 5—: RDiT: Policy Effect of Amount of Trash per Capita & Recycle Rate (New Taipei City)

C. *Taichung*

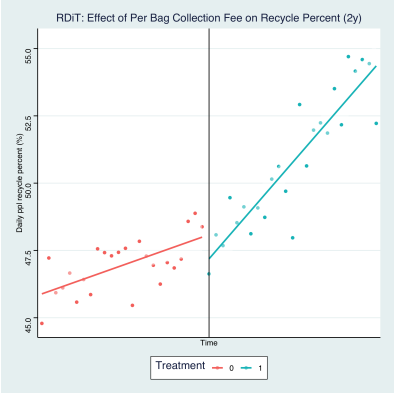
As a control group for New-Taipei, the experiment settings for Taichung is same as New-Taipei. Since the regression result is not significant, we may conclude that the dramatic decrease in New-Taipei is not some random event that decreases Taiwan's trash amount. Similar experiments for robustness are also conducted.

(a) Taichung 2y rdd

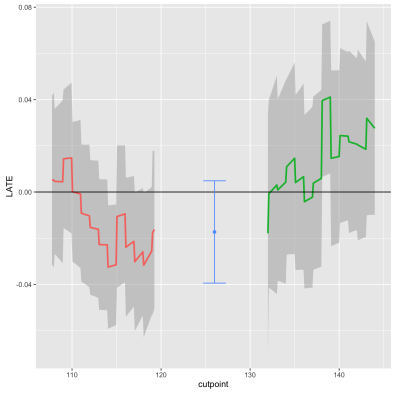


(b) Taichung 2y placebo

Figure 6. : Taichung trash RDD



(a) Taichung 2y rdd



(b) Taichung 2y placebo

Figure 7. : Taichung Recycle Rate RDD

Taichung City				
	Amount of Trash per Capita		Recycle Rate	
	2 Year	3 Year	2 Year	3 Year
Policy Implemented	0.0022601	0.0079213	-0.017301	-0.0129750
D	(0.0259140)	(0.0213805)	(0.010997)	(0.0139481)
Before Policy	-0.0002524	0.0012174	0.001951**	0.0035398
X	(0.0013337)	(0.0007318)	(0.000566)	-0.0004774***
After Policy	0.0026477	-0.0008777	0.003923***	-0.0002819
x_right	(0.0018309)	(0.0010143)	(0.000777)	(0.0006617)
Intercept	-0.2213529***	-0.2075898***	3.873047***	3.8926526***
	(0.0190563)	(0.0155267)	(0.008087)	(0.0101292)
Sample Size	24	36	24	36
R^2	0.1561	0.1758	0.8812	0.8392
Adjusted R^2	0.09986	0.14	0.8732	0.8322
Residual Std. Error	0.04523 (df=45)	0.04561(df=69)	0.01919(df=45)	0.02976(df=69)
F Statistic	2.775(df=3;45)	4.907(df=3;69)	111.2 (df=3;45)	120(df=3;69)

Table 6—: RDiT: Policy Effect of Amount of Trash per Capita & Recycle Rate (Taichung City)

D. Comparison

By comparing Taipei City and New Taipei City, we may observe that "Per Bag Trash Collection Fee" policy do have a sizable effect on trash amount. By comparing New Taipei City and Taichung City, we may conclude that a the effect in New Taipei City is not a random event.

VI. Conclusion & Discussion

The "Per Bag Trash Collection Fee" policy do have an effect in the reduction of trash amount per captia, but not as significant as claimed by government officials. Nonetheless, it is still fascinating that an policy can has such a huge impact on the daily lives of citizens. This research partially reveal the mask of causal relationship between the "Per Bag Trash Collection Fee" policy and the amount of trash per capita. Although the results of this research provided a certain level of evidence toward the effectiveness of trash reduction policies, it is still insufficient to call it a success, due to the lack of monthly basis data of cities aside form Taipei before 2000. Moreover, even though we do not find other important event regarding amount of trash in the year when the policy executed, we cannot be sure there isn't one. It is the prospect of this research team to further research into the trash data from different cities and utilizing additional empirical methods such as Difference in Difference or Synthetic Control.

REFERENCES

1) 桑鴻文（2002）。台北市垃圾專用袋政策之研究。中國文化大學政治學研究所碩士論文，台北市。 取自https://hdl.handle.net/11296/77nc4y
2) 賀力行、陳月香 (民92)，新竹市實施垃圾費隨袋徵收之可行性探討，會計與管理，1396卷頁1022-1024。
3) 臺北市政府環境保護局，75-110年5月垃圾量
4) Wikipedia page of Typhoon Nari
5) Hausman, Catherine and Rapson, David S. Regression Discontinuity in Time: Considerations for Empirical Applications
6) Abadie, A. (2005). "Semiparametric difference-in-differences estimators". Review of Economic Studies. 72 (1): 1–19. CiteSeerX 10.1.1.470.1475. doi:10.1111/0034-6527.00321.
7) 公視新聞網：北市隨袋徵收滿20年 環保局：垃圾量減6成
8) 垃圾費隨袋徵收近10年 新北垃圾減量35%
9) 環保署納莉颱風災後環境清理及消毒工作辦理情形