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ABSTRACT

Municipal governments commonly confront problems with property tax collection. We model tardy taxpayers as procrastinators that have a present bias. Late payments arise due to lack of salience, lack of deterrence or lack of tax morale. To test the importance of the different theoretical explanations, we developed and implemented a randomized controlled experiment conducted with the City of Philadelphia. The structure of the experiment allows us to identify the relative importance of the three key sets of parameters of our model. We find that lack of salience and lack of deterrence are key components of non-compliance behavior.

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1 Introduction

Property taxation is the primary tax for most U.S. cities. In fiscal year 2013, 30 percent of all local government revenues and over 73 percent of local taxes came from the property tax (Census of Governments, 2013). Yet collection of the tax has, in many cities, been problematic. While some U.S. cities do an excellent job in collecting the tax and receive over 95 percent of assessed revenues the year the tax is due, other cities have over the last ten years done significantly worse – notably Flint (78%), Cleveland (84%), Pittsburgh (86%), Milwaukee (87%), Philadelphia (88%), Detroit (89%), and St. Louis (89%).[1] While Flint, Detroit, Cleveland and Milwaukee are relatively poor cities, Philadelphia and Pittsburgh are not. Among the list of cities with outstanding tax collection records are Buffalo, Birmingham, Houston, and New Orleans. While city poverty is important, it cannot be the whole explanation for low rates of collection. Poor tax administration is likely to be an important contributing factor.

This failure to collect the property tax on time creates budget uncertainty at best and budget deficits at worst. Late payments are costly to the city. If not enforced, delinquent taxpayers may become permanent tax evaders. Furthermore, significant rates of delinquency today may become a signal to other taxpayers that avoidance is possible, encouraging further delinquency.[2] Yet collecting the property tax should be straightforward. In contrast to collecting self-reported taxes on income, profits, and sales, property tax obligations equal the city's assigned assessed value of the property times the city chosen tax rate, and are known by both the city and the taxpayer. There is no uncertainty as to what is due, or when. Property tax payment is a matter of enforcement.

[1] For details, see Chirico et al., (2016).

[2] See Besley et al.,'s (2015) study of local property taxation in England following imposition of a local head tax as a replacement for the local property tax. In response to widespread citizen resistance, the poll tax was removed two years later and the property tax restored. But compliance rates for the reinstated property tax fell by 14 percent. Though efforts to improve compliance emphasized high penalties it has taken nearly eighteen years to return to the original levels of tax compliance.

Following the prescriptions of the economic theory of tax enforcement as outlined in Allingham and Sandmo (1972), the most common enforcement strategy is the economic stick: fines and penalties. Failure to pay property taxes in time leads to interest penalties sufficiently large that there is no arbitrage advantage to waiting, and perhaps to a significant late fine as well. When a delinquent taxpayer does not respond to penalties and fines, the city can issue a tax lien on the property equal to the value of the taxes owed and accrued interest and penalties. A lien does not impose an immediate direct cost on the taxpayer since payment to the holder of the tax lien will not occur until the sale of the property.[3] The owner of the lien, typically the city, can start forced sale of the property through a foreclosure process. The home is then sold at auction with proceeds of the sale used to pay taxes, interest, and penalties due with any remaining proceeds from the sale returned to the property owner. It is only possible to avoid payment by abandoning the property, a costly option for most homeowners.

Despite the significant penalties associated with late payments many taxpayers do not pay on time. Understanding why taxpayers may be tardy has policy implications for the design and implementation of property tax administration. Taxpayer motivation for late payments may be simply economic – the homeowner could be cash constrained – or behavioral. Cash constrained households can be helped by offering payment plans. Those who do not pay on time for behavioral reasons, however, may need a "nudge." The nudge can be a simple reminder, a reminder that also stresses the fines and penalties associated with late payments, or a reminder that appeals to an intrinsic motive for tax payment such as "most of your neighbors pay their taxes on time," "taxes provide valuable city services," or "with citizenship comes an obligation to pay one's taxes." Reminders that work can be implemented to improve city tax collection, and if collected revenues exceed the cost of the reminder provide a valuable additional tool for efficient tax administration (Keen & Slemrod, 2017).

[3] A city can sell a tax lien to a private firm to increase the city's current revenue collections from delinquent taxes. Selling liens to "vulture investors," however, can be politically costly.

Recent empirical research on the use of nudges to improve tax collections have shown targeted reminders can be effective motivators for increased taxpayer compliance. But success depends upon the action being nudged and the exact wording of the reminder. Most successful nudges have been applied to truthful reporting of the taxpayer's tax base, with the reminders stressing the likelihood of a taxpayer audit and associated economic fines on unreported income or sales; see Kleven, Knudsen, Kreiner, Pedersen, and Saez (2011) and Pomeranz (2015) specifically, and Alm, McClelland, and Schulze (1992), Hallsworth (2014), and Slemrod (2017) for general reviews. Less successful have been reminders that stress an intrinsic or "tax morale" motive for tax reporting or payment; see Slemrod, Blumenthal, and Christian (2001) and Luttmer and Singhal (2014) for a review. That said, well-targeted tax morale messages have worked, in particular those that stress compliance behavior by the taxpayers' peers; see Dwenger, Kleven, Rasul, and Rincke (2016) and Hallsworth, List, Metcalfe, and Vlaev (2017).

Only four published studies have directly evaluated the impact of nudges on taxpayer compliance for the paying of local government taxes. Torgler (2004) finds no increased compliance associated with tax morale messages for the payment of income taxes to Swiss local governments. Dwenger et al. (2016) find increased compliance associated with tax morale messages stressing peer behavior in the payment of the local church tax in Germany. Meiselman (2018) finds improved compliance by "ghost" filers of Detroit's local income tax for reminders that stress economic penalties but no improved compliance for reminders that stress taxes are essential for Detroit's economic future. Castro and Scartascini (2015) study of the payment of local property tax to Argentine municipalities finds significantly increased compliance for those receiving reminders stressing economic sanctions. There were only mixed results for those receiving a tax morale message, however. On average, the intrinsic messages stressing peer behaviors or the public service benefits of paying taxes had no impact on payment, but behavior differed by whether one had paid taxes in the past or owned property in, but lived outside, the city. Interestingly, being reminded that 30

percent of taxpayers did not pay their taxes reduced the rate of compliance among those who usually pay their taxes. But, taxpayers who live outside the city and had initially lower average rates of compliance increased their rates of payment in response to both the peer and public service reminders.

The mixed results for the impact of nudges on taxpayer compliance is an important reminder that context matters. Nudges that work for one tax and for one government may not work in other settings. This fact is nowhere more clearly evident than in the careful decomposition by Castro and Scartascini (2015) of the impact of nudges on compliance for property taxpayers in Argentina. That there are no general lessons beyond that that nudges, in some form and in some settings, can improve compliance is perhaps the empirical literature's most important lesson. The implied recommendation is that nudges can be a useful policy tool for efficient tax administration, but each nudge must be evaluated and compared in a specific setting of tax compliance.

With this conclusion in mind, we report the results for our evaluation of a policy experiment to increase tax compliance in Philadelphia for the payment of fiscal year 2016 property taxes. The sample included all 21,500 taxpayers who were tardy in their tax payments for that fiscal year. Taxpayers who received a reminder letter were mailed one of seven letters: a simple reminder, either of two reminders stressing either a "gentle" or "strong" economic sanction, and one of four reminders stressing a role of taxes in paying for neighborhood or city-wide services, the payment behavior of their neighbors, or a civic duty of citizens to pay their taxes. Of the 21,500 tardy taxpayers, 2,088 received no reminder and served as our control group.

The evaluation reached six conclusions. First, a simple reminder letter had a statistically significant effect on compliance when compared to our control group who received no reminder. Second, the content of the reminder letter matters. The two letters that stress the likely economic sanctions of continued tardy payment led to faster and higher levels compliance than the simple reminder. Third, adding an intrinsic message to the reminder,

one that stressed the value of public services, neighbors' compliance, or civic duty did not increase compliance over receiving only the simple reminder. Fourth, most of the taxpayers who did respond with payments, paid their full tax obligation. Fifth, reminders were very cost effective on the margin. Each letter cost one dollar to send and returned on average $37 in increased city tax revenues. The two letters stressing economic sanctions were the most effective, returning $65 in extra revenues for each letter sent. Sixth, reminders had no staying power. Having received a 2016 reminder letter had no effect on the taxpayers likelihood of paying their 2017 property taxes on time.

The rest of the paper is organized as follows. Section 2 discusses details of our field experiment including a description of the treatments and the randomization procedure. Section 3 discusses our randomization procedure. Section 4 reports the main empirical findings. Section 5 discusses the urban fiscal policy implications of our experiment. Section 6 discusses the effectiveness of nudges. Section 7 offers conclusions.

2 A Field Experiment

The research setting for the experiment is the City of Philadelphia for calendar year, 2015, for the payment of property taxes for fiscal year 2016. Notices of property tax payments are sent on January 1, and the full balance of taxes are due by March 31. If payment has not been received by that date, or the taxpayer has not entered into a tax payment plan with the City, then taxes are considered tardy and interest and penalties begin to accrue. On April 1, the City's Department of Revenue (DoR) begins contacting all taxpayers with unpaid accounts, informing them of taxes due and accumulated interest and penalties for late payment. At this time, the City will normally send two-thirds of the tardy accounts to outside collection agencies acting as co-counsel for the City. The outside collection agencies are reimbursed at the rate of six percent of all their tardy revenues collected by December 31. The remaining one-third of the tardy accounts remain with the DoR for collection. All

accounts still tardy on December 31 are designated as "delinquent" and then assigned to new outside collection agencies. For the purposes of our experiment the City of Philadelphia agreed to delay sending any of the tardy accounts to the collection agencies until August 15, 2015.

Our experiment was implemented with those taxpayers newly tardy on March 31, 2015. Of the 579,828 properties in the city receiving 2015 tax bills, approximately 100,000 or 17 percent were late in payment as of April 1. Of these 100,000 properties, 27,264 (owned by 21,468 taxpayers) had tax obligations of more than $10 as of May 15, 2015, but had not owed property taxes from prior years. Our experiment excludes all chronically delinquent taxpayers who owed taxes from prior years. Of the 21,468 tardy taxpayers, 2,429 taxpayers owned more than one property. While all 21,468 taxpayers were included in our experiment, we focus our empirical work on the 19,039 taxpayers who owned only one property.[4]

Our experiment began with the mailing of our experimental reminder letters in mid-June, 2015 and continued to December 31, 2015. Of the tardy taxpayers with a single property, 16,940 received a reminder letter and 2,088 taxpayers did not receive a reminder. This sample of 2,088 taxpayers became our "holdout" sample and the basis for identifying the importance of reminders in taxpaying behavior. To ensure that our experiment was not contaminated by other treatments not under our control, the DoR agreed to postpone all other enforcement activities until August 15. In particular, the outside collection agencies were not allowed to begin their collection efforts until after that date. The likely earliest date that those efforts led to any contact with a taxpayer is September 1.

Each reminder letter was approved by City's DoR to ensure that it could be understood by a taxpayer with at least a fourth or fifth grade level of English reading comprehension. Each letter also provided contact information for assistance for non-English speaking taxpayers. Translation were available for a number of different languages.[5]

[4]As a robustness check we repeated our empirical analysis for the full sample of 21,468 and the results are identical those we report in Sections IV and V below. These results are available upon request.

[5]Templates of the "reminder only" and "lien" letters are attached in the appendix. The full template for

Each reminder letter in our experiment was drafted to identify a potential channel that may affect taxpayers compliance. For brevity we present here the important distinguishing feature of each letter.

Reminder-only: **Our records indicate that you have a balance due of *balance.*** If you have already paid, thank you. If not, please pay now or contact us to arrange a payment plan. The fastest and easiest way to pay is online at www.phila.gov/pay. Paying by E-check only costs 35 cent – less than the cost of a stamp!

The reminder-only letter allows us to identify the potential importance of tax saliency to taxpayer compliance.[6]

Reminder plus Tax Lien: Failure to pay your Real Estate Taxes may result in a tax lien on your property in an amount equal to your back taxes plus all penalties and interest. When your property is sold, those delinquent tax payments will be deducted from the sale price. By paying your taxes now, you can avoid these penalties and interest. Properties near you in your neighborhood that have liens placed on them include: < List Three Properties and Sale Dates > **Pay your taxes now to avoid a lien being placed on your property. Our records indicate that you have a balance due of *balance.***

Reminder plus Lien and Sheriff's Sale: Failure to pay your Real Estate Taxes may result in the sale of your property by the City in order to collect back taxes. In the past year we have sold N properties in your neighborhood at a Sheriff's Sale. Included in these N properties are the following properties near you: <List Three Properties and Sale Dates> **Pay your**

the other letters are available as an online appendix.

[6]On the potential importance of saliency for individual choices, see (O'Donoghue & Rabin, 1999) and (Gabaix, 2017). Our experimental design identifies the effect of saliency alone as a trigger for tax compliance by estimating the difference in the rate of compliance for our holdout sample receiving no letter compared to the sample receiving the simple reminder letter only. Our reminders were mailed six months after the initial notification of taxes due, and thus could estimate the loss of saliency for this period only. Staggered mailings of the simple reminder letter could identify the rate of decline in saliency, but this was not possible in our experiment because of time constraints imposed by DoR.

taxes now to prevent the sale of your property. Our records indicate that you have a balance due of *balance*.

The reminder letter coupled with the threat of a lien, or a lien plus a sheriff's sale of the taxpayer's home, increase the expected interest and penalties to the costs of delay – that is, an increase in penalties. Both letters make clear that interest and penalties are not an empty threat and will be collected by listing neighborhood properties where these added enforcement measures have been implemented. A taxpayer lien for all interest and penalties will be collected at the future date of home sale, which may be a very large obligation if the home is sold significantly in the future. A lien coupled with a sheriff's sale may occur sooner and thus have lower accumulated interest and penalties, but the forced sale of one's home is likely to have very high psychic costs. Which of the two added penalties is larger, and therefore likely to have a stronger impact on compliance, will depend upon the circumstances of the individual tardy taxpayer. However, both letters should increase compliance over the holdout cohort from (i) the reminder effect on saliency and (ii) from the added expected penalty, and both letters should increase compliance over the reminder-only letter from the added expected penalty.

Our final four reminder letters test for the potential role of "tax morale" motives for compliance. An appeal to a tax morale is meant to cue a possible benefit from having paid one's taxes. In contrast to user fees, property tax payments are not tied to the citizen's receipt of particular services during our experimental period. In effect, each delinquent taxpayer is a potential free rider, and the appeal to a tax morale for payment is meant to overcome such self-interest.

We test for the importance of four such motives: 1) the value of knowing one is a contributor to the immediate services of one's neighborhood; 2) the value of knowing one is a contributor to the wider services that benefit the city as a whole; 3) the value of knowing one is part of a collective effort with other taxpayers or "peers" in paying for city services;

and 4) the value of knowing one has meet one's obligations as a citizen in a democracy. Each of these benefits may motivate taxpayer compliance, and our reminder letters are meant to trigger a possible recognition of the importance of each motive. Some tardy taxpayers may respond to one motive, some to another, and perhaps others to none at all if the free-rider motive is decisive. The four tax morale reminder letters are:

Reminder Plus Appeal to Neighborhood Services: We want to remind you that your taxes pay for essential public services in *neighborhood name*, such as <List Two Local Amenities such as a Park or a Library>, your local police officer, snow removal, street repairs, and trash collection. **Please pay your taxes to help the city provide these services in your neighborhood. Our records indicate that you have a balance due of *balance*.**

Reminder Plus Appeal to City-Wide Services: Your taxes pay for important services that make a city great. Your tax dollars are essential for ensuring all Philadelphia's children receive a quality education and all Philadelphians feel safe in their neighborhoods. **Please pay your taxes as soon as you can to help us pay for these important services. Our records indicate that you have a balance due of *balance*.**

Reminder Plus Appeal to Peer Behavior: You have not paid your Real Estate Taxes. Almost all of your neighbors pay their fair share: 9 out of 10 Philadelphians do so. **By failing to pay, you are abusing the good will of your Philadelphia neighbors. Our records indicate that you have a balance due of *balance*.**

Reminder Plus Appeal to Civic Duty: For democracy to work, all citizens need to pay their fair share of taxes for community services. **By failing to do so, you are not meeting your duty as a citizen of Philadelphia. Our records indicate that you have a balance due of *balance*.**

We take as evidence that an increase in tax morale increases the likelihood of tax compliance when a tax morale reminder letter increases the rate of compliance above that of those

receiving a reminder-only letter. If none of the tax morale letters impact compliance above a reminder-only letter then, at least on the margin for paying the property tax, the free-rider motivation is decisive for tardy Philadelphia taxpayers. In this case, increased enforcement will need to appeal to reminders and penalties.

3 Randomization Procedure

Randomization took place in two stages. As a baseline control, we randomly removed 3,000 tardy properties from the possibility of receiving any reminder letter at all, representing 2,088 property owners. These taxpayers (N=2,088) became our holdout sample and allowed us to estimate the efficacy of simply communicating with the taxpayer after the date that taxes are due. We next grouped all remaining properties by owner and randomized all owners to treatments based on the total amount of property taxes owed on all of their properties.

While the vast majority of properties in the city of Philadelphia are owned by those with just one property, approximately 10 percent of the properties are owned by individuals or firms that own two or more properties. Since we are interested in taxpayer compliance and not property compliance, we identified owners of multiple properties by their legal name and randomly assigned each owner to a treatment group.[7] Any tardy taxpayer holding multiple properties within each treatment group received the same letter for each of those properties. Given the high correlation between the propensity to pay taxes and total debt owed, randomization blocks were defined according to owner-level total debt to assure uniformity of samples along the dimension of debt owed. Each property assigned to receive a reminder letter was equally likely to receive each of the seven treatments. Since most tardy property owners own only one property, our main interest in this study will be households that only own one property in the city. Once we restrict attention to this sample, we have 16,940 tax-

[7]We lacked an objective identifier such as a social security number. There is some possibility that two or more different owners have the same name, but inspection by the authors found this to be very rare. To the extent that it occurs, we consider this random noise to the experiment.

payers in the treatment group and 2,088 taxpayers in the holdout sample. The total sample size for single property owners is 19,039. Table 1 checks whether the treatment and holdout groups are balanced based on the two most important variables, taxes due and assessed property value.

Table 1 shows that randomization was successful in the single property owner sample. The average debt owed by each owner was $1,287 in the treatment group and $1,233 in the holdout sample. The average assessed property value is $144,145 in the treatment group and $142,630 in the holdout group. The average tenure was 15 years across all groups. As a further test of our randomization procedure, we also checked to see whether randomization achieved spatial uniformity throughout the geographic expanse of the city. As reported in Table 1 geographic balance was achieved.

Next we test whether randomization was successful among the seven experimental treatment groups. Table 1 shows the results for the single property owner sample. Overall, we find no evidence that would suggest any problems with randomization. Results for multiple property owners, which do not differ from results for single property owners, are reported in Table A2 in the appendix.

4 Empirical Results

Table 2 presents our core results for the three month period of our experiment unaffected by the intervention of the two outside collection agencies hired by the City to begin their own enforcement efforts in September, 2015. We consider three distinct measures of tax compliance behavior. First, did the taxpayer make any contribution at all towards their tax bill; this is the *ever-paid* response. Second, did the taxpayer make a full payment of their tax bill; this is the *paid-in-full* response. Third, what was the total amount paid by the taxpayer; this is the *total-paid*. The sample in Table 2 includes only the 19,039 taxpayers who own a

Table 1: Balance on Observables (Unary Owners)

Variable	1	2	3	4	5	6	7	8	p-value
Amount Due	\$1,233	\$1,383	\$1,389	\$1,613	\$1,950	\$1,290	\$1,338	\$1,316	0.32
	(\$1,840)	(\$6,510)	(\$4,130)	(\$13,118)	(\$25,290)	(\$2,021)	(\$3,413)	(\$2,158)	
Prop. Value	\$142	\$163	\$147	\$155	\$206	\$130	\$130	\$166	0.29
	(\$509)	(\$1,316)	(\$699)	(\$966)	(\$2,035)	(\$181)	(\$181)	(\$1,336)	
Years Tenure	18.7	18.7	19.0	18.6	18.5	18.8	18.9	18.9	0.96
	(15.6)	(15.2)	(15.7)	(15.5)	(15.7)	(15.6)	(15.6)	(16.0)	
Center City	5%	5%	5%	5%	5%	4%	5%	5%	0.66
Northeast Philly	17%	18%	16%	15%	17%	16%	18%	16%	
North Philly	22%	21%	22%	22%	21%	20%	22%	22%	
Northwest Philly	26%	25%	27%	28%	26%	27%	25%	25%	
South Philly	10%	9%	10%	10%	10%	10%	10%	10%	
West Philly	21%	23%	21%	21%	22%	23%	20%	22%	
# Owners	2,088	2,420	2,432	2,419	2,389	2,441	2,417	2,433	

p-values in rows 1-2 are F-test p-values from regressing each variable on treatment dummies. A χ^2 test was used for the geographic distribution.

Standard deviations in parentheses. Property values are reported in \$1000.

1: Holdout, 2 : Reminder, 3: Lien, 4: Sheriff, 5: Neighborhood, 6: Community, 7: Peer, 8: Duty

single property.[8] For ease of interpretation, Table 2 presents OLS estimates for the linear probability model; logit estimates are available in Tables A3 and A4 in the Appendix and are identical in significance and interpretation to the OLS results reported here.

The top line of Table 2 reports the mean rate of compliance of our holdout sample for *ever-paid* or *paid-in-full* one month from the starting date of the experiment (July 15) and for the three months to the ending date of the experiment (September 15). The rate of *ever-paid* compliance for taxpayers in the holdout sample rises from 30.5 percent after one month to 51.4 percent after three months; the rate of *paid-in-full* compliance for the holdout sample raises from 23.5 percent after one month to 40.8 percent after three months.

The next seven rows report the additional impact on compliance from our seven treatment letters: Reminder-only, Reminder/Lien, Reminder/Sheriff, Reminder/Neighborhood, Reminder/Community, Reminder/Peer, and Reminder/Duty. Receiving the reminder-only letter increases the rate of compliance after one month for an *ever-paid* tax payment by 3.7 percent above the holdout's rate of compliance and by 3.9 percent after three months. Both effects are statistically significant at the 99 percent level of confidence. These estimates for the reminder-only letter indicate the relative importance of salience and the benefit of simple notification strategies to taxpayer compliance behavior.[9]

Our letter is particularly effective early in our experiment, where the pure effect of a reminder increases the rate of compliance after one month by approximately 12 percent (= 3.7/30.5). While receipt of the reminder letter is still effective after three months, its relative impact on compliance behavior is less, adding an additional 8 percent (= 3.9/51.4) to the rate of *ever-paid*. The same statistical significance and declining rate of impact of reminder-

[8]We have repeated our analysis for the sample of taxpayers, including multi-property owning taxpayers. Results for the full sample are identical to those reported here for single property owners. We limit our reported results here and our discussion to the single property owner sample. For comparison, results for the sample with multiple property owners are reported in Appendix Tables A1 and A4.

[9]For evidence from other settings that saliency matters and reminders have significant impacts in inducing appropriate behaviors, see Thaler and Sunstein (2003) and Karlan, Morton, and Zinman (2016). For evidence that simple reminders matter for the payment of local taxes, see Del Carpio (2013) and for the payment of local fines see Heffetz, O'Donoghue, and Schneider (2016).

Table 2: Short-Term Linear Probability Model Estimates

	Ever Paid		Paid in Full		Total Paid	
	One Month	Three Months	One Month	Three Months	One Month	Three Months
Holdout	30.5	51.4	23.5	40.8	$324.0	$636.6
Reminder	3.7***	3.9***	2.2*	3.0**	36.6	15.2
	(1.4)	(1.5)	(1.3)	(1.5)	(31.6)	(43.1)
Lien	9.0***	9.2***	5.7***	7.3***	117.0***	122.7**
	(1.4)	(1.5)	(1.3)	(1.5)	(43.9)	(54.9)
Sheriff	7.3***	8.8***	4.5***	6.7***	68.4**	96.8*
	(1.4)	(1.5)	(1.3)	(1.5)	(34.1)	(49.5)
Neighbor.	1.7	2.6*	−0.2	1.6	51.0	40.1
	(1.4)	(1.5)	(1.3)	(1.5)	(37.6)	(48.8)
Community	3.8***	2.8*	1.3	2.5*	41.1	18.3
	(1.4)	(1.5)	(1.3)	(1.5)	(32.6)	(45.1)
Peer	3.9***	3.5**	1.8	3.4**	59.0	119.6
	(1.4)	(1.5)	(1.3)	(1.5)	(36.6)	(76.1)
Duty	2.4*	3.6**	0.7	2.3	35.8	70.7
	(1.4)	(1.5)	(1.3)	(1.5)	(35.6)	(49.2)
Num. obs.	19039	19039	19039	19039	19039	19039

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Robust standard errors.

Holdout values in levels; remaining figures relative to this.

only on compliance is observed for the outcome, *paid-in-full*. Here the reminder-only letter increases the one month rate of compliance over the holdout sample by 2.2 percent on a mean rate of holdout compliance of 23.5 percent (9.4 percent improvement) and the three month rate of compliance over the holdout sample by 3.0 percent on a mean rate of 40.8 percent (7.4 percent improvement). While most of the new taxpayers paid in full – 3 percent compared to the 3.9 percent of all new payers after three months – the additional revenues raised by the reminder letters over that paid by those with no letter is never significant and is quantitatively very small, on average only $15.20 more than the amount paid by the holdout sample after three months.

Similar to results from other tax compliance studies, adding a more substantive message to the reminder letter produced a mixed impact on taxpayer compliance, depending on the content of the message. Table 3 reports the joint effects of receiving a reminder and one of the substantive messages. Of the six messages, only the reminder/lien and the reminder/sheriff letters had a statistically significant added impact on compliance above the simple reminder. After one month, the sample receiving the reminder/lien letter had an additional 9.0 percent rate of *ever-paid* compliance over the hold-out samples rate of compliance of 30.5 percent (30 percent improvement) and after three months an additional 9.2 percent rate of *ever-paid* compliance over the hold-out samples compliance rate of 51.4 percent (18 percent improvement). The impacts are statistically significant at the 99 percent level of confidence. The results for *paid-in-full* compliance for the reminder/lien letter are also statistically significant and add 5.7 to the rate of compliance over the holdout sample after one month and 7.3 percent to the rate of compliance after three months. Importantly, the impact of the reminder/lien letter on total taxes paid over that for the holdout sample is statistically significant and shows increased payments of from $117 per letter (36 percent improvement) to $122.7 per letter (19 percent improvement) after one and three months, respectively. Though with slightly smaller impacts on compliance and taxes paid, the reminder/sheriff letter also yields significantly higher compliance rates and tax payments above the holdout sample.

Table 3: Short-term Results: Relative to Generic Reminder

	Ever Paid		Paid in Full		Total Paid	
	One Month	Three Months	One Month	Three Months	One Month	Three Months
Reminder	34.3	55.3	25.7	43.8	360.6	651.8
Lien	5.3***	5.3***	3.5***	4.2***	80.4*	107.5**
	(1.3)	(1.4)	(1.2)	(1.4)	(41.6)	(45.7)
Sheriff	3.6***	4.9***	2.3*	3.7***	31.8	81.5*
	(1.4)	(1.4)	(1.2)	(1.4)	(27.9)	(42.4)
Neighborhood	−2.1	−1.2	−2.5**	−1.5	14.4	24.8
	(1.3)	(1.4)	(1.2)	(1.4)	(34.6)	(40.6)
Community	0.1	−1.0	−0.9	−0.5	4.4	3.0
	(1.3)	(1.4)	(1.2)	(1.4)	(24.4)	(32.3)
Peer	0.1	−0.4	−0.4	0.3	22.4	104.3
	(1.3)	(1.4)	(1.2)	(1.4)	(35.4)	(71.8)
Duty	−1.3	−0.3	−1.6	−0.8	−0.8	55.4
	(1.3)	(1.4)	(1.2)	(1.4)	(32.4)	(39.9)
Num. obs.	16951	16951	16951	16951	16951	16951

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Standard errors clustered by block.

Reminder values in levels; remaining figures relative to this.

The four tax morale letters stressing the payment's benefits of neighborhood (*neighbor*) and city (*community*) services, compliance behavior by other Philadelphians (*peer*), or civic duty (*duty*) to pay one's taxes have a "reminder-only" effects on compliance behaviors. There is no statistically significant added compliance to the tax morale reminders above that obtained from just the simple reminder letter. This is seen most clearly in Table 3 where we compare compliance in the reminder-only sample to that of the samples receiving one of the six message letters. In this comparison, both the reminder/lien and the reminder/sheriff letters stressing economic sanctions of noncompliance have statistically significant and policy relevant additional impacts on compliance above reminder-only, both for the *ever-paid* and *paid-in-full* outcomes and at the one month and three month intervals. The lien letter adds more than a 5 percent increase in the rate of compliance above the reminder-only letter for *ever-paid* and about 4 percent to the rate of compliance for *paid-in-full*. These effects represent a 10 to 15 percent improvement in the rates of compliance over those obtained with the reminder-only letter. The sheriff letter also offers a significant improvement over the reminder-only letter, though the effects are slightly lower than those obtained with the lien letter. Compliance rates for *ever-paid* increase by 3 to 5 percent and for *paid-in-full* by to 2 to 4 percent above those achieved with the simple reminder. These effects represent a 9 to 11 percent improvement in compliance performance over what had been obtained with a reminder only. Table 3 also shows most clearly the inability of the tax morale reminders to induce greater compliance from Philadelphia's tardy taxpayers. Among those reminders, only the neighborhood letter is ever statistically significant and its effect is negative for those paying in full.[10] Our results are similar in statistical significance and impact to those

[10] Our results for both the positive impact of penalties the limited effectiveness of tax morale messages beyond a simple reminder are consistent with most of the current literature on nudges and tax compliance. We need to mention, however, that in contrast to our results here, our pilot study for this project found no significant effect for a letter stressing economic sanctions but did find modest effects for letters stressing the community benefits of taxation and a civic duty for tax payments; see Chirico, et. al. (2016). The community letter increased rate of compliance in our pilot sample by 4 percent (though the effect was not quite statistically significant) and a letter that combined a peer and civic duty motivation increased compliance by 2 percent and was statistically significant. Neither effect was economically large. It is worth

in Castro and Scartascini's (2015) study of property tax payments in Junin Argentina, the other major field experiment seeking to improve property tax collection.

Table 4: Long-Term Linear Model Estimates

	Six Months			Subsequent Tax Cycle		
	Ever Paid	Paid in Full	Total Paid	Ever Paid	Paid in Full	Total Paid
Holdout	73.3	63.2	937.9	65.5	52.5	1043.9
Reminder	1.3	1.5	21.2	−1.4	−0.7	−24.7
	(1.3)	(1.4)	(50.0)	(1.4)	(1.5)	(69.1)
Lien	3.7***	4.8***	87.5	−0.9	−0.7	38.9
	(1.3)	(1.4)	(58.8)	(1.4)	(1.5)	(96.9)
Sheriff	3.7***	2.9**	74.5	−0.6	−1.1	245.8
	(1.3)	(1.4)	(55.9)	(1.4)	(1.5)	(260.6)
Neighborhood	−0.2	−0.0	47.6	−3.1**	−2.1	181.3
	(1.3)	(1.4)	(55.3)	(1.4)	(1.5)	(189.6)
Community	0.9	1.1	55.0	−1.8	−2.0	−52.9
	(1.3)	(1.4)	(53.6)	(1.4)	(1.5)	(66.8)
Peer	1.4	2.3	130.0	−1.9	−1.1	−69.0
	(1.3)	(1.4)	(79.5)	(1.4)	(1.5)	(65.9)
Duty	2.1	1.0	120.3**	−1.6	−1.9	37.1
	(1.3)	(1.4)	(57.6)	(1.4)	(1.5)	(70.2)
Num. obs.	19039	19039	19039	19036	19036	19036

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Robust standard errors. Holdout values in levels; remaining figures relative to this.

Change in sample size between long-term and subsequent year results reflects property dissolution for three properties.

Table 4 estimates the longer run impacts of our seven nudge interventions on compliance. Our reminder letters were sent on June 15th and received soon thereafter. The first two

speculating as to why our results here differ from those in our pilot study. We suspect the difference is due to differences between the two studies sample populations. Here we have the full sample of all tardy taxpayers. In contrast, our pilot study was limited to a small sample of tardy taxpayers who had not yet paid by November of the fiscal year taxes were due. These taxpayers were more than eight months tardy in their payments, even after repeated reminders by the city and collection agencies that taxes were due. Also in contrast to our results here, the taxpayers who did respond to the reminder letters made only partial payments, typically around $100, suggesting again the importance of heterogeneity of tardy taxpayers. It is likely these "very late taxpayers" are significantly cash constrained, and a payment plan and meeting directly with the taxpayer may be necessary for improved compliance.

columns of Table 4 show the estimated effects of having received a letter on compliance six months later, again compared to compliance behavior in our holdout sample. Six month responses for those in the holdout sample and in our seven treatment groups now include the possible influence of the outside collection agencies on still delinquent taxpayers. We do not know their "treatment" strategies. The effects observed for the six month window therefore predict the impact of our "pure" treatments from our June letters interacted with the unknown treatments by the outside agencies. Since all tardy taxpayers including our holdout sample now receive some form of a reminder, it is not surprising that our original reminder letter no longer has a differential impact on payment behavior. What does continue to impact behavior, however, is our original reminders that stressed the risk of liens and sheriff's sales. The effects of our lien and sheriff reminders are now slightly smaller in percentage terms, though not significantly so. Again, none of the tax morale intrinsic nudges show a statistically significant impact on compliance behaviors. Those taxpayers are now receiving extrinsic reminders for the first time, just like those in the holdout sample. They appear to respond identically, resulting in no significant behavioral differences between those in the original holdout sample and in the tax morale intrinsic motivation samples.[11] This provides further evidence that extrinsic (penalties) messages are the only effective messages for converting non-payers to payers.

Left unanswered by these results is the question of why taxpayers respond to extrinsic messages that communicate pre-existing penalty information. One possible explanation is that taxpayers interpret the threat of enforcement as new information rather than a reiteration of existing information. The best evidence to date of this possibility is provided by a survey of risk perception accompanying Bergolo et al. (2017). They report evidence consistent with the idea that this new threat information is used to update the recipients perceived risk of enforcement and punishment.

[11]It is our understanding from DOR that their treatments are a combination of simple reminders and reminders coupled with extrinsic messages stressing penalties, liens, and perhaps sheriff sales.

The last two columns of Table 4 carry our sample into the next tax year, beginning with the receipt of a new property tax bill in early January, 2016, and asks if having received a reminder letter in June, 2015 improves compliance behavior for the payment of the 2016 taxes by June of 2016. Consistent with the importance of saliency, none of the 2015 reminder letters appear to have "staying power" into the next tax year. Tardy Philadelphians need constant reminders.

Table 5 shows the compliance behavior of tardy taxpayers by the size of their tax bill. Tardy taxpayers are divided into four quartiles by taxes owed: Quartile 1 (mean owed = \$149); Quartile 2 (mean owed = \$597), Quartile 3 (mean owed = \$1,133), and Quartile 4 (mean owed = \$3,885). All comparisons are for the outcomes *ever-paid* and total (taxes) paid relative to those in the holdout sample in Quartile 1. Three conclusions follow. First, tardy taxpayers in Quartile 1 owing the least in taxes are the most likely to make a tax payment, whether they receive a reminder letter or not; note the significant negative effect of being in Quartiles 2-4 of the holdout sample. Second, receiving a reminder/lien and reminder/sheriff letter improves *ever-paid* compliance for all four Quartiles, but the effects are greatest for those in the lowest two Quartiles. Third, if resources are limited and the objective is to maximize additional revenue collected, then from the results for total-(taxes)-paid the City should send the reminder/lien letter to taxpayers in Quartile 4, those who the most.[12]

Finally, our results shed light on the importance of liquidity constraints as a motivation for tardy tax payments. If liquidity constraints are important, then nudges may be insufficient unless accompanied by a way to smooth payments of the original tax obligation. Taxpayer agreements that spread payments over several months (typically, three to six months) without penalty provide for payment smoothing. Each reminder letter included a sentence stressing

[12]From Table 5, the expected average revenue after six months for each quartile will be the sum of payments by the holdout sample in that quartile plus the impact of each letter on payment for that quartile. For example, payments after six months by taxpayers in quartile 1 receiving the lien letter will be \$184.90 + \$5.30 = \$190.20. For all quartiles, returns after six months for the lien (sheriff) letter will be \$190.20 (\$182) for tardy taxpayers in quartile 1, \$269.90 (\$245.90) for tardy taxpayers in quartile 2, \$652.80 (\$672.30) for tardy taxpayers in quartile 3, and \$2,419.90 (\$2377.3) for those in quartile 4.

Table 5: Treatment Effect Heterogeneity by Debt Quantile

	Ever Paid			Total Paid		
	One Month	Three Months	Six Month	One Months	Three Month	Six Months
Holdout in Quartile 1	38.1	56.4	74.7	118.0	152.0	184.9
Holdout in Quartile 2	-9.8^{***}	-11.8^{***}	-7.4^{***}	20.1	97.5^{***}	217.4^{***}
	(2.9)	(3.1)	(2.8)	(32.3)	(33.6)	(33.5)
Holdout in Quartile 3	-9.9^{***}	-5.2^{*}	-0.1	134.1^{***}	388.8^{***}	658.5^{***}
	(2.9)	(3.1)	(2.7)	(38.6)	(39.5)	(39.3)
Holdout in Quartile 4	-10.7^{***}	-2.5	2.2	691.1^{***}	1494.0^{***}	2193.8^{***}
	(2.9)	(3.1)	(2.7)	(92.1)	(126.0)	(129.1)
Lien in Quartile 1	13.5^{***}	9.9^{***}	3.4	14.6	13.4	5.3
	(2.9)	(2.9)	(2.5)	(38.4)	(38.9)	(38.8)
Lien in Quartile 2	8.9^{***}	13.0^{***}	8.0^{***}	52.7^{***}	68.8^{***}	52.5^{***}
	(2.8)	(2.9)	(2.7)	(16.4)	(19.4)	(19.0)
Lien in Quartile 3	6.4^{**}	7.2^{**}	-0.3	79.9^{**}	67.3^{*}	-5.2
	(2.8)	(3.0)	(2.6)	(33.1)	(34.8)	(34.4)
Lien in Quartile 4	7.0^{**}	6.2^{**}	3.5	293.6^{*}	289.4	226.9
	(2.8)	(3.0)	(2.5)	(163.5)	(199.9)	(204.4)
Sheriff in Quartile 1	10.7^{***}	10.7^{***}	4.9^{*}	3.7	1.2	-2.9
	(3.0)	(2.9)	(2.5)	(34.4)	(34.6)	(34.7)
Sheriff in Quartile 2	7.4^{***}	10.0^{***}	5.4^{**}	39.2^{**}	50.2^{**}	28.5
	(2.8)	(3.0)	(2.7)	(16.2)	(19.5)	(19.2)
Sheriff in Quartile 3	5.8^{**}	7.7^{***}	3.0	89.0^{***}	65.6^{*}	13.8
	(2.8)	(3.0)	(2.5)	(32.4)	(35.1)	(33.8)
Sheriff in Quartile 4	5.1^{*}	6.2^{**}	1.1	114.6	215.6	184.3
	(2.8)	(3.0)	(2.5)	(123.6)	(177.4)	(191.7)
Num. obs.	19039	19039	19039	19039	19039	19039

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Holdout values for first quartile in levels; other holdout figures are relative to this and remaining figures are treatment effects for the stated treatment vs. holdout owners in the same quartile.

the availability of taxpayer agreements to help with payments. The results in Tables 2 and 5 suggest, however, that liquidity constraints are not binding for most of our tardy taxpayers. First, from Table 2, most taxpayers who respond positively to a tax nudge after one and three months and who make some payment will pay in full. For all statistically significant nudges, including simple reminder, the percent increase in the "ever paid" taxpayers that "paid in full" is never less than 60 percent (1 month, simple reminder), typically 75 to 80 percent, and as high as 97 percent (three month, peer reminder). Second, from Table 5, taxpayers in the 1st quartile, who owe the least in taxes, have the highest rate of payment, even without the nudge. Further when taxpayers respond to a nudge, again the share who "pay in full" (not shown in Table 5) is over 70 percent of those who "ever paid" for the two strongest nudges, the lien and sheriff letters.

Still approximately thirty percent of those tardy taxpayers who respond to a nudge do not, or cannot, make full payment. One likely explanation for these taxpayers is a liquidity constraint. Offering these incomplete taxpayers a tax payment agreement can ease this constraint. Table 6 shows what fraction of tardy taxpayers are in a tax payment agreement by the end of our experiment. Recipients of the reminder/lien and reminder/sheriff letters are a bit more likely to have chosen payment agreements than those in our holdout sample as are those who receive the reminder/peer and reminder/duty letters. That said, agreements are only being used by about 1 percent of the initial 19,039 tardy taxpayers (approximately 200 taxpayers) and only about 3 to 4 percent of all tardy taxpayers who have not yet made a full tax payment.

5 Tax Revenue Implications

While of interest as a specification and test of a behavioral theory of tax compliance, our results are directly relevant for city tax collection policies. As a strategy for improving collection from tardy taxpayers, our analysis informs two important policy issues. First, cities

Table 6: Liquidity Linear Probability Model Estimates

	Payment Agreement
Holdout	0.9
Reminder	0.4
	(0.4)
Lien	1.0***
	(0.4)
Sheriff	1.6***
	(0.4)
Neighborhood	0.6
	(0.4)
Community	0.4
	(0.4)
Peer	0.8**
	(0.4)
Duty	0.8**
	(0.4)
Num. obs.	19039

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Holdout values in levels; remaining figures relative to this

need revenues: Do reminders improve collection, and then do reminders with a message raise more money than a simple reminder? Second, in light of recent municipal fiscal crises and the potential for an unraveling of citizen commitment to local governance: Do reminders with a message, and then which message, improve tax collection as a "nudge" to citizen engagement? Table 7 provides answers to these two questions.

Listed in Table 7 are our seven treatments, the sample size to which each treatment applied and total taxes owed, and then estimates of the impact of each treatment on the number new payers three months after receipt of the treatment letter, the average new revenue received per letter sent, total new revenues collected from each treatment letter above that paid by the holdout sample, and finally, the percent of owed taxes paid because of each treatment.

For single property owners, the total number of new taxpayers above the holdout sample

Table 7: Three Month Impact of Collection "Nudges"*

Treatment	Sample Size	Total Taxes Owed	New Payers	Revenue/ Letters	New Revenues	New % of Taxes Paid
Reminder	2,419	$3.038 M	95	$28.79	$69,643	.023
Lien	2,429	$3.109 M	224	$67.67	$164,370	.053
Sheriff	2,416	$3.177 M	213	$64.90	$156,798	.049
Neighborhood	2,387	$3.077 M	65	$19.77	$47,191	.015
Community	2,441	$3.149 M	68	$20.91	$51,041	.016
Peer	2,416	$3.092 M	85	$25.65	$61,970	.020
Duty	2,432	$3.159 M	88	$26.62	$64,739	.020
Totals	16,490	$22.143 M	838	$37.34	$615,752	.028

* Sample Size are the number of single property taxpayers in the treatment group. Total Taxes Owed is the total taxes owed by single property taxpayers in the treatment group. New Payers equals the new payers after three months computed as the estimated increase in rate of compliance of those receiving the letter over those in the holdout sample as reported in Table 2; for example, for the reminder letter the number of new payers equals 95 = .039 x 2,419. Revenue per letter for each treatment equals the median new revenue collected from those who received a treatment letter and made some payment (=$ 738/letter) times the three month increase in compliance from each treatment letter; for example for the reminder letter the median estimated revenue per letter equals $28.79 = .039x$738. The total for revenue per letter is the sample weighted average of each letter's revenue per letter. New revenues for each treatment equals the revenue/letter times the number of single owner properties receiving a treatment letter: for example, for the reminder letter the estimated total new revenues equals $69,643 = $28.79x2,419. New % of Taxes Paid equals New Revenues Divided by Total Taxes Owed; for example, for the reminder letter .023 = $69,643/$3,038,000.

from all reminder letters is 838, an average increase in the overall rate of compliance from receiving one our treatment letters of 4.9 percent (838/16,940). Table 7 also provides an estimate of additional revenues raised by each of our treatment letters and then the total revenue raised from each treatment group. From the perspective of the City's Department of Revenue, our experiment was a good investment of Department resources. Each letter cost about $1 to process and send and raised on average over all letters $37.34. The estimated benefit to cost ratios for the seven treatments ranged from a low of $19.77 (the Neighborhood letter) to a high of $67.67 (the Lien letter). The approximately $17,000 spent on our experiment to mail the 16,940 treatment letters raised $615,752 in additional city revenues: an average benefit to cost ratio of 36.3.

Among our seven treatments, our experimental results clearly show the power of the lien and sheriff letters compared to a simple reminder or the tax morale nudges. The number of new taxpayers above the holdout sample is three to four times larger and the revenue/letter

is two to three times larger with the letters stressing penalties. As a consequence, total new revenues (above the holdout sample) from the penalty letters and new revenues as a share of all taxes owed are three to four times larger as well. If we had sent only the lien or sheriff's letter to the 16,940 taxpayers in our treatment groups we would have raised $1.15 million in new revenues rather than $616,752 – nearly twice as much. The paid share of taxes owed would have risen from our experiment's average of .028 to that of the lien letter only of .053.

6 Discussion: What Role for Nudges?

While the seven treatments are effective on the margin in increasing compliance and in raising revenues, and the letters stressing economic sanctions particularly so, the final column of Table 7 makes clear that at least in Philadelphia our treatments will not solve the larger problem of unpaid City property taxes. The contributions of each reminder letter towards total taxes owed range from a low of 1.5 percent for the neighborhood letter to a maximum of 5.3 percent for the lien letter after the three months of our experiment. The reminders together raised an additional $616,000 in property tax revenues from the total of $22,143 million owed in tardy payments, or 2.8 percent. Importantly, since our sample was very close to the full sample of all tardy taxpayers, these revenue estimates are very close to what the City might expect in new revenues were our experiment to become annual policy.

Should we conclude from these very modest revenue gains that a nudge strategy should not become part of Philadelphia's fiscal policy? We think not. First, our work here was an experiment looking for an effective collection strategy, not an evaluation of an established policy. The reminder/lien and reminder/sheriff letters were significantly more effective than the average reminder letter. If those letters were to be adopted as part of the City's collection strategy for tardy taxpayers and applied alone to the entire sample of 19,039 taxpayers, the city could expect to collect an additional $1.288 million (= $67.67/letter x 19,039 letters) within three months after mailing the reminders.

Second, no one policy is likely to be the best and only means for collecting revenues. Any collection policy will involve a range of collection strategies, ranging from voluntary compliance on each annual 'tax day,' to mailed reminders as here, to detailed in person audits, to policing, trial, and impoundment of assets. Each strategy will have its own costs and benefits. All strategies that provide revenue benefits greater than collection costs should be included as part of the final collection policy (Keen and Slemrod, 2017). Our reminder/lien and reminder/sheriff letters raising over $65 in new revenues of each $1 of administrative costs seem to have earned their place in Philadelphia's collection strategy.

Third, and perhaps most importantly for designing a cost-effective strategy to collect tardy taxes, our experiment revealed an important advantage to being patient. After three months of our experiment, the holdout sample of tardy taxpayers receiving no letter increased their tax compliance by 51.4 percent in making at least some payment and by 40.8 percent in making their full payment. The average payment received after three months was $637 per new taxpayer; see Table 2. These are revenues the City received without any expenditure of City administrative resources, just waiting for taxpayers to recognize on their own that their property tax payments are due. Had the City adopted this 'wait-and-see' strategy applied to all 19,039 of the tardy, single property owner taxpayers, then after three months 9,786 tardy taxpayers would have made some payment. With an average payment of $637 per new taxpayer, City revenues would have increased by $6.234 million, or approximately 28 percent of revenues owed by all tardy taxpayers. Other than a small opportunity cost of waiting, this is free money and clearly the most efficient beginning strategy for the City for collecting tardy property taxes. The efficient administrative package would combine the waiting policy with the most efficient reminder letter stressing economic sanctions, mailed to all tardy taxpayers. Assuming those who pay without a nudge will not be annoyed by receiving the reminder letter (and thus less likely to pay) the City would receive payments of $6.234 million from those who pay without the nudge and $1.288 million from those who pay in response the nudge with economic sanctions. This administrative package raises a total

$7.522 million, or 34 percent of all tardy revenues owed. The cost of the combined policy will be just the $19,039 for the reminder letters. After three months (say September), the City can then move to more aggressive strategies run perhaps by outside collection agencies. Today the City uses such agencies beginning immediately in May after taxes become tardy. The collection agencies are reimbursed at the rate of $.06 for each dollar collected, for an implied City revenue to cost ratio of $16.67, lower than any of our nudges including the simple reminder.[13]

Finally, nudge strategies can have important effects on the aggregate rate of taxpayer participation, but the direction of the impact is not obvious and may depend upon the current level of participation. The results of Hallsworth, et. al. (2017) and Dwenger, et. al. (2017) found announcing high rates of peer participation encouraged additional participation by delinquent taxpayers, but in contrast, Castro and Scartascini (2015) found announcing a relatively low rate of peer participation (70 percent) discouraged future participation by those who had been paying their taxes in the past. Without a realistic threat of large penalties, paying ones taxes may be seen as a voluntary contribution decided in response to the equilibrium behaviors of other taxpayers, Such games can have both low and high participation equilibria (Bergstrom, Blume, & Varian, 1986). Nudge strategies that exogenously increase participation may be able to move the outcome from the low to the high participation equilibrium. See, for example Wenzel (2005) and Besley, et. al (2015). For cities in a low participation equilibrium the initial nudge might emphasize economic sanctions. As participation increases, however, the reminder letter might place a greater emphasis on peer

[13]Currently the City allocates 100 percent of tardy taxpayers to outside collection agencies beginning in early May. Adapting our efficient collection strategy rather than allocating to outside agencies may save the City approximately $400,000 a year. We do not know the actual collection strategy used by these firms but our results suggest they are likely to be earning a significant profit when reimbursed at the rate of $.06 for every dollar collected. Doing nothing as revealed by our holdout sample will earn these agencies approximately $6,234 million in three months. Assuming they have discovered the high marginal returns of the sanction strategy as revealed here ($65 per $1 invested) and they invest $19,000 as we have here, the firms would then earn an additional $1.235 million. Total revenues collected would then be $7.469 million earning the firms $448,000 when reimbursed at the rate of $.06 for every dollar collected. Our efficient collection strategy raises the same revenues at a cost of $19,000, saving the City $429,000.

behavior or civic duty, perhaps with a soft reminder that compounding economic sanctions will apply after a future date.

Our results provide strong evidence that economic sanctions can have a significant positive effect on the rate of taxpayer participation. The lien reminder added 9.2 percent (= 224/2429) new taxpayers above the holdout sample while the sheriff reminder letter added 8.8 percent (=213/2416) new taxpayers. And while not quite statistically significant, the peer and civic duty reminders do encourage tax payments beyond that obtained with a simple reminder letter, both after three months and particularly so after six months.[14] The payment magnitudes are comparable to those for the lien and sheriff letters. Further, those who are likely to be credit constrained respond favorably to peer and duty reminders, and at almost the same rate as they do to the sanction reminders, by entering tax payment agreements as shown in Table 6.[15]

7 Conclusion

With the cooperation of the Department of Revenue of the City of Philadelphia, we developed and implemented a policy experiment in the use of written nudges to improve the collection of property tax revenues from citizens who had not paid their fiscal year 2016 taxes by the due date of March 31, 2015. The experiment entailed the full sample of 21,500 "tardy" taxpayers. The results reported here are for the 19,039 taxpayers who own a single property, excluding those who own multiple properties; the results here generalize to the full sample. The experiment reached six substantive conclusions: First, a simple reminder letter

[14]The six month results for the peer and civic duty reminders reported in Table 6 are suggestive of the potential usefulness of the joint peer/duty reminder coupled with the threat of latter sanctions. This is exactly what had happened to taxpayers in peer and duty subsamples who received the peer and duty letters in the first three months of our experiment, and then the possible threat of sanction by the collection agencies in the second three months, from September to December.

[15]A result consistent with our pilot study's finding that "very tardy" taxpayers, also likely to be credit constrained, responded positively to a peer/duty reminder.

had a statistically significant effect on compliance when compared to our control group who received no reminder. Second, the content of the reminder letter matters. The two letters that stress the likely economic sanctions of continued tardy payment led to faster and higher levels compliance than the simple reminder. Third, adding an intrinsic message to the reminder, one that stressed the value of public services, neighbors' compliance, or civic duty did not increase compliance over receiving only the simple reminder. Fourth, most of the taxpayers who did respond with payments, paid their full tax obligation. Fifth, reminders were very cost effective on the margin. Each letter cost one dollar to send and returned on average $37 in increased city tax revenues. The two letters stressing economic sanctions were the most effective, returning $65 to $67 in extra revenues for each letter sent. Sixth, reminders had no staying power. Having received a 2016 reminder letter had no effect on the taxpayers likelihood of paying their 2017 property taxes on time.

The results of our experiment suggested three policy conclusions for the design of an efficient tax collection strategy for Philadelphia First, appropriately designed reminder letters as nudges contribute positively to revenue collection and should be part of the City's collection strategy. Simply reminding tardy taxpayers that their taxes are due is valuable; our average reminder letter cost $1 to mail and generated on average $37 in additional revenues. As noted, the most effective reminders stress economic sanctions and raised $65 to $67 per reminder letter. Given these high marginal returns, nudges should be included as part of the City's collection strategy.

Second, while effective on the margin, reminder letters alone will not solve the problem of tardy tax collections in Philadelphia. Our study had the full sample of tardy taxpayers, and our reminder letters alone succeeded in collecting only a small fraction of what was owed. The total owed for fiscal year 2016 was $22.143 million and the experiment using all our reminders raised only $616,000 of new revenues. Had we used only the most effective reminders – the two stressing economic sanctions – we would have doubled collected revenues from reminders to $1.288 million in new revenues; still only 6 percent of outstanding payments.

Third, and perhaps most interestingly, just being patient had high returns. Our study included a sample of holdout taxpayers who received no reminder. That group increased their rate of compliance by 51.4 percent from the start of our study to its three month conclusion date. The average payment from this sample receiving no reminder was $637 per new taxpayer. Total new City revenues from this group equaled $6.234 million dollars, all raised at no cost to the City other than the small opportunity cost from delay. Relying upon tardy taxpayers to recognize and pay their taxes on their own and then using the sanction reminder to leverage those who continue to forget or need a nudge would together raise $7.522 million of the $22.143 owed by all tardy taxpayers, or 34 percent. The total cost to the City of this collection strategy would be $19,039 for the reminder letters. After three months, a more aggressive but also more expensive collection strategy might be tried.

It is useful to stress again here an important motivation for why we ran our study. As the large empirical literature on nudges and tax collection now makes very clear, successful strategies are context specific. Collection strategies that work well for one tax and for one government may fail to do so for another tax and in another fiscal setting. Our results are for Philadelphia taxpayers alone. What we think does generalize, however, is the value of repeating studies such as ours for the design of tax administration strategies. We feel that our seven reminder letters and the importance of having a holdout sample provide an effective methodology for use by other cities for understanding how best to collect their own tardy and delinquent property taxes. Further, at an average cost of $1 per reminder letter including mailing and office expenses, there is no reason not to implement a study such as ours on the full sample of tardy or delinquent taxpayers.

Motivated by the results of our work here, Philadelphia's Department of Revenue now uses a reminder letter stressing the risk of a tax lien and subsequent sheriff's sale and has delayed by three months (to mid-July) the use of outside agencies for the collection of tardy taxes.

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A Appendix: Additional Figures and Tables

The appendix contains Tables A2 and A1 which summarizes additional balance tests and robustness analyses using all owners (including multiple property owners).Tables A3 and A4 report estimates based on Logit models for single property owners and single plus multiple property owners.

Table A1: Robustness Analysis: Relative to Reminder (All Owners)

	Ever Paid		Paid in Full	
	One Month	Three Months	One Month	Three Months
Reminder	34.9	56.5	23.9	41.8
Lien	4.8***	4.7***	3.3***	4.0***
	(1.3)	(1.3)	(1.2)	(1.3)
Sheriff	3.4***	4.6***	2.3**	3.6***
	(1.3)	(1.3)	(1.2)	(1.3)
Neighborhood	−1.0	−0.8	−1.2	−0.4
	(1.3)	(1.3)	(1.2)	(1.3)
Community	−0.4	−1.4	−0.6	−0.2
	(1.3)	(1.3)	(1.2)	(1.3)
Peer	0.3	−0.8	0.4	0.8
	(1.3)	(1.3)	(1.2)	(1.3)
Duty	−1.3	−0.2	−1.0	−0.8
	(1.3)	(1.3)	(1.2)	(1.3)
Num. obs.	19333	19333	19333	19333

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Reminder values in levels; remaining figures relative to this.

Table A2: Balance on Observables

Single Property Owners								
Variable	Reminder	Lien	Sheriff	Neighborhood	Community	Peer	Duty	p-value
Amount Due (June)	\$1,256	\$1,280	\$1,315	\$1,289	\$1,290	\$1,280	\$1,299	0.98
Assessed Property Value	\$158,370	\$130,642	\$134,334	\$159,079	\$130,265	\$130,936	\$165,617	0.46
# Owners	2,419	2,429	2,416	2,387	2,441	2,416	2,432	0.99
Single and Multiple Property Owners								
Variable	Reminder	Lien	Sheriff	Neighborhood	Community	Peer	Duty	p-value
Amount Due (June)	\$1,593	\$1,593	\$1,590	\$1,589	\$1,583	\$1,572	\$1,583	1
Assessed Property Value	\$180,664	\$155,499	\$157,398	\$180,172	\$153,528	\$155,438	\$183,991	0.48
% with Single Property Owner	87.6	88.0	87.5	86.4	88.4	87.5	88.1	0.42
% Overlap with Holdout	3.69	3.44	3.29	3.73	3.40	3.55	3.40	0.97
# Properties per Owner	1.27	1.26	1.26	1.32	1.26	1.26	1.26	0.67
# Owners	2,762	2,761	2,762	2,762	2,762	2,762	2,762	1

p-values in rows 1-5 are F-test p-values from regressing each variable on treatment dummies. A χ^2 test was used for the count of owners.

Table A3: Short-Term Logistic Model Estimates (Single Property Owners)

	Ever Paid		Paid in Full	
	One Month	Three Months	One Month	Three Months
Holdout	−0.8	0.1	−1.2	−0.4
Reminder	0.2***	0.2***	0.1*	0.1**
	(0.1)	(0.1)	(0.1)	(0.1)
Lien	0.4***	0.4***	0.3***	0.3***
	(0.1)	(0.1)	(0.1)	(0.1)
Sheriff	0.3***	0.4***	0.2***	0.3***
	(0.1)	(0.1)	(0.1)	(0.1)
Neighborhood	0.1	0.1*	−0.0	0.1
	(0.1)	(0.1)	(0.1)	(0.1)
Community	0.2***	0.1*	0.1	0.1*
	(0.1)	(0.1)	(0.1)	(0.1)
Peer	0.2***	0.1**	0.1	0.1**
	(0.1)	(0.1)	(0.1)	(0.1)
Duty	0.1*	0.1**	0.0	0.1
	(0.1)	(0.1)	(0.1)	(0.1)
AIC	24493.1	26068.9	21605.6	26093.5
BIC	24556.0	26131.7	21668.4	26156.3
Log Likelihood	-12238.6	-13026.4	-10794.8	-13038.7
Deviance	24477.1	26052.9	21589.6	26077.5
Num. obs.	19028	19028	19028	19028

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Holdout values in levels; remaining figures relative to this

Table A4: Logit Estimates Including Multiple Owners

	All Owners		Single Property Owners	
	One Month	Three Months	One Month	Three Months
Lien	0.21***	0.20***	0.23***	0.22***
	(0.06)	(0.05)	(0.06)	(0.06)
Sheriff	0.15**	0.19***	0.16**	0.20***
	(0.06)	(0.05)	(0.06)	(0.06)
Neighborhood	−0.05	−0.03	−0.09	−0.05
	(0.06)	(0.05)	(0.06)	(0.06)
Community	−0.02	−0.06	0.00	−0.04
	(0.06)	(0.05)	(0.06)	(0.06)
Peer	0.01	−0.03	0.01	−0.02
	(0.06)	(0.05)	(0.06)	(0.06)
Duty	−0.06	−0.01	−0.06	−0.01
	(0.06)	(0.05)	(0.06)	(0.06)
AIC	25179.24	26349.91	21922.44	23174.00
BIC	25234.33	26405.00	21976.61	23228.16
Log Likelihood	-12582.62	-13167.95	-10954.22	-11580.00
Deviance	25165.24	26335.91	21908.44	23160.00
Num. obs.	19333	19333	16940	16940

$^{***}p < 0.001$, $^{**}p < 0.05$, $^{*}p < 0.1$

CITY OF PHILADELPHIA
DEPARTMENT OF REVENUE
TAX | WATER | LAW

Real Estate Tax Delinquency Notice

January 27, 2017

RICHARD ROE
706 CRESHEIM RD
PHILADELPHIA, PA 19119

Owner(s):	RICHARD ROE
Property Address:	706 CRESHEIM RD
Account Number:	124578340
Balance Due:	$2,087.37

Se brindan servicios de interpretación.
خدمات الترجمة الشفهية متوفرة لدينا.
提供口译服务.
Services d'interprétation disponibles.
통역이 제공됩니다.
Предоставляются услуги устного переводчика.
អាចផ្តល់ជូនសេវាកម្មអ្នកបកប្រែភាសា ។

Dear Richard Roe,

Our records indicate that you have a balance due of $2,187.27.

If you have already paid, thank you. If not, please pay now or contact us for to arrange a payment plan. The fastest and easiest way to pay is online at www.phila.gov/pay. Paying by E-check only costs 35¢—less than the cost of a stamp!

Sincerely,

Deputy Commissioner Marisa Waxman
Department of Revenue
City of Philadelphia

Revenues for Schools & Services
Have questions or need help? Visit www.phila.gov/revenue or call 215-686-6442

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提供口译服务.
Services d'interprétation disponibles.
통역이 제공됩니다.
Предоставляются услуги устного переводчика.
[illegible]

Dear Richard Roe,

Failure to pay your Real Estate Taxes will result in a tax lien on your property in an amount equal to your back taxes plus all penalties and interest. When your property is sold, those delinquent tax payments will be deducted from the sale price. By paying your taxes now, you can avoid these penalties and interest.

Properties near you in Upper Kensington that have had liens placed on them include:

- 117 EAST WISHART STREET — Sold November 19, 2014
- 401-11 E ALLEGHENY AVE — Sold April 15, 2015
- 3419 F ST — Sold April 15, 2015

Pay your taxes now to avoid a lien being placed on your property. Our records indicate that you have a balance due of $2,187.27.

If you have already paid, thank you. If not, please pay now or contact us for to arrange a payment plan. The fastest and easiest way to pay is online at www.phila.gov/pay. Paying by E-check only costs 35¢—less than the cost of a stamp!

Sincerely,

Deputy Commissioner Marisa Waxman
Department of Revenue
City of Philadelphia

Revenues for Schools & Services
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