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An Experimental Evaluation of Notification Strategies to Increase Property Tax Compliance: Free-Riding in the City of Brotherly Love

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Executive Summary

This study evaluates a set of notification strategies intended to increase property tax collection. To test these strategies, we develop a field experiment in collaboration with the Philadelphia Department of Revenue. The resulting notification strategies draw on core rationales for tax compliance: deterrence, the need to finance the provision of public goods and services, as well as an appeal to civic duty. Our empirical findings provide evidence that carefully designed and targeted notification strategies can modestly improve tax compliance.

I. Introduction

The lack of tax compliance has become a policy issue of central importance to all levels of government in developed and developing economies. In 2009, the developed economies of the Organization for Economic Cooperation and Development (OECD) reported a tax noncompliance rate of 14.2, ranging from a low of 2 to 3% in Austria, Denmark, Germany, Korea, and Norway; to 25% or more in Belgium, Iceland, Portugal, the Slovak Republic; to a high of 73% in Greece (OECD 2011, table 36). In developing economies with significant cash economies, tax noncompliance is likely much higher. The OECD estimates an average rate of tax noncompliance in non-OECD countries of 37% (OECD 2011, chart 7).

Noncompliance is a significant concern for at least four reasons. First, governments are denied the revenues needed to provide basic public services essential for ensuring the safety, health, and minimal well being

of all citizens. Second, if there is significant noncompliance and basic services are to be provided, then tax rates will need to rise on those who pay taxes. Rising tax rates for honest payers will discourage their use and desire of public services, potentially encouraging their exit from the formal economy. The negative consequences for overall economic performance can be sizable; Greece today serves as an unfortunate reminder. Third, noncompliance undermines the principle that everyone has to pay their "fair share" of taxes. The evidence suggests upper-income taxpayers are more likely to be noncompliers. Finally, significant noncompliance may threaten the stability of democratic governance. When democratic governments fail to deliver essential services, impose large tax burdens on the legitimate private economy, and are viewed as capricious or actively unfair, then dictatorial alternatives may become attractive. In an important sense, tax compliance is a first order of business for efficient, fair, and democratic governance.[1]

Tax compliance requires government to manage the taxpayer's decision to pay taxes. Taxpayers may ask: what do I owe, and what happens if I don't pay? Taxpayers have the ability to influence what is owed on any tax that requires self-reporting of income or assets, such as self-reported consulting or business income. Taxing jurisdictions can, in principle, increase compliance by requiring less self-reporting and directly assessing the tax base. Because property cannot be hidden, scuppered away to a tax haven, or concealed in an electronic data system, self- or nonreporting is less of an issue in a property tax system. Privately assessed wages, dividends, and interest income by individuals and businesses are easier to conceal to the tax authorities. However, private assessors have an incentive to report incomes truthfully as those payments are typically deductible expenses for their own taxes. The need for self-reporting is also reduced as the formal economy and the use of audited business records expands. Taxes that can take advantage of those records maximize tax compliance and increase city tax revenues for just this reason. The increased popularity of the value-added tax (VAT) over the past 20 years in economies with developing formal consumption sectors is a case on point (see Keen and Lockwood 2010; Pomeranz 2015). Self-reporting matters for tax compliance in developed economies as well. Kleven et al. (2011), for example, show that tax noncompliance among Danish taxpayers is significantly higher for individuals with self-reported income.

The taxing jurisdiction can also control compliance by influencing the decision to evade, once the tax liability has been assessed. The most

common strategy is the economic stick-fines and penalties. (See, for example, Allingham and Sandmo [1972].) Failure to pay 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. For long-time non-payers, fines may include the garnishment of wages, seizure of property, or jail. Early empirical studies found little impact of such penalties on aggregate tax compliance, however; see Slemrod (2007). But more recent, nuanced studies have found an impact of fines on both the level and speed of tax payments. Fellner, Sausgruber, and Traxler (2013) find that a reminder letter for payment of the Austrian TV license fee that explicitly threatens legal action if the resident does not provide the required information for assessment performed significantly better than the standard reminder letter informing residents that they had not yet returned the required forms. Wenzel and Taylor (2004) find that including a letter reminding taxpayers that their statement of rental income can be audited and that faulty reporting may lead to fines significantly reduced deductions when compared to forms submitted by taxpayers who did not receive the threatening letter. Hallsworth et al. (2014) find the speed with which taxpayers pay their liabilities can also be improved with increased fines.

But fines only work if taxpayers believe they will be enforced. Large fines may be seen by taxpayers as a signal of a desperate and ineffective tax collector, as politically inviable and, thus, as empty threats, or, in the extreme, as a breakdown of cooperative democratic governance. If so, an increase in fines may even reduce tax compliance as indeed happened in Israel with the payment of corporate taxes; see Ariel (2012). On balance, the estimated effects of fines on tax payments have been positive but modest in magnitude.

Given evidence as to the limited ability of economic sanctions to impact aggregate collections, attention has turned to other behavioral motivations for increasing tax compliance. Such motives are grounded in the value taxpayers place upon their role and position within the democratic community. The role may be instrumental leading to outcomes valued by the taxpayer, such as additional public services or of value in its own right. Both may provide an incentive for tax compliance.[2]

Instrumentally, for example, if each taxpayer thought of himself as simply a single citizen within the democracy, there would be no incentive, apart from a fine, to pay for services. If fines are too low or unenforced, then free-riding is the preferred private strategy. If all taxpayers think of themselves as private citizens only, then all might free-ride, and no services would be provided. Alternatively, citizens might think

of themselves as representative of a community of like-minded residents, where cooperation by any one citizen is reflective of how all citizens may think; see Feddersen and Sandroni (2006). If so, a cooperative, tax-paying outcome might occur. As examples, we vote, we tip in restaurants we will never visit again, and we put our litter in waste cans.

Or the citizen may view their role as a cooperating member of the community, not in an instrumental or strategic way, but rather as having value in its own right, quite apart from any impact playing such a role may have on valued social outcomes. Individuals may derive satisfaction from knowing, or from having others know, that they have done their "civic duty." Duty can extend far beyond tax compliance to all forms of law abiding behavior; see Posner (2000). Consistent with theories of social norms, the more people conform to law-abiding behavior, the more likely it may be that the "marginal" citizen will conform as well (see Benabou and Tirole 2011).

Both the instrumental motive and the motive born from civic duty have been used to stimulate tax compliance. The evidence is mixed. The most careful study of the two motives was done by Blumenthal, Christian, and Slemrod (2001), where two different letters were sent to Minnesota state taxpayers reminding the taxpayer when taxes were due and to report their income accurately. Hoping to elicit cooperative behavior from an instrumental perspective, one letter stressed that taxes pay for important state services. Hoping to tap a personal sense of civic duty, the second letter emphasized that most state taxpayers correctly report their taxable income on time. There were 15,000 taxpayers in each group, and their reported taxable incomes were compared to a control group of 15,000 taxpayers who received no letter. We should expect the largest effect on self-reported incomes (see Kleven et al. 2011; Pomeranz 2015). For both letters, there were statistically significant positive and negative effects on the various categories of self-reported incomes, with no statistically significant change in aggregate taxable income over that reported by the control group. The one strong effect was a relatively large negative effect on reported income by the richest taxpayers from having received the civic duty letter.

Three more recent studies have been more encouraging as to the impact of behavioral appeals. In an effort to improve the speed of tax compliance for British income taxpayers, Hallsworth et al. (2014) sent either of two letters to taxpayers both encouraging them to pay their taxes on time. Again, appealing to the strategic advantages of cooperative behavior in the decision to pay taxes, one letter stressed that payment

ensures important national services will be provided. A second letter appealed to a citizen's personal sense of community and stressed that "nine out of ten" taxpayers pay their taxes on time. Both sets of letters had a statistically significant effect in encouraging sooner tax payments, and the effects were greatest for the appeal to "civic duty" when the letter explicitly mentioned the taxpayer's most likely reference group of fellow citizens.

Perez-Truglia and Troiano (2015) explored the impact of what they call a "shaming penalty" administered through a letter to a subset of delinquent state taxpayers reminding them that the state has placed their name on a publicly available list of tax delinquents and that only payment in full or acceptance of a payment schedule can remove their name from the delinquent list. The reminder letter made a significant positive difference to eventual tax compliance, with the greatest effects observed for taxpayers with the lowest level of taxes owed. In addition, reminding tax delinquents that there is a growing financial penalty to late payments also had a positive impact on compliance and particularly so for wage-only taxpayers whose income could be most easily attached for payment and penalties.

Finally, Besley, Jensen, and Persson (2014) estimate a dynamic model of tax compliance to explore whether more complying taxpayers encourages further compliance as implied by social norm behaviors. The theory is tested for British local government tax compliance following the tax revolt of 1990 in response to the replacement of the wealth-based property tax by a regressive poll or "head" tax. Local compliance fell from an average rate of 97% to 82% within two years. The poll tax was removed and wealth taxation restored in 1993, but it took more than 10 years for tax compliance for the wealth tax to only gradually return to its original levels, suggesting a dynamic process for learning of the cooperative tax behavior of other citizens.

Our agenda here is to extend our understanding of tax compliance to include the payment of local property taxation. We do so by implementing a pilot tax compliance experiment in one large US city: Philadelphia. The city's historical performance in tax compliance has not been good. Compared to a national average tax collection rate of 95%, Philadelphia has collected only 88% of assessed property tax revenues on average over a recent ten year period. The city's performance has improved in recent years. Hoping to improve performance still further, the city asked for our assistance in an evaluation of possible alternative formats for their letter reminding tardy taxpayers that their payments are due.

Each year, property a property tax bill is mailed to property owners by mid-January, and payment is due in full by March 31st of that year. If payment has not been received by the end of April, reminder letters are mailed beginning in May, usually once every two months until payment is received. The current reminder letter states the taxpayer's liability and accrued interest and penalties. If payment has not been received by September of the tax year, then two out of three of the tardy taxpayers are assigned to either of two law firms for collection; the remaining third of the tardy taxpayers remain with the Department of Revenue (DoR) for continued efforts at internal collection. We assisted the DoR with collection from their share of these tardy taxpayers.[3]

We proposed three additional formats for the DoR's reminder letter. In addition to the listing of tax payments, interest, and penalties, the alternative letters contained a sentence that either (a) threatened the potential loss of the taxpayer's home or property if taxes were not paid, or (b) appealed to the positive community benefits in provided public services that the taxpayer's dollars provide, or (c), appealed to the positive benefits of fulfilling your civic duty to yourself and others by paying your taxes.

Our empirical findings provide evidence that carefully designed and targeted notification strategies can modestly improve tax revenues. For the sample of owners of single properties, the average treatment effects range from $41 to $152. Two of the three treatments are different from zero at conventional levels of statistical significance. Our results are also consistent with the view that targeted notification letters may improve overall tax compliance.

The rest of the paper is organized as follows. Section II provides a brief overview of tax compliance in US cities. Section III provides a detailed discussion of our three treatments and the control. It also discusses the experimental design and the fidelity of its implementation. Section IV presents a descriptive analysis summarizing the main effects of our experiment on city revenues. Section V provides some additional analysis of discrete outcomes focusing on whether taxpayers made payments at all or paid the debt back in full. Section VI offers some conclusions and discusses future research.

II. Property Tax Compliance in US Cities: An Overview

The property tax is one of the most important taxes for the financing of local government services in the United States. For the coun-

try as a whole, approximately 21% of all state and local government revenues were raised using the property tax in 2011 (Gruber 2013). For the largest cities, that percentage is much higher. The potential economic advantages of the property tax are well known.[4] But so, too, does the tax have significant administrative advantages. With modern techniques for assessment, properties can be accurately assessed at their market values, and assessments can be easily updated at the time of each "arms-length" transaction. Thus, there is no need for taxpayer reporting of the tax base, as with income, profits, sales, or VAT taxation. Property values, based as they are on long-run economic returns, are usually less volatile than tax bases dependent on current economic activity, such as income or sales. Stable tax bases allow for stable revenue flows and, thus, less volatile service flows or, alternatively, tax rates.[5] Finally, when the tax base is determined by market-based assessments, the taxpayer's tax bases will have been objectively set and easily understood. There is no need for complicated tax forms or contentious appeals. This, too, saves on administrative costs, and, one hopes, increases citizen confidence in the fairness of their tax payments.

Once market-based assessments are in place, the administrative issue that remains is this: Will property owners pay their taxes? Table 1 summarizes the record for property tax compliance for 40 of the largest US cities, plus Flint, Michigan, a poster child for weak compliance. Tax compliance is defined as the percent of taxes levied in the collection year that are paid in the year due. Taxes not paid in the collection year are then considered delinquent.[6]

Property tax compliance in these large cities over the past 10 years, years that included the deepest recession in decades, has been very good. On average, these large cities collected nearly 95% of their property taxes in the tax year due, and the recession years did not lower collection rates at all significantly. Still, the average amount of uncollected, delinquent revenues is significant, too, and particularly so for the seven poorest performing cities: Cleveland (.85), Detroit (.89), Flint (.79), Milwaukee (.88), Philadelphia (.88), Pittsburgh (.86), and St. Louis (.89).

Taxes that have not been paid in the tax year become delinquent payments, and cities seek to collect those taxes through various enforcement mechanisms. The most common strategy is to send a reminder letter to the taxpayer stressing that unpaid taxes accumulate interest and penalties and need to be paid. If still unpaid, the tax bill can be given to

Table 1
Property Tax Compliance: 2005–2014

City	Percent Compliance Current Year: 10-Year Average	Delinquent Tax Collected: Five-Year, Yearly Average
Large City Average	.946; .945	.112
Atlanta*	.982 ; .960	.182
Baltimore*	.960 ; .950	.128
Birmingham*	.983; .955	–
Boston	.996; .992	–
Buffalo*	.947; .945	.175
Charlotte	.984; .980	–
Chicago*	.962; .930	–
Cincinnati*	.940; .925	.120
Cleveland*	.841; .850	.090
Columbus*	.938; .920	.075
Dallas*	.989; .985	.085
Washington, DC	.985; .980	–
Denver	.990; .989	–
Detroit*	.683; .891	–
Flint*	.654; .785	.151
Houston*	.983; .975	.171
Kansas City	.943; 938	–
Los Angeles	.992; .940	–
Memphis*	.984; .945	.085
Miami*	.975; .970	.045
Milwaukee*	.865; .875	.191
Minneapolis*	.985; .972	.102
Nashville	.984; .986	–
New Orleans*	.948; .921	.172
New York City	.915; .925	.041
Oklahoma City	.958; .949	.161
Orlando	.991; .988	.072
Philadelphia*	.940; .880	.125
Phoenix*	.977; .965	.130
Pittsburgh*	.849; .860	.048
Portland	.942; .934	.109
Richmond*	.924; .955	.171
Riverside	.990; .982	–
Sacramento	.996; .980	–
Salt Lake City	.985; .980	.140
San Antonio	.989; .985	.134
San Diego	.980; .950	–
San Francisco	.988; .980	–
San Jose	.999; .990	–
Seattle	.985; .983	.170
St. Louis*	.921; .890	.123
Tampa	.959; .957	.032

Source: *Annals of Statistics*, each city's comprehensive annual financial report, annually over the years, 2005 to 2014.

Notes: Percent compliance is computed as the percent of property taxes levied in each fiscal year that are actually paid during the fiscal (or collection) year. Delinquent taxes collected are delinquent taxes not paid in the year due that may be paid in subsequent years. The annual rate is computed as the average collection rate over a five-year period following the year after the tax is first due. The aggregate percent of the delinquent taxes paid after five years, the typical horizon over which no further payments can be expected, can be computed as 5 × (yearly average). The (–) indicates that data were not available to compute the rate of delinquent tax collection for that city.

The (*) indicates the city poverty rate is greater than or equal to .20 in 2009 to 2013.

a private collection agent with revenues shared between the agent and city or perhaps sold to the agent for immediate revenues or the wages of, or payment to, the tax delinquent can be garnished. Philadelphia does so for public employees and for private contractors working for the city. Finally, a tax lien can be imposed on the property to be paid when the home is sold. As a last resort, the city can seize the property and require a sheriff's sale to collect back taxes. The end result is the collection of some portion of delinquent taxes. Table 1 reports each city's five-year, yearly average for the collection of delinquent taxes.[7] The typical pattern of collection for delinquent taxes shows a relatively high success rate in the first year of delinquency and then a very sharp decline in payments thereafter.[8] Most cities view tax bills that have been delinquent for more than five years as uncollectible. Multiplying the five-year average rate reported in table 1 by five yields the average aggregate collection rate of any one year's delinquent taxes. For the average city in our sample, this aggregate collection rate is .560 (= .112 × 5). The better performing cities, such as Atlanta, may eventually collect more than 90% of their delinquent taxes, the poorer performing cities perhaps not much more than 30%.

Table 1 also indicates with an asterisk those cities with poverty rates greater than .20 for the period 2009 to 2013. The expectation is that high-poverty cities should have lower rates of initial tax compliance and possibly more difficulty in collecting delinquent taxes. A comparison of the mean rates of tax compliance shows this to be the case for initial collection efforts: .92 for the 22 high-poverty rate cities (.94 excluding Detroit and Flint) and .98 for the 20 cities with relatively low poverty rates. The average annual ability to collect delinquent taxes in the two sets of cities is about the same (= .11), however, perhaps because the pool of delinquent taxpayers is very poor in all cities. Importantly, however, some cities with high poverty rates are very successful in collecting property taxes on time and in collecting delinquent taxes. Among the poorer cities, Atlanta, Baltimore, Houston, New Orleans, and Phoenix perform as well, and often better, than the average low-poverty city. The fact that property tax compliance can be well managed in the face of difficult economic realities suggests the value of looking at the administrative strategies of successful cities and searching for new strategies as well. It is the latter agenda we pursue here, using taxpayer compliance in Philadelphia as a laboratory to experimentally evaluate three alternative collection strategies to encourage payment by very tardy, soon-to-be-delinquent city taxpayers.

III.   The Philadelphia Tax Experiment

A.   Treatments

In Philadelphia, each year's property tax payments are mailed to property owners by mid-January and are due in full by March 31st of that year. Beginning in May of the tax year, the DoR sends a common reminder letter to each late taxpayer, usually once every two months until payment is received. The common reminder letter is impersonal and simply states the taxpayer's liability and accrued interest and penalties (see appendix figure A1). The only means for responding to the letter is to either send a check with the detached portion of the letter to the DoR or to call a phone number given at the top of the letter, but without instructions. If payment has not been received by September of the tax year, the taxpayer is assigned to either of two law firms for collection or to the DoR for continued efforts at collection. The law firms are free to pursue the collection of the debt as they see fit. Proceeds from their efforts are shared with the city. In the past, the DoR's efforts at collection from these very tardy taxpayers have been limited to simply remailing the usual reminder letter.

In collaboration with the staff of the DoR, we proposed two changes to their usual tax collection efforts. First, a generic reminder letter, that included a Spanish translation of the letter on the reverse side and also provided a list of contact numbers for taxpayers whose native language is not English, was included with the traditional tax bill.[9] This revised letter serves as our "control" treatment. Second, we offered three alternative letters to the control letter that might encourage additional tax compliance: one that threatened the potential loss of the taxpayer's home or property if taxes were not paid, a second that appealed to the positive aggregate benefits in provided public services that a cooperating taxpayer's dollars provides, and a third letter that appealed to the positive benefits the taxpayer alone may feel from fulfilling their civic duty to themselves and to others by paying their taxes:

Treatment Letter 1: Threat: **Not paying your real estate taxes is breaking the law.** Failure to pay your real estate taxes may result in seizure or sale of your property by the city. Do not make the mistake of assuming we are too busy to pursue your case.

Treatment Letter 2: Public Service Appeal: **We understand that paying your taxes can feel like a burden.** We want to remind you of all the great services that you pay for with your real estate tax dollars. Your tax

dollars pay for schools to teach our children. They also pay for the police and firefighters who help keep our city safe. Please pay your taxes as soon as you can to help us pay for these essential services.

Treatment Letter 3: Civic Duty Appeal: **You have not paid your real estate taxes.** Almost all of your neighbors pay their fair share—9 out of 10 Philadelphians do so. Paying your taxes is your duty to the city you live in. By failing to pay, you are abusing the good will of your Philadelphia neighbors.

The formats of the three letters were constructed to only differ in their wording of the middle paragraph (see appendix). Care was taken to minimize issues of communication for those with limited English literacy, ensuring that each letter was intelligible to those with a fifth grade education. Like the revised control letter, all treatment letters also included a Spanish translation as well as a list of phone lines for different language translations on the reverse side of the letter. Letters were mailed in the November mailing cycle to the taxpayers who had not yet paid, those we and the city consider to be the "most tardy" of the tardy taxpayers. The receipt of tax payments, or not, were recorded for 30 days, beginning five days after the mailing date.

B. *Experimental Design*

To ensure that the results of the experiment allow for a causal interpretation from the receipt of the letter to increased revenues and tax compliance, great care was taken to establish a random assignment of all four letters across the pool of the DoR's "most tardy" taxpayers. Unfortunately, the DoR's administration for mailing the letters did not allow for a purely random assignment of tardy taxpayers to each letter.[10]

Our approach to randomization was constrained by the logistics of the DoR's enforcement capabilities. We concluded after several discussions with the staff of the DoR that it would be difficult in practice to assign individual properties at random to different treatments. Instead, we chose to exploit the pseudo-random assignment of properties by billing cycles and randomized treatments across them. To understand assignment, it is useful to discuss the current practice of posting reminder letters by the DoR.

Mailing of tardy real estate tax bills is as follows. Because it is cheaper and simpler to send all bills at once to those owners owing taxes on multiple properties, assignment to cycles is done at the owner level so that each mailing cycle has roughly the same number of owners. Every

morning, the DoR accounting and records system identifies all properties that owe taxes to the city and are in the current day's mailing cycle. The mailing cycles progress in sequence, day by day. After identifying the bills to be printed for the day, the DoR printer then merges the tax bill with the mailing address of the owner and an in-house identifier associated with the property. The printed bills for each day are then brought to the city's mailing room, wherein they are inserted by machine into envelopes and mailed to property owners.

Given the volume of bills printed each day and the fact that the envelopes are stuffed by machine meant that the most practical means for randomization was to use the DoR's mailing cycle. As a result, every bill printed on the same day was paired with one of the four reminder letters. Thus, we randomized by a four-day mailing cycle. For each four-day period, we randomized among the 4! = 24 possible arrangements of treatment letters. Our experiment was conducted over 15 days from November, 4, 2014, to November 25, 2014.

While we are certain of the sanctity of our mailing cycle-level randomization process, one may be concerned about the assignment of properties to mailing cycles. Fortunately, however, the city uses a pseudo-random mechanism to assign owners to billing cycles, which means that we achieve proper full-scale two-stage randomization of the properties through our process of day-level randomization. In particular, the city assigns properties to cycles based on the last two digits of the property owner's social security number, or Employer Identification Number, or (lacking those identifiers) to a DoR nine-digit identification number. We believe that this quasi-random assignment removes any significant sorting or self-selection bias in the assignment of treatment letters.

C.   Implementation Fidelity

To assess whether the final implementation of our mailing of treatment letters is as intended, we leveraged a unique feature of the DoR's mailing process. The DoR regularly posts envelopes destined for addresses that are either unattended (vacant) or do not exist in the first place due to typos. Either before or after an attempted delivery to such an address, the postal service identifies these letters and returns them to the DoR, which then processes the letters and attempts, if they can identify a suitable alternative address, to redeliver the tax bill. We took advantage of the fact that a subset of bills made their way back to DoR to

Table 2
Descriptive Statistics

	All Delinquent	Law Firm	Restricted	Analysis
Average amount due	$4,409	$4,608	$3,761	$3,465
Median amount due	$1,695	$2,216	$1,285	$1,311
Average assessed property value	$138,867	$76,478	$242,604	$186,691
Median assessed property value	$66,700	$50,100	$82,900	$81,900
Original tax due	$1,586	$925	$3,123	$2,405
Average years of debt	6	8	4	4
Median years of debt	2	4	1	1
% residential	80	74	81	80
% with Philadelphia address	88	87	82	83
% owner-occupied	24	14	21	22
Number of observations	134,887	70,031	29,951	4,927

Note: This table provides some descriptive statistics for all properties in Philadelphia, all properties that satisfy our sampling restrictions, and the sample used in the analysis.

check first-hand the extent of treatment fidelity. Our final sample consists of the nine treatment days for which greater than 90% fidelity was achieved.[11]

D. Sample Size

From the original full sample of 134,888 "most tardy" properties, we select a final sample of 4,927 properties for our experiment. This final sample removes all properties no longer handled by the DoR (= 61,170); or for which payment agreements have been reached (= 31,456); or were not part of our nine day mailing cycle (= 24,800); or which qualified for a tax abatement (= 4,706); or because of one or more years of tax delinquency qualified for a sheriff's sale (= 4,098), a sequestration (= 1,130), or for a bankruptcy (= 948). In addition, there were properties for which the DoR had no working address (= 1,429) or had a bill remaining of less than $.61 (= 224).[12]

Table 2 provides descriptive statistics for the full sample for all tardy and delinquent properties as of November 2014, not (yet) restricted by a sheriff sale, sequestration, or bankruptcy. Also shown are the descriptive statistics for properties in the restricted sample and then for 4,927 sample properties that qualify for our experiment.

Note in particular that this sample selection means that our sample consists only of properties that are not in the purview of the two law firms that the DoR uses as collection agencies. It is, therefore, useful to

compare briefly the properties that are kept in-house with those that are assigned to the law firms. We find that properties kept in-house have lower balances, with a median of $1,311, as compared to $1,695 overall. However, in-house properties have higher market values—the DoR median is $81,900 versus $66,700 overall. Properties handled by the DoR have younger debt—an average of four years versus six and eight for the two law firms. Even conditional on age of debt, in-house balances are low. The DoR-managed accounts are less likely to be owner-occupied, less likely to be in payment agreements, and more likely to result in a sheriff's sales. In summary, it appears that the outside firms are holding properties which, even given other characteristics, have the highest potential returns.

E.   Sample Balance on Observables

To confirm whether we indeed achieved randomization, we performed a series of balance-on-observables tests. Analysis of balance on observables is complicated by the random assignment of our treatments by mailing addresses. If the mailing address is to an owner with multiple holdings, for example, the University of Pennsylvania, then our analysis of sample balance by each treatment letter may be skewed by those addresses that are for owners with multiple properties. Further, if there are multiple properties associated with one mailing address, it is not obvious how best to aggregate property-level characteristics for the owner's multiple holdings. For these reasons, table 3 only examines sample balance on the subset of properties for which there is a unique property for each owner. This is 79% of all properties in our full sample.

Most of the observed characteristics are categorical variables, so we can test balance using standard χ^2 tests. The full sample consists of letters mailed over nine days, two of which sent the Threat treatment letter, four of which sent the Public Service treatment letter, two of which sent the Civic Duty treatment letter, and one final day, which mailed the control letter. This meant that of the 4,927 letters mailed, 22% (2/9s) were threat letters, 44% (4/9s) were public service letters, 22% (2/9s) were civic duty letters, and 11% (1/9) were control letters. If our treatment letters are randomly allocated across observable characteristics of properties owing taxes, then we should observe the same distribution of letters by each observable characteristic. Table 3 shows the empirical distributions for each characteristics and the resulting p values for the

Table 3
Tests of Sample Balance on Observables

Variable	Threat Control	Public Service Threat	Civic Duty Public Service	Control Civic Duty	p-value p-value
Taxes due quartiles					
< $300	0.22	0.10	0.40	0.28	0.00
[$300, $1,300)	0.24	0.08	0.46	0.22	
[$1,300, $3,300)	0.23	0.11	0.45	0.20	
> $3,300	0.18	0.11	0.48	0.23	
Market Value Quartiles					
< $46K	0.24	0.12	0.43	0.21	0.33
[$46K, $82K)	0.22	0.09	0.46	0.23	
[$82K, $151K)	0.21	0.09	0.45	0.25	
> $151k	0.21	0.10	0.45	0.24	
Land area quartiles					
< 800 square feet	0.22	0.10	0.45	0.23	0.92
[800, 1,200) square feet	0.23	0.10	0.43	0.24	
[1200, 1800) square feet	0.21	0.10	0.47	0.22	
> 1800 square feet	0.21	0.10	0.44	0.24	
Number of rooms					
0–5	0.22	0.11	0.44	0.23	0.51
6	0.21	0.09	0.46	0.23	
7+	0.22	0.10	0.44	0.24	
Years of debt					
1 years	0.23	0.09	0.43	0.24	0.11
2 years	0.22	0.10	0.44	0.24	
3–5 years	0.20	0.10	0.48	0.22	
6+ years	0.20	0.13	0.47	0.20	
Category					
Residential	0.22	0.09	0.45	0.23	0.28
Hotels and apartments	0.20	0.12	0.45	0.23	
Store with dwelling	0.21	0.09	0.48	0.22	
Commercial	0.15	0.11	0.50	0.24	
Industrial	0.27	0.11	0.42	0.20	
Vacant	0.25	0.13	0.39	0.23	
Empirical distribution	0.22	0.10	0.45	0.23	0.62
Expected distribution	0.22	0.11	0.44	0.22	

Note: This table shows that there are no significant differences in the distribution of observed variables among the treatment and control samples.

test of the null hypothesis that the means of the relevant distributions are equal to the predicted true probabilities.

As can be seen from table 3, randomization appears to have been mostly successful. The properties appear to be randomly distributed by market value, land area, years of debt, property size, and category. The only exception is "balance due" for which we find significant differences among the control and the three treatment groups. Randomization also appeared to have worked for the following variables not reported in the preceding table: location (their political ward, of which there are 66 in Philadelphia), case assignment (this variable captures, if applicable, to which outside law firm a property is assigned), and whether the property is in sequestration or has entered a payment agreement with the city. The number of properties assigned to each treatment is further exactly as expected, given the unequal number of mailing days in our treatment. As consequence, we conclude that randomization has been mostly successful.

IV. Average Treatment Effects: Revenues

We consider results for three different samples. The first sample is the full sample and consists of all 4,927 observations. The second sample eliminates commercial property owners, which reduces the sample to 4,749 observations. The third sample eliminates owners of multiple properties, resulting in a sample size of 3,888.

Table 4 summarizes the impact of our experimental intervention on total revenue collection. The table reports the total taxes owed, the amount generated, and the number of mailing days for the three treatments and the control groups. It also reports the % of properties that paid the city anything and the percent that paid off their tax debt in full in our sample period.

Table 4 suggests that all treatment raised positive amounts of revenue for all three samples. The overall magnitude of the gains depends on the sample, with larger gains in the full sample and the sample of sole owners and smaller gains in the sample of noncommercial owners. While table 4 provides some evidence that suggests that our treatments were successful in raising revenues for the city, we need to turn to formal statistical testing to determine whether these gains are statistically significantly different from zero.

Table 5 provides estimates of the average treatment effect of each reminder letter on the revenues collected per letter from our sample of these

Table 4
Estimated Average Treatment Effects: Revenues

Sample	Treatment (Properties)	Total Debt Owed ($)	Percent Ever Paid	Percent Paid in Full	Dollars Received	Percent Debt Received	Dollars above Control Per Property	Total Surplus: All Properties
Full	Control (n = 1,075)	3,294,516	16	10	120,585	3.7	0	$0
(N = 4,927)	Threat (n = 499)	1,839,826	14	8	71,176	3.9	30	$15,202
	Public service (n = 2,211)	8,003,148	15	7	447,728	5.6	90	$199,714
	Civic duty (n = 1,142)	3,794,900	18	12	152,217	4.0	21	$24,116
Noncommercial	Control (n = 1,048)	2,930,759	16	10	120,069	4.1	0	$0
(N = 4,749)	Threat (n = 480)	1,657,379	15	8	71,176	4.3	34	$16,183
	Public service (n = 2,122)	7,024,458	15	7	288,758	4.1	22	$45,642
	Civic duty (n = 1,099)	3,350,147	19	12	146,227	4.4	18	$20,315
Unique owner	Control (n = 837)	3,007,232	16	9	66,597	2.2	0	$0
(N = 3,888)	Threat (n = 406)	1,437,902	15	9	51,309	3.6	47	$19,005
	Public service (n = 1,754)	6,956,034	16	7	418,767	6.0	159	$279,207
	Civic duty (n = 891)	3,331,168	20	13	130,016	3.9	66	$59,123

Note: The table shows how much additional revenues were generated by the different treatments.

Table 5
Estimated Average Treatment Effects: Revenues

	Main Sample	Noncommercial Sample	Unique Owner Sample
Threat	10.78	23.00	40.55
	(42.34)	(41.65)	(31.37)
Public service	76.04	14.03	152.38**
	(55.53)	(31.27)	(66.57)
Civic duty	28.95	22.96	82.31**
	(38.15)	(38.62)	(40.58)

Note: The intercept captures the baseline effectiveness of the control group. The coefficients of the treatments measure the difference in the mean effectiveness relative to the control group.
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

most tardy taxpayers. Estimates are provided for each of three samples: the full sample of all most tardy properties, the sample of properties excluding commercial properties, and, finally, the sample of properties having a single owner. Estimates are obtained from a simple ordinary least squares (OLS) regression of revenues collected per letter mailed against each treatment letter: threat, public service, or civic duty, and an intercept. Because table 3 showed the receipt of each treatment letter is only correlated with "balance due," we also include this regressor in the three OLS regressions.[13] The estimated regression coefficients for each treatment letter measure the additional revenues raised by the treatment in the preceding those revenues raised by the city's standard reminder letter (the control). Robust standard errors are also reported in the table.

Table 5 shows that there is significant heterogeneity in the impacts of the three treatments across our three samples. For the full sample, the average treatment effect is $76 for the public service treatment, $29 for the civic duty treatment, and $11 for threat treatment. If we restrict our analysis to the subsample of properties that are noncommercial, we find that impact of the public service treatment is now much smaller, only $14. This difference implies that those making the largest contribution in response to the public service letter are commercial properties. None of the estimates of these treatments are, however, statistically significantly different from zero.

When we restrict attention to the subsample of singe property owners, we find all letter's average treatment effects are large and more significant statistically. This single-owner sample includes resident homeown-

ers, single owners of rental properties, or single owners of city businesses and represents 79% of the properties receiving treatment letters. This sample is most representative of the average voting taxpayer in the city. For this subsample of tardy taxpayers, the Threat letter raises an additional \$41/letter, the public service letter raises an additional \$152/letter, and the civic duty letter raises an additional \$82/letter. The public service and civic duty treatment effects are significant at the 5% and 10% confidence levels, respectively.

V. Average Treatment Effects: Compliance

While collecting additional revenues from this "most tardy" group of taxpayers is of interest, it is also of value to know how we might encourage taxpayer compliance and, particularly so, if there is a dynamic to tax payments where one is more likely to pay if one's fellow citizens are also paying their taxes. Greece, for example, has experienced a significant downward spiral in compliance as more and more citizens avoided tax payments. To gain insight into the nature of tax compliance in Philadelphia, we consider a discrete measure of tax compliance. The compliance outcome is one if the tardy taxpayer makes any payment at all and zero if not, that is, $y = 1$, if the tax payer made a positive payment, and $y = 0$ if not.[14] The outcome is of interest because even small additional payments help, but, perhaps more importantly, a tax contribution represents a willingness by the taxpayer to be engaged with city governance. It is worth stressing again that our sample is for the "most tardy" of the city's taxpayers, perhaps those least likely because of inclination or because of resources to feel a stake in the city's fiscal fortunes.

We specify and estimate compliance as a logistic function of the control and three treatments, with each estimated effect measuring the treatment's impact on tax payment relative to that available from receipt of the control letter. The probability of paying taxes can be specified as:

$$Pr\{y = 1 \mid X\} = \frac{exp(X'\beta)}{1 + exp(X'\beta)},$$

where X is a vector of explanatory variables and β a vector of coefficients to be estimated.

The benefits of the logistic specification, over the more familiar linear specification, is that once estimated, the computed probabilities of payment are bounded between 0 and 1, and the partial effect of any of the independent variables on the probability of payment can vary according

Table 6
Logistic Regressions for Ever Paid: Compliance

	Full Sample	Noncommercial	Sole Owner
Threat	−0.07	−0.04	−0.03
	(0.17)	(0.17)	(0.17)
Public service	−0.06	−0.08	0.05
	(0.13)	(0.13)	(0.11)
Civic duty	0.22	0.20	0.30**
	(0.13)	(0.14)	(0.12)
Log likelihood	−2,127.64	−2,054.97	−1,749.98
Number of observations	4,927	4,749	3,888

Note: This table reports the parameter estimates from the basic logit model that uses "ever paid" as outcome.
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

to the overall value of $X'\beta$. For our analysis, the vector of explanatory variables X will include three (1,0) indicator variables for whether the taxpayer received one of the three treatment letters (threat, public service, or civic duty), the level of taxes owed represented by one of four categories of debt as LOW (less than $300), MODerate ($301 to $1,300), HIGH ($1,301 to $3,300), or Very HIGH (greater than $3,301), and the interaction of treatment letters with the level of taxes owed. The taxpayer is assigned a value of 1 if the property's tax bill falls within a debt category and 0 otherwise. The omitted debt level for comparison is LOW. The interactions of the debt levels with treatments will explore the possible advantages of targeting treatment letters to taxpayers of varying debt levels.[15]

First, we consider the model without interaction effects. Table 6 summarizes the estimates and the estimated standard errors for the three samples that we considered in the preceding. We report robust standard errors that are clustered to deal with multiple ownership. As can be seen from table 6, the civic duty letter is the only treatment that is significant in the sole owner sample. All other treatments had a insignificant effect on "ever paid" at the conclusion of the 30-day payment period.

However, it is possible that certain subgroups were affected by the treatments. We, therefore, investigate whether there is heterogeneity in response to the treatment. It is plausible that very tardy taxpayers who owe small amounts of money behave differently than those who owe larger amounts. To gain insight into this possibility, we include in our regression for "ever paid" the indicator variables for the levels of taxes

Table 7
Logistic Regressions for Ever Paid with Interactions: Compliance

	Full Sample	Noncommercial	Sole Owner
Balance MOD	−0.46	−0.52*	−0.33
	(0.25)	(0.24)	(0.24)
Balance HIGH	−1.03***	−0.97***	−1.54***
	(0.28)	(0.27)	(0.32)
Balance VHIGH	−1.25***	−1.15***	−1.36***
	(0.33)	(0.32)	(0.34)
Threat	−0.05	−0.01	−0.13
	(0.29)	(0.28)	(0.29)
Threat × balance MOD	−0.27	−0.27	−0.22
	(0.46)	(0.45)	(0.45)
Threat × balance HIGH	0.40	0.38	0.94
	(0.44)	(0.43)	(0.48)
Threat × balance VHIGH	−0.07	−0.20	−0.19
	(0.57)	(0.59)	(1.22)
Public service	−0.30	−0.34	−0.34
	(0.20)	(0.20)	(0.21)
Public service × balance MOD	0.02	0.10	0.10
	(0.31)	(0.31)	(0.30)
Public service × balance HIGH	0.53	0.53	1.07**
	(0.33)	(0.32)	(0.37)
Public service × balance VHIGH	0.70	0.62	0.92*
	(0.38)	(0.37)	(0.39)
Civic duty	0.16	0.13	0.21
	(0.21)	(0.22)	(0.21)
Civic duty × balance MOD	−0.23	−0.09	−0.30
	(0.33)	(0.33)	(0.32)
Civic duty × balance HIGH	0.27	0.15	0.59
	(0.35)	(0.36)	(0.40)
Civic duty × balance VHIGH	−0.13	−0.14	−0.06
	(0.42)	(0.42)	(0.44)
Log likelihood	−2,010.63	−1,948.34	−1,639.28
Number of observations	4,927	4,749	3,888

Note: This table reports the parameter estimates from the logit model with interactions that uses "ever paid" as outcome. Control coefficients omitted.
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

owed—LOW, MOD, HIGH, and VHIGH—and the interaction of those variables with our three treatments. The variable LOW is omitted from the regression so all results provide comparisons to the behavior of those in the higher debt levels to taxpayers in the lowest level of taxes owed. Table 7 summarizes the estimates and the estimated standard errors for the full sample and the two subsamples.

Table 8
Marginal Predictions: Ever Paid

	LOW	MOD	HIGH	VHIGH
Control	23.35	16.13	9.82	7.99
Threat	22.42	12.23	13.41	7.12
Public service	18.45	12.69	12.10	11.44
Civic duty	26.37	15.23	14.38	8.25

Note: This table reports the marginal effects from the logit model
with interactions that uses "ever paid" as outcome.

Table 7 shows that the indicator variables for taxes owed by quartile
are significantly negative, that is, the more a taxpayer owes, the less
likely he or she is to pay the taxes. For the public service, we find that
those with low or moderate levels of taxes owed react negatively or not
at all to the public service letter, while those with high and very high
levels of taxes owed are more likely to make a contribution when they
receive the public service letter. The threat letter is mostly insignificant.
We find some limited evidence that tax payers with high balances due
responded positively to the letter in the sole owner sample. Finally, the
civic duty appeal never helps tax compliance.

Table 8 shows the marginal predictions for the probability that a very
tardy taxpayer in each treatment group and for each quartile of taxes
owed will make some payment ("ever paid"). The values here repre-
sent the predicted probabilities of payment, computed for the "aver-
age taxpayer" as represented by the sample average level of all indica-
tor control variables and the median values of the continuous control
variables. Table 8 reinforces our findings that heterogeneity in response
to treatments is potentially important. Because of this heterogeneity in
response to different treatments, a preferred overall strategy may be to
target different treatment letters to different cohorts of tardy taxpay-
ers by taxes owed. One can speculate as to why motives for payment
are tied to the levels of taxes owed. More research is clearly needed to
evaluate such a strategy.

We also examined whether our treatment strategies might also im-
pact the larger matter: when do tardy taxpayers pay their full amount
of taxes owed? The ever-paid outcome does not differentiate between
taxpayers that made full payment and those who made only a partial
contribution. Overall, our findings are similar to the case in which we

use "ever paid" as the outcome of interest. The main difference is that we find less support for the hypothesis that heterogeneity in treatment is important.

VI. Conclusions

This field experiment evaluated three alternative notification strategies intended to increase property tax compliance. We implemented our experiment in collaboration with Philadelphia's Department of Revenue. This initial study of property tax compliance in Philadelphia has value for at least three reasons. First, it is the first study that systematically examines alternative tax compliance strategies for taxation in a large city. Second, the study of property tax compliance for which there is a known tax liability has allowed us to focus directly on motives for paying taxes. Third, great care was given to separately specify, identify, and directly compare the three common motives for tax payment that play a prominent role in the tax compliance literature.

Our findings provide tentative support for the conclusion that our carefully designed notification letters can modestly improve property tax collections and taxpayer compliance. The average treatment effects on city revenues are largest, and most significant statistically, for the sample of single-owner properties. For this sample of very tardy taxpayers, the public service appeal adds \$152/letter and the civic duty appeal adds \$82/letter, and the threat collects \$41/letter over revenues raised by the city's current reminder letter. Our results for taxpayer compliance show why. The public service appeal is particularly effective in encouraging those with large debts to make at least some payment toward their taxes owned. The fact that taxpayers responded differentially to the three reminder letters suggests that a strategy that targets different reminders to specific cohorts may improve collection performance. A uniform reminder to all late or noncompliant taxpayers is unlikely to be revenue maximizing.

We find limited support for the use of our threat letter as a means to increase revenues collected or taxpayer compliance. This result deserves further analysis, for at least three reasons. First, our sample of taxpayers receiving the threat letter is relatively small. Second, our sample may be unique in its taxpaying motivations. These are the very tardiest of the city's taxpayers. By the time they have received our threat letter in mid-

to late November, they had already received at least one and maybe as many as three previous reminders to pay their taxes, and each reminder had included a summary of the fines and penalties that were accruing with continued delays. Further appeals to an economic motivation may be irrelevant for this cohort of very tardy taxpayers. Third, the wording of our threat letter is very blunt and, therefore, may seem too draconian or too remote to be credible. Alternative specifications for the threat of penalty should be considered to make it seem more relevant and, thus, enforceable.

If there is a single, strong lesson to be learned from our analysis, it is that tax compliance experiments that explore a range of motivations for city taxpayer behavior are well worth doing for two reasons. First, moving beyond the usual practice of simply mailing the tax bill and assuming payment and toward mailing tax bills and reminder letters that invoke a reason to pay can be profitable. Second, for this sample of very tardy taxpayers, the nudge letters may also encourage increased taxpayer compliance. Quite apart from any additional revenues, citizen participation through tax payments can be an important motivation for additional citizen engagement with the fiscal management of their city and particularly so if there are dynamic effects onto tax compliance and citizen engagement by other citizens.

There are limitations to our study, of course. Strictly speaking, our conclusions apply only to Philadelphia taxpayers and, among those citizens, only to those who are most tardy in paying their taxes. Second, our sample of taxpayers is small, only 4,927 taxpayers in total. Third, randomization was successful for most variables but not for "balance due." Finally, while our focus on property tax compliance has the advantage of allowing us to more cleanly identify motives for tax payments, Philadelphia and other cities raise significant revenues from wage taxes, income and profits taxes, sales taxes, and fees. Payment compliance for cities for these other revenue instruments deserves careful analysis, too. All said, however, we feel our work here is an encouraging first step toward introducing the new methodologies of tax compliance into the practice of city government finances.

Appendix

Figures A1 through A5

PO BOX 148
PHILA PA 19105-0148

CITY OF PHILADELPHIA
DEPARTMENT OF REVENUE

I...III.I .... II..II....IIII...I
RICHARD ROE
5107   DUNLAP   ST
PHILADELPHIA   PA
19131

AUGUST 12, 2014

TEMP: 000359764
NOTICE SflIAllHIMOflia
Phone: (215) 686-6442

Property: 5707 DUNLAP ST

REAL ESTATE TAX BILL
Includes payments posted through AUGUST 07, 2014

This bill represents the real estate tax liabilities for this account You must pay these liabilities immediately. Interest, penalty, and/or additions have been calculated to the due date. Additional amounts will accrue after that date. Only payment in full or a payment agreement will prevent enforcement action.

THIS BILL MAY NOT REPRESENT YOUR TOTAL TAX LIABILITY

BRT Number	Period	Tax Due Balance	Additions/ Interest	Penalty	Charges	Total Amount Due
023459700	2014	755.76	68.02	0.00	0.00	823.78
Total		755.76	68.02	0.00	0.00	823.78

----------------- DETACH HERE --------------------------
RETURN THIS PORTION WITH PAYMENT

PAYMENT DUE: $823.78
ON OR BEFORE SEPTEMBER 06, 2014
AMOUNT ENCLOSED:

MAKE   CHECKS   PAYABLE   TO:

CITY OF PHILADELPHIA

NOTICE #: 5518914149812
RICHARD ROE
TEMP: 000359764

DEPARTMENT OF REVENUE
P.O. BOX 148
PHILA, PA 19105-0148
I.,.III.I,,,..(III....I.I.II..................II.I..II..I....I

333bII231TTQ0DD5fIlfITIM140fII20000000D00D000D000DD0000D00D00DITfiI]i0500

N000200n HFAI FSTATF TAX BILL 466

Fig. 1.   Standard due letter

Not paying your Real Estate Taxes is breaking the law.

Failure to pay your Real Estate Taxes may result in seizure or sale of your property by the City.

Do not make the mistake of assuming we are too busy to pursue your case.

Contact the **Department of Revenue** as soon as possible at 215-686-6442, M-F 8:30AM-5PM, or by e-mail at revenue@phila.gov to arrange for payment.

CITY OF PHILADELPHIA
DEPARTMENT OF REVENUE

For more information visit the Department of Revenue website at www.phila.gov/revenue or call 215-686-6442.

Stay connected

Commissioner Clarena I.W. Tolson, Chief Revenue Collections Officer • 1401 JFK Boulevard, Concourse Level Philadelphia, PA 19102

Fig. 2. Treatment 1: Deterrence

We understand that paying your taxes can feel like a burden.

We want to remind you of all the great services that you pay for with your Real Estate Tax dollars.

Your tax dollars pay for schools to teach our children. They also pay for the police and firefighters who help keep our city safe. Please pay your taxes as soon as you can to help us pay for these essential city services.

Contact the **Department of Revenue** as soon as possible at 215-686-6442, M-F 8:30AM-5PM, or by e-mail at revenue@phila.gov to arrange for payment.

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Fig. 3. Treatment 2: Public service appeal

You have not paid your Real Estate Taxes.

Almost all of your neighbors pay their fair share--9 out of 10 Philadelphians do so. Paying your taxes is your duty to the city you live in. By failing to pay, you are abusing the good will of your Philadelphia neighbors.

Contact the **Department of Revenue** as soon as possible at 215-686-6442, M-F 8:30AM-5PM, or by e-mail at revenue@phila.gov to arrange for payment.

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Fig. 4. Treatment 3: Civic duty

The enclosed bill details your outstanding Real Estate Taxes due to the City of Philadelphia.

Contact the **Department of Revenue** as soon as possible at 215-686-6442, M-F 8:30AM-5PM, or by e-mail at revenue@phila.gov to arrange for payment.

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Fig. 5. Control

Endnotes

We would like to thank Rob Dubow (Director of Finance), Clarena Tolson (Revenue Commissioner), and Marisa Waxman (Deputy Commissioner for Assessment of Properties) in the Department of Revenue of the City of Philadelphia for their help and support. We would also like to thank Jeff Brown, Chris Sanchirico, Wolfgang Schön, Reed Shuldiner, and participants of numerous seminars for comments and suggestions. The views expressed here are those of the authors and do not necessarily represent or reflect the views of the City of Philadelphia. For acknowledgments, sources of research support, and disclosure of the authors' material financial relationships, if any, please see http://www.nber.org/chapters/c13690.ack.

1. See Alm (1999) for a detailed survey of the literature.

2. See, for example, Reekers, Sanders, and Roark (1994), Torgler (2002) and Wenzel (2005).

3. See Pew Charitable Trust (2013) for a detailed evaluation of tax compliance in Philadelphia.

4. A well-administered property tax is has two potential economic advantages, one relating to economic efficiency and the other to economic fairness. First, if households and businesses are mobile across local political jurisdiction and, if local jurisdictions use their zoning powers to "sort" taxpayers by the value of their properties, then the property tax becomes the economic equivalent of a benefit tax relating taxes paid directly to the costs of the services provided (see Hamilton 1975). This will lead to the efficient provision of local government services. The two efficiency assumptions are likely to hold in suburbs but not in central cities. In the case of the central city, efficiency will require the tax be close to a tax on existing structures and ideally land, rather than on new investment. The tax will be least efficient in those cities with very elastic demand and supply for new construction. In declining cities with no new construction, the supply curve is inelastic at the level of existing structures. In successful, growing cities, demand for location is likely to be inelastic and new supply constrained by available land. In these two cases, therefore, the property tax remains a relatively efficient local tax. With regard to economic fairness, if the property tax is based on market value assessments, then the tax becomes a proportional tax on property wealth (see Aaron 1975; Mieszkowski 1972). Because property wealth increases at least in proportion to increases in income, the tax will be proportional or, perhaps, progressive.

5. Any remaining volatility in revenues can be managed with rainy day funds.

6. A city's collection year need not correspond to the city's fiscal year. For example, in Philadelphia, the collection year is the calendar year while the fiscal year runs from July 1 to June 30 of the next year. Tax bills are mailed in January of each collection year—the middle of the fiscal year—and are due on March 31 of that year. Payments received after March 31 are considered late payments and will incur interest and late payment penalties. All payments received by December 31 of the collection year are then recorded as taxes paid during the collection year. Payments that are not paid by December 31 are then classified as delinquent for that collection year. Because property tax payments arrive in the last half of each fiscal year, Philadelphia will use some its tax receipts to repay the short-term "cash-flow" loans of that fiscal year and then save a significant fraction of the remaining revenues for spending in the first half of the next fiscal year.

7. The average annual collection rate for delinquent taxes was estimated from data provided by the sample cities in each city's Comprehensive Annual Financial Report. The required data was reported either as the amount finally collected from a given year's delinquent taxes—reported as "Collections in Subsequent Years"—or as all delinquent taxes collected in a year from all previous years—reported as "Delinquent Tax Collections." For cities reporting "Collections in Subsequent Years," the average annual rate was computed as ratio [Collections/(Tax Year Taxes Levied – Tax Year Taxes Collected)] then divided by 5. The assumption is that all taxes levied but not collected in the tax year are classified as delinquent and that no significant amount of delinquent taxes are collected after five years. For cities reporting "Delinquent Tax Collections" the average annual

rate was computed as ratio [Collections/ Σ (Tax Year Taxes Levied – Tax Year Taxes Collected)], summed over the previous five tax years. In both cases, the average annual rate is an average of the actual collections in each of the five years following tax delinquency, where typically the first year rate of collection is the highest, with a declining rate in years two to five. Included in "Collections" in both cases will be taxes plus interest plus penalties collected, the proceeds from the sale of tax liens to private collection agents, and the proceeds from the sheriff's sales of delinquent properties.

8. Atlanta is one of the better performing cities in its collection of delinquent taxes and the pattern of its collection success is typical. We estimate that in the first year of delinquency for its 2005 tax collection year, the city collected 56% of delinquent taxes owed. That was in 2006. In 2007, the second year of delinquency for 2005 taxes, an additional 8% was collected. In 2008, an additional 1% was collected. In 2009, an additional 7% was collected. And in the 2010, an additional 12% was collected. After five years, the final amount collected of the 2005 delinquent tax owed was 84%. The five-year annual average for 2005 was, therefore, .168. In subsequent years, Atlanta has done a bit better. Its annual average collection rate has been .182 for an aggregate average collection rate of delinquent taxes of .91.

9. The Spanish translation was targeted at the substantial Latino population and is available upon request. Phone contacts were also included.

10. For a discussion of experimental design in field experiments see, for example, Harrison and List (2004).

11. From letters that were returned to the mailroom because they could not be delivered, we discovered that 6 of our 15 mailing cycle days involved possible errors to the insertion of our reminder letters with the tax bill. As a result, the experiment's fidelity for those six treatment days was potentially compromised. Because we could not be certain which reminder letters had been mailed on those mailing days, we removed all responses for those days from our sample. This left a final sample of 4,927 letters mailed that could be identified with treatments. Because the nine remaining days were not distributed evenly among treatments, there is a sample size imbalance across treatments.

12. The city operates 50 billing cycles. Each cycles has approximately 2,500 observations. Once we apply the sample selection criteria discussed in the preceding, we obtain between 493 and 633 observations per day.

13. We find that "balance due" is highly significant, but the overall results are similar to the case in which "balance due" is excluded from the analysis.

14. We also briefly consider a second compliance outcome is if the taxpayer makes a full payment of taxes owed (called "paid in full").

15. We also include in our basic logistic regression as elements of X measures of the location of the property within 1 of 10 city neighborhoods (each a city council district); the exterior condition of the property (classified as a "sealed/compromised," that is, dilapidated and dangerous); and whether the property qualified for a low-income homestead exemption.

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