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Research Article

Good for you or good for us? A field experiment on motivating citizen behavior change

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Abstract: In recent years, public sector agencies have increasingly been moving citizen services online to reduce administrative burdens for citizens and costs for governments. However, motivating citizens to make the transition to online services can be difficult. In this paper, I report on a randomized control trial with the Philadelphia Licenses and Inspections Department, testing a letter intervention with 11,579 rental license holders designed to encourage them to register for an account and renew online. Subjects were randomly assigned to either a control group that did not receive a letter or one of three treatment groups: 1) Standard (a simple reminder letter); 2) Personal Benefits (a letter with added language emphasizing the reduced burden for citizens from online renewal); and 3) City Benefits (a letter with added language emphasizing the benefits to the city from online renewal). I find a statistically significant, positive effect of letter receipt on both online registration and renewal; for example, the treatment letters increased the probability of renewing at least one license online from 12.3% in the control to 20.4% for the treatments pooled together. Furthermore, the City Benefits letter was the least effective treatment, though there were only small differences between treatments. Finally, the letters were generally more effective for subjects not residing in Philadelphia, suggesting that "nudge" campaigns to reduce administrative burden may be most effective for those facing the highest burdens from in-person public service delivery.

Keywords: Field experiment, Administrative burden, Motivation, Behavioral policy, E-government

Supplements: Open materials

Recent developments in the public administration literature suggest that administrative burden, defined as the learning, psychological, and compliance costs citizens[1] bear when interacting with government, play an important role in influencing citizen uptake of and attitudes about public programs (Moynihan, Herd, & Harvey, 2015; Burden, Canon, Mayer, & Moynihan, 2012; Herd, 2015; Keiser & Miller, 2020). Governments at the local and national levels have sought to reduce these burdens in several ways, including by allowing citizens to complete routine processes online rather than in-person or through the mail (an effort that falls under the broader "e-Government" umbrella).[2] The process of moving citizen services online is particularly popular because it can reduce compliance costs for citizens seeking public services (Coolidge & Yimaz, 2015; Al-Kibsi, de Boer, Mourshed, & Rea, 2001),[3] while simultaneously reducing implementation costs for governments (Montagna, 2005; de la Rosa, Rovira, Beer, Montaner, & Gibovic, 2010).

However, encouraging behavior change in this domain has proved challenging. Moving processes online entails the disruption of the behavioral status quo and often requires citizens to remember and complete a set of unfamiliar digital steps (registering for and setting up an online account, entering personal details, etc.). Given the well-documented power of inertia and status quo bias in decision making (Samuelson & Zeckhauser,

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1988; Madrian & Shea, 2001; Schirrmacher, Ondrus, Hardoon, & Loh, 2019), it is not surprising that citizens are slow to make this change in how they interact with government.

In this paper, I report on a field experiment conducted with the City of Philadelphia's Department of Licenses and Inspections (L&I), which sought to increase use of an online (as opposed to in-person or by-mail) system for license renewal. The study specifically targeted 11,579 individuals with licenses for rental properties in the city that were up for renewal in 2017 (spanning 21,460 different rental licenses).[4] There were four experimental conditions in the experiment: a control condition and three treatment conditions. Subjects in the control condition were not sent a letter of any kind. Subjects in the three treatment groups received one of three letter versions: 1) a "Standard" letter that informed license holders that the city was phasing out mail-in renewals soon and encouraged them to register for the online service and (eventually) renew their license online; 2) a "Personal Benefits" letter with the same information as the Standard letter but with additional language that highlighted the personal benefits of online renewal, namely less hassle, wasted time, and stress; and 3) a "City Benefits" letter with the same information as the Standard letter but with additional language that highlighted the benefits accrued to the city of Philadelphia with online renewal, namely increased city efficiency and an overall reduction in in-person wait times.

There are two key findings from the experiment. First, there is clear evidence that subjects who received a treatment letter were more likely to register online and to renew their licenses online than those in the control group. For example, while subjects in the control condition were 18.5% likely to register online and 12.3% likely to renew at least one license online, the figures for subjects in the three treatment conditions pooled were 36.3% and 20.4% respectively (with $p<0.0001$ for the differences between control and all treatments pooled in both cases). Second, the City Benefits letter was the least effective treatment on average, while the Personal Benefits letter performed best (slightly outperforming the Standard letter); for example, 21.5% of subjects in the Personal Benefits letter renewed at least one license online, versus 20.8% of subjects in the Standard condition ($p=0.51$ for the difference between Standard and Personal Benefits) and 19.1% of subjects in the City Benefits condition ($p=0.10$ for the difference between Standard and City Benefits).

An exploratory analysis of disaggregated treatment effects produces two additional findings. First, I explore the hypothesis that subjects who reside in the city might be impacted differently by the motivational letters (particularly the City Benefits letter). I find that license holders residing in Philadelphia were actually less responsive to the treatment letters than those living outside the city, with little evidence to suggest that the City Benefits letter was especially effective for city residents. These findings suggest that letters promoting online public services are more behaviorally motivating for those who face greater compliance costs from in-person services in particular (in this case, those not residing in Philadelphia).

Second, I explore the extent to which responsiveness to treatment letters varies by income, using two income proxies: 1) the number of rental licenses held by a given individual (one versus two or more); and 2) the median household income in the license holder's ZIP code. I find limited evidence of large differences in treatment effects by experimental condition using these two proxies for income, though the latter analysis does hint at a potential positive relationship between income and treatment effects. However, because this analysis uses rough proxies for income, we must interpret the results with caution.

These results have both academic and practical implications. From an academic perspective, my findings provide causal evidence on an intervention designed to reduce administrative burden for citizens and help shed light on the underlying drivers behind citizen reluctance to move online. Specifically, while the differences between treatments are small, the relatively poor performance of the City Benefits letter suggests that citizens are unmoved by messaging emphasizing the benefits to government from citizen use of online public services. Furthermore, the relative efficacy of the Personal Benefits letter implies that citizens may not perceive online systems as time-saving ex-ante, suggesting that increasing the salience of burden reduction in messaging is effective (consistent with Castelo, Hardy, House, Mazar, Tsai, & Zhao, 2015; Faulkner, Jorgensen, & Koufariotis, 2019).

From a practical perspective, there are three main implications of this work. First, these results show that letters sent to citizens to encourage behavior change intended to reduce administrative burden are effective. Notably, while the magnitude of the effects differs by letter framing, the differences across treatment letters are dwarfed by the overall "salience" effect of sending a letter at all (versus not sending one). That said, these letter campaigns should be viewed as effective but not sufficient; the treatments only raised online renewal rates by

around 8-10 percentage points. While this is not trivial, it is worth noting that the comfortable majority of the treated sample continued to use by-mail or in-person renewal. Second, the exploratory analysis suggests that inducements to move online will be more effective for those who face greater administrative burden (in this case, those not living in Philadelphia). Third, there is not much evidence that letters like the ones sent are differentially impactful based on recipient income, meaning that such interventions are unlikely to alleviate disparities in e-Government access caused by technological inequities (though these results should be viewed cautiously as they are based on rough proxies for income).

Background

There is growing literature in public administration exploring how administrative burden, which refers to the learning, psychological, and compliance cost of accessing services (Moynihan et al., 2015), influences the behavior and attitudes of citizens. There is little doubt that these burdens are substantial. For example, Marcuss, Contos, Guyton, Langetieg, Ler-man, Nelson, Schafer, and Vigil (2013) find that the average American spends around 13 hours filing taxes with the IRS, while Shapiro (2020) estimates that Americans spend over 30 hours on federal paperwork each year. These burdens are not just problematic because of inefficiency through wasted time, effort, and resources, but also because they might deter citizens from utilizing public services in welfare-enhancing ways. For example, Bartlett, Burstein, and Hamilton (2004) report that 64% of surveyed households who were eligible (but had not applied) for food stamp benefits stated that the costs of applying for food stamps (paperwork, challenges to getting to the food stamp office, and having to take time off work) prevented them from participating in the program. Similarly, Daigneault and Macé (2019) provide qualitative evidence from Québec that citizens inquire specifically about the logistical complexity of obtaining benefits before deciding whether or not to apply for them, suggesting that the mere perception of potential administrative burdens may discourage program uptake.

Furthermore, there is clear evidence that reducing administrative burden can boost citizen uptake of important programs and enhance citizen welfare. Herd, DeLeire, Hope, & Moynihan (2013) argue that when the burden of determining eligibility requirements is handled by the government rather than individual citizens, uptake in federal programs (such as Medicaid) increases dramatically. Similarly, Fox, Feng, and Stazyk (2019) find that when the state automatically enrolls individuals in Medicaid programs (thereby eliminating compliance costs associated with enrollment), participation in Medicaid increases. Finally, Linos and Riesch (2020) use a field experiment on recruitment with the Los Angeles Police Department to show that reducing friction costs – by making the job application process simpler – improved compliance with deadlines during the application process, and ultimately increased the likelihood of a given applicant being hired. Across the board, burden reduction seems to bolster citizen engagement with public sector programs and processes.

One tool for governments seeking to reduce administrative burden is to provide services online rather than in-person or by mail. This is often a mutually beneficial option. There is evidence that online services can significantly reduce compliance costs for citizens (Al-Kibsi et al., 200; Coolidge & Yilmaz, 2015; Ibrahim, 2014; Gallo, Giove, Millard, & Thaarup, 2014). For example, in a meta-analysis on the rise of e-Government, Al-Kibsi, et al. (2001) argue that e-Government provides faster, more accurate services than other approaches. Additionally, Coolidge and Yilmaz (2015) find that taxpayer compliance costs are reduced with the introduction of e-filing in developing countries. Meanwhile, there is evidence that providing services online can significantly cut costs for governments, due to reduced input and processing hurdles. Montagna (2005), for example, found a 50% cost reduction for the government when documents were processed online rather than in paper. Similarly, de la Rosa et al. (2010) observed that in Greenwich, Massachusetts, the shift of Information and Referral Services (I&R) online reduced the number of individuals required to man telephones by 33%, leading to a significant decrease in cost.

However, the move towards online public services has the potential to exacerbate existing inequities stemming from differential access to the internet by socioeconomic group. There is no shortage of evidence of major technological inequities in society (Benjamin, 2020; Gonzales, 2016), and subsequent work has found that e-Government is generally more beneficial for wealthy, internet-ready households than other households (Robinson, Schulz, Dodel, Correa, Villanue-va-Mansilla, Leal, Magallanes-Blanco, Rodriguez-Medina, Dunn,

Levine, McMahon, & Khilnani, 2020; Belares & Carter, 2006). Therefore, while appeals to move online have the potential to help citizens on average, whether or not they are of broader social value depends not only on the efficiency impacts of the online transition, but also the equity impacts. I will return to this point later in the paper, as the experiment I describe offers some evidence (albeit not precisely estimated) on this topic.

If we accept that burden reduction via online public services can be beneficial for all parties, it behooves public officials to determine the best way to promote the citizen behavior changes required in the transition. Recent research in the social sciences has established that behavioral interventions in government, including clear messaging that reduces complexity or increases benefit salience, can help reduce administrative burden directly or motivate citizens to overcome existing burdens (Castelo et al., 2015; Bhargava & Manoli, 2015; Hallsworth, List, Metcalfe, & Vlaev, 2015; John & Blume, 2017; Faulkner et al., 2019). For example, Bhargava and Manoli (2015) reports on a field experiment conducted with the IRS in California, finding that reducing the complexity of letters and making salient the benefits of the Earned Income Tax Credit (EITC) encouraged eligible citizens to claim their EITC benefits at a higher rate. Similarly, Castelo et al. (2015) find that letters to citizens that increase the salience of the benefits of online license plate renewals and reduce the complexity of the online renewal process lead to greater participation in online services.

Evidence suggests that framing behavior change appeals around the benefits to the collective can also be efficacious (John & Blume, 2017; Bernedo, Ferraro, & Price, 2014). For example, John and Blume (2017) report on an experiment that tested the effect of different letters on renewal of disability parking placards, which found that letters that emphasized the collective benefits of renewal were effective in increasing online renewals. In the context of city government, it seems plausible that such appeals would be more effective among individuals who feel a sense of connection with the city, perhaps because such appeals trigger a mindset of collectivism or "co-production" in the citizen (Bovaird, Van Ryzin, Loeffler, & Parrado, 2015; Omoto & Snyder, 2009). As it pertains to the present work, this supports the hypothesis that license holders residing in Philadelphia will be more compelled by messaging that highlights what the city gains from citizen behavior change (the City Benefits treatment) than will license holders residing outside the city.

Experiment Details

Implementing Partners

I worked with several institutional partners to plan, design, and implement the field experiment presented here. Specifically, the intervention was developed directly with the Department of Licenses and Inspections (L&I) in Philadelphia, which also served as the implementing partner. I also received institutional support from the Philadelphia Mayor's Office, through GovPHL and the Philadelphia Behavioral Science Initiative, a broader effort to integrate behavioral science into public policy through collaborations between academic researchers and city policymakers.

Context, Subjects, and Design

Moving citizen services online has been a priority for L&I largely because the online system is considered both more convenient for license holders – many of whom do not reside in the city – and cheaper for the city than either in-person or by-mail renewal. Note, however, that online renewal does not incur any fees or discounts relative to other methods of renewal. Furthermore, in the years since this study was run, the city phased out the by-mail option due in part to inefficiencies in that renewal system.

The sample for the study comprised 11,579 individuals holding housing rental licenses from the City of Philadelphia (a housing rental license is required for a property owner to legally rent their housing units or properties to tenants and must be renewed annually). These individuals were chosen as subjects for the study because they met three criteria: 1) having at least one license in need of renewal in 2017; 2) having previously only renewed rental licenses by mail or in-person; and 3) having not registered for an online user account (a prerequisite for renewing licenses online).

The process for a citizen to set up online renewal of rental licenses in Philadelphia involves two steps. First, citizens wishing to renew online have to register for an online account via a city website for this purpose, either during or in advance of the actual license renewal period. Second, when the license renewal period begins, citizens with online accounts must log in and complete the online renewal procedure for any and all licenses

they wish to renew online. I explore both outcomes, online registration and actual online renewal, in this paper, though the latter is the actual aim of the intervention I describe. Note that outcome data was collected in October 2017, after the license renewal deadline.

I randomly assigned license holders to one of four treatment groups: a control group receiving no letter and three treatment groups receiving a different type of letter encouraging online registration and renewal. The letters were sent in February 2017, prior to the renewal period opening up (though subjects were able to register online for an account upon letter receipt). The treatment letters varied in the framing used to encourage online registration in the body of the letter. The differences between the four letter conditions are visible in Figure 1.[5] Full-page visuals of all treatment letters are also provided in the Online Appendix. Table 1 also provides some basic summary statistics by condition.

Figure 1
Letter Templates by Treatment Condition

Standard Letter:

It is nearly time for your Housing Rental license renewal. To expedite the renewal process, register your account at https://eclipse.phila.gov and renew online. Even though the renewal period starts January 16th, 2017, you may register online now.

Please note, the department will begin phasing out the option to mail-in renewals. Therefore we encourage you to use the online platform this year.

Private Benefits Letter:

DO YOURSELF A FAVOR AND REGISTER TODAY!

It is nearly time for your Housing Rental license renewal. To expedite the renewal process, register your account at https://eclipse.phila.gov and renew online. Even though the renewal period starts January 16th, 2017, you may register online now.

Please note, the department will begin phasing out the option to mail-in renewals. Therefore we encourage you to use the online platform this year.

HOW DOES REGISTERING ONLINE NOW HELP YOU?

-**YOU avoid wasted time and stress:** if you register now, we have staff available to assist you should you experience any issues. Don't wait until peak renewal season.
-**YOU get it out of the way:** Things get busy in the winter, and it's better to take care of this NOW to save yourself the hassle LATER! It will make renewing online later a breeze!

City Benefits Letter:

DO THE CITY A FAVOR AND REGISTER TODAY!

It is nearly time for your Housing Rental license renewal. To expedite the renewal process, register your account at https://eclipse.phila.gov and renew online. Even though the renewal period starts January 16th, 2017, you may register online now.

Pleas note, the department will begin phasing out the option to mail-in renewals. Therefore we encourage you to use the online platform this year.

HOW DOES REGISTERING ONLINE NOW HELP THE CITY?

-**WE need your help:** Every year, an overwhelming number of license holders try to register at the last minute. We don't have the staff to meet the rush of people and this means longer wait times for everyone. By registering online early, you can do us a huge favor in reducing the burden, and help us improve services for all.
-**WE can together build an efficient Philadelphia!:** By registering online TODAY you help modernize our system and streamline our processes. Together we can build Philadelphia into a modern, efficient city we can be proud of!

Table 1
Experimental Conditions

	(1) Control	(2) Standard	(3) Personal Benefits	(4) City Benefits
% residing in Philadelphia	61.0%	61.2%	61.0%	61.4%
Mean licenses held	1.86	1.85	1.84	1.87
Sample size (n)	2,895	2,904	2,893	2,887

Randomization and Logistics

In coordination with L&I, I completed a stratified randomization at the individual license holder level using Stata. Stratification was based on the geographic location of the individual using their mailing address, with individuals stratified into three categories: Philadelphia ZIP codes, non-Philadelphia ZIP codes in Pennsylvania, and non-Pennsylvania ZIP codes.

All data used in this study were already regularly collected by L&I and were provided at the individual license level. The variables included in the data were an anonymized ID number, treatment assignment, behavioral data on online registration and renewal, the ZIP code of the recipient, and a few other variables of limited importance to the present work.

Hypotheses

The experiment was designed to test three ex-ante hypotheses. First, based on the significant evidence on the efficacy of letter interventions on behavior change (see DellaVigna & Linos (2020) and Behavioural Insights Team (2010) for examples), I hypothesized that license holders who received one of the three treatment letters would be more likely to renew their licenses online than people in the control group, who did not receive a letter. Second, I hypothesized that the Personal Benefits and City Benefits treatment letters would have a larger effect on online renewal than the Standard letters. These hypotheses were motivated by prior work in the literature suggesting that making benefits of an action salient can drive behavior change, whether those benefits are personal (Castelo et al., 2015; Bhargava & Manoli, 2015) or collective (John & Blume, 2017; Bernedo et al., 2014). Third, I hypothesized that the City Benefits letter would work especially well for license holders with a Philadelphia ZIP code. This was motivated by the idea that Philadelphia residents might feel a greater connection with the city and might therefore be more swayed by prosocial appeals invoking the impact on city government efficiency (Omoto & Snyder, 2009).

In addition, I explore one ex-post hypothesis in this paper, namely that the treatment letters might differ in their efficacy by income level of the recipient. The challenge in exploring this is that I do not have a measure of individual-level income in the data. Therefore, I rely on two proxy measures for income instead: 1) the number of licenses held by a given individual (one vs multiple)[6]; and 2) the median income (based on 2017 U.S. Census Bureau data) in the ZIP code where the individual resides.

Empirical Approach

In this paper, I report on the average treatment effects of the letters on both online registration (the most immediately actionable response a subject could have to the letter) and eventual online renewal (which was the ultimate goal). While online registration is a binary variable at the individual level, online renewal is a bit more complicated as it can vary across licenses for a given subject. That is, a subject could have several licenses up for renewal and only renew a subset of them online (renewing the rest by mail or in-person). Therefore, I report on two individual-level binary variables related to online renewal: 1) completing at least one license renewal

online; and 2) completing all possible license renewals online (i.e., completing one online renewal when you only have one to renew, completing two online when you have two to renew, etc.).

The regression specification used in this analysis is a simple regression of the binary outcome variables on the treatment conditions. The basic specification is as follows:

$$Y_i = \beta_0 + \beta_1(\text{Standard}_i) + \beta_2(\text{Personal}_i) + \beta_3(\text{City}_i) + z_i$$

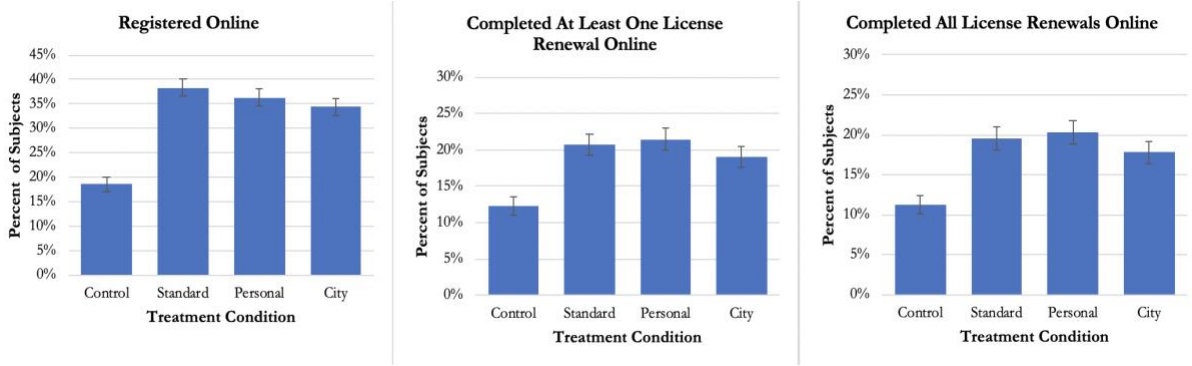
Here, Y_i is the binary outcome variable at the individual level (online registration, renewing at least one license online, or renewing all licenses online), the three treatment variables (Standard, Personal, and City) are binary variables associated with each of the three possible treatments (with the Control group omitted), and z_i represents a vector of appropriate individual-level controls for a given specification. Note that I use a linear probability model here, meaning that the betas on the three treatment variables in the results represent percentage point treatment effects. In addition, for the exploratory analyses on the differential effects of the treatments by geographical location and income, I use both the above specification restricted to demographic subgroups (i.e., running the regression only for license holders in Philadelphia) and regressions using interaction effects between the treatment groups and the demographic variables.[7]

Results

Average Treatment Effects

Figure 2 shows the means for the three outcome variables of interest, comparing the control group to each of the three treatment groups. The error bars mark 95% confidence intervals around the binary proportion displayed. The displayed means suggest an obvious effect of letter receipt on behavior, with the treatments associated with a roughly 15-20 percentage point increase in registration and a roughly 6-10 percentage point increase in the two measures for online renewal. I confirm these findings using the pre-specified regression models; the output from these regressions is shown in Table 2.

Figure 2
Outcome Means by Condition



Notes: The figure above depicts the percentage of subjects who registered online, completed at least one license renewal online, and completed all license renewals online, by treatment group. The error bars depict the 95% confidence interval.

The results in Figure 2 and Table 2 also suggest that the City Benefits letter was the poorest performer on aggregate, with the Private Benefits letter performing best. However, F-tests for the equality of coefficients in Table 2 reveal that the differences across treatments are not all statistically significant, with only the differences between the Personal Benefits and City Benefits coefficients for the renewal outcome variables (in columns 2 and 3) significant at the 95% level (with p=0.0254 and p=0.0174, respectively). Together, these analyses paint

a clear picture: letters are efficacious relative to no letter, and there are small differences in treatment effects by letter content, though these differences by treatment condition are much smaller than the treatment effects relative to the control.

Table 2
Average Treatment Effects

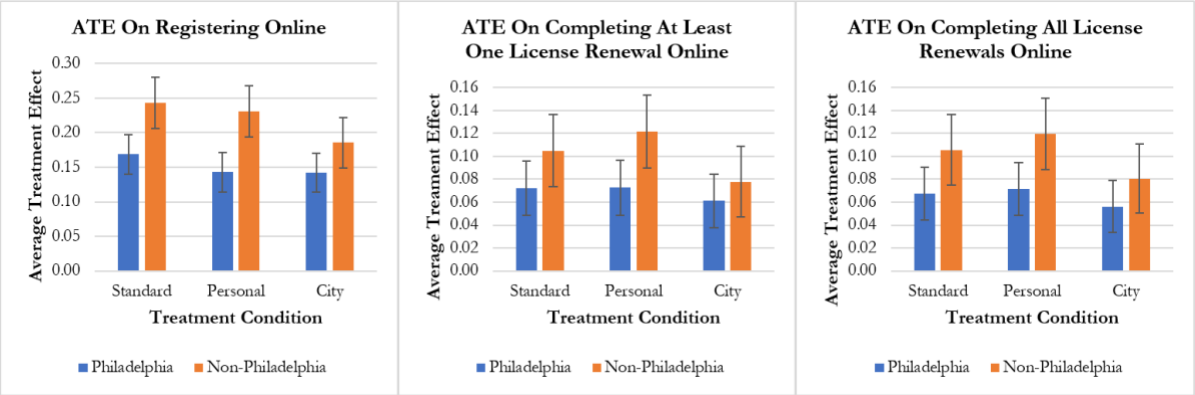
	(1) Registered	(2) Renewed at least one license online	(3) Renewed all licenses online
Standard	0.199***	0.0856***	0.0827***
	(0.0115)	(0.00966)	(0.00940)
Personal	0.177***	0.0914***	0.0902***
	(0.0114)	(0.00974)	(0.00950)
City	0.159***	0.0679***	0.0657***
	(0.0114)	(0.00947)	(0.00922)
Multiple Licenses	0.0687***	0.0674***	0.0297***
	(0.00938)	(0.00810)	(0.00772)
Philadelphia ZIP code	-0.0619***	-0.331***	-0.0355***
	(0.00882)	(0.00746)	(0.00729)
Constant	0.201***	0.122***	0.125***
	(0.00944)	(0.00799)	(0.00780)
R^2	0.0374	0.0173	0.0124
Observations	11,579	11,579	11,579

Notes: This table shows the experiment's main results, in the form of average treatment effects using linear probability models. The three columns show average treatment effects for each of the three main outcome variables. All three specifications include binary controls for holding multiple licenses and for having a Philadelphia ZIP code. Standard errors are shown in parentheses. *p<0.05, **p<0.01, ***p<0.001.

Disaggregated Treatment Effects I: Geographic Location

Next, I explore the possibility that the treatment letters might have differential treatment effects based on the residence of the recipient. The ex-ante hypothesis here was that the City Benefits letter might be especially impactful for Philadelphia residents, since they might feel a greater sense of connection with the messenger in this case (their local government). It is also useful to note one key finding in Table 2 here as well, namely that the coefficient on the binary control for a Philadelphia ZIP code in all regressions presented there is negative and significant. This means that, on average, residents of Philadelphia were less likely to register and renew online in general. This seems logical, since the compliance costs associated with in-person renewal in particular are lower for city residents than for those living outside the city.

Figure 3
Disaggregated Average Treatment Effects (ATEs) by Geographic Location



Notes: The figure above depicts the average treatment effects on registering online, completing at least one license renewal online, and completing all license renewals online, by geographic location and treatment group. The regressions to match these figures are in Online Appendix Table A1. The error bars depict the 95% confidence intervals.

Figure 3 plots disaggregated average treatment effects by whether or not the recipient had a Philadelphia address, for each treatment condition (with 95% confidence intervals marked). These regressions include binary controls for whether or not the subject held multiple licenses (see Online Appendix Table A1 for the full regression output). Across the point estimates, the results show that the treatment letters were more effective for those residing outside Philadelphia than for Philadelphia residents (with treatment effects roughly 50% larger for those outside the city). These results are not entirely surprising. That is, mailer campaigns that advertise a "remote" option for renewing licenses are more likely to persuade people who face higher administrative burdens from renewing in person (namely those who live far from the city). Note also that the results do not support the hypothesis about the potential efficacy of the City Benefits letter for city residents, though the gap between the treatment effects (City Benefits versus the other treatments) is marginally smaller for people residing in the city than for those living elsewhere (which I will return to, below).

The results in Figure 3 are further supported by analyses in a regression framework with interaction effects, presented in Online Appendix Table A2. The use of interaction terms allows for a direct test of differential treatment effects by geographical location. These tables confirm that the treatments were statistically significantly less efficacious for individuals residing in Philadelphia than for those living outside of the city (see the consistently negative coefficients on the interaction terms in Online Appendix Table A2, again suggesting the treatment effects were around 50% larger for non-Philadelphia residents).

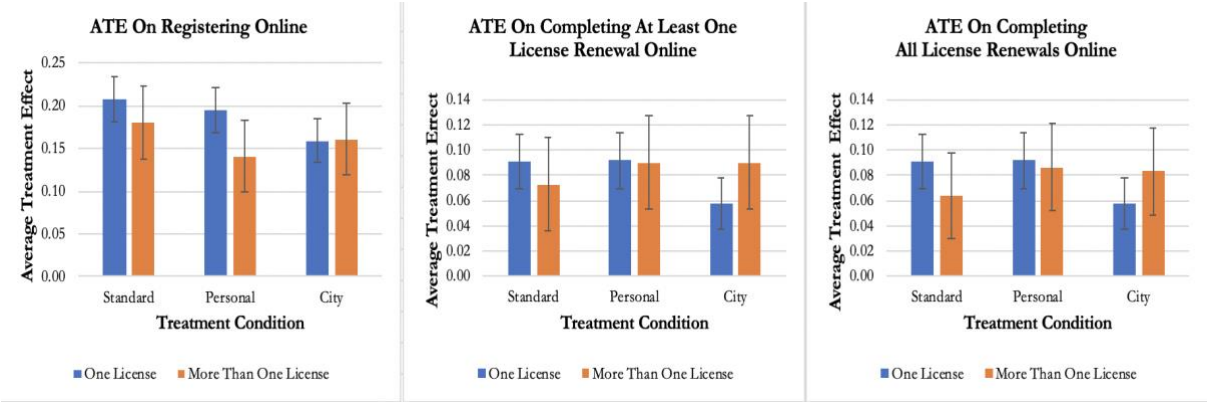
The interaction effect regression results show that while the City Benefits letter was less effective for subjects in Philadelphia than for subjects not in Philadelphia, the underperformance of the City Benefits treatment for Philadelphia residents was smaller than for the other treatment conditions. The key coefficients are in Online Appendix Table A2, where the interaction coefficients are smaller in magnitude for the City Benefits letter (minus 1-5 percentage points) than for the other treatments (minus 3-9 percentage points). Intuitively, this suggests that while all treatments were less effective with Philadelphia residents, the City Benefits letter suffered the smallest drop in efficacy. A set of F-tests on the relative differences in the interaction coefficients, however, shows that the differences between the City Benefits letter and the other two treatment letters fall shy of traditional statistical significance thresholds. For example, for column 1 (treatment effects on online registration), the p-value associated with the difference in the coefficients between the City Benefits/ZIP interaction and the Standard/ZIP interaction is 0.1877, and is p=0.0630 for the difference in the coefficients between the City Benefits/ZIP interaction and the Personal Benefits/ZIP interaction. The corresponding p-values from F-tests in columns 2 and 3 are even larger than the p-values from column 1. So, there is (at best)

weak evidence that the City Benefits letter had a differentially "less detrimental" impact on the outcome variables for subjects living in Philadelphia than those living outside the city.

Disaggregated Treatment Effects I: Income (via proxies)

Lastly, I investigated whether there were differences in online renewal and registration rates by income, using two proxies for income. The first proxy is whether or not an individual held more than one license (with holding more than one license implying higher income/wealth). The results of this analysis are summarized in Figure 4, which plots disaggregated average treatment effects by whether or not the recipient held multiple licenses, for each treatment condition (with 95% confidence intervals marked). Note that these regressions include binary controls for whether or not the subject had a Philadelphia ZIP code (see Online Appendix Table A3 for the full regression output). The figure shows that the treatments were, in general, similarly effective for people who held one versus more than one license. Online Appendix Table A4 supports this conclusion using interaction effect analysis similar to Online Appendix Table A2, but for the income proxy variable. This table (and particularly the non-significance across the interaction terms) provide minimal evidence of differential treatment effects by this proxy for income.

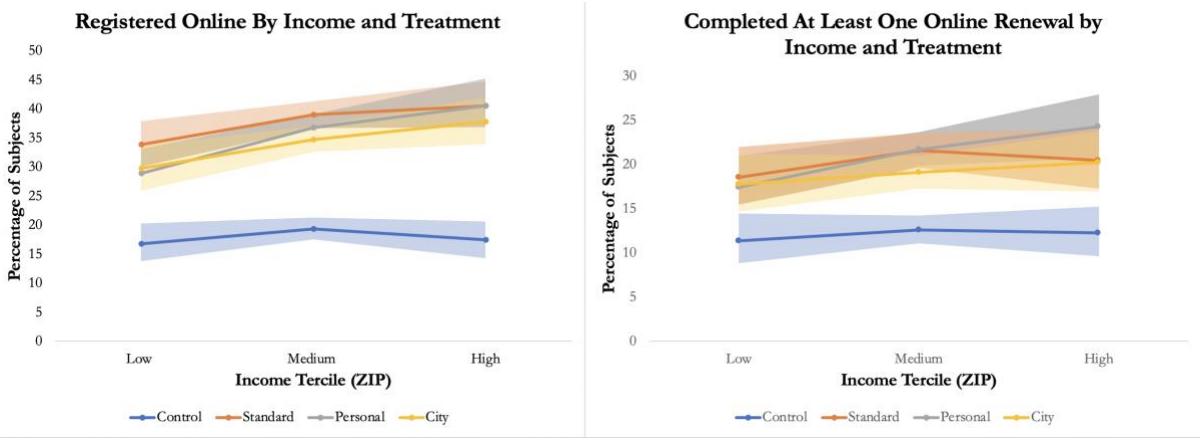
Figure 4
Disaggregated Average Treatment Effects (ATEs) by Licenses Held



Notes: The figure above depicts the Average Treatment Effects of subjects on registering online, completing at least one license renewal online, and completing all license renewals online, by licenses held and treatment group. The regressions to match these figures are in Online Appendix Table A3. The error bars depict 95% confidence intervals.

Admittedly, the number of licenses held is a rough proxy for income; I therefore use a second proxy for income to test the robustness of the results. Specifically, I use 2017 data from the U.S. Census Bureau to determine the median income in each subject's ZIP code (U.S. Census Bureau, 2017). I then categorize subjects into "Low," "Medium," or "High" income ZIP codes, using terciles created based on the 2017 Annual Social and Economic Supplement (ASEC) of the Current Population Survey (CPS) (U.S. Census Bureau, 2017). To visualize these results, in Figure 5, I plot the mean values for the outcome variables of interest, by treatment condition, for each of three household income terciles, with shading to denote 95% confidence intervals around the plotted means. Intuitively, this provides a visual test of the possibility that the letters might have worked differentially well for individuals living in low, medium, or high income areas. Admittedly, this analysis is exploratory, as median income in a given individual's ZIP code is another rough proxy for the income of that individual. The results here hint at larger treatment effects at higher incomes (intuitively captured by the upward slopes in the treatment lines across panels in Figure 5, relative to the control lines), but are not definitive.

Figure 5
Outcome Means by Income Tercile (Using Subjects' ZIP Codes)



Notes: The figure above depicts two outcomes (registering online and completing at least one renewal online) by income tercile and treatment group. The relevant sample sizes are: Low (n=2,194), Medium (n=7,108), and High (n=2,277). The income terciles are based on ZIP code level data and are as follows: Low (≤$37,499), Medium (between $37,500 and $87,499), and High (≥87,500). The shaded regions depict 95% confidence intervals.

While it would be inappropriate to view this analysis as definitive given its reliance on proxies for income, the evidence here does little to suggest that moving citizens online can help alleviate inequities in public service provision. That is, if letter campaigns like this are (if anything) more effective at alleviating compliance costs for those with higher incomes, they do not shrink inequities in administrative burdens, but instead help the wealthy reduce their burdens at a relatively higher rate than those with lower incomes. However, this topic requires further study, to be sure; the results here are mixed and rely on income proxies with their own complications, making it difficult to say anything definitive based on this paper's findings.

Discussion and Conclusion

To summarize, the experiment presented here generated several empirical findings. First, license holders who received one of the treatment letters were roughly twice as likely to register and around 60% more likely to renew their licenses online than those in the control group. Second, the City Benefits treatment letter was, marginally, less effective than the other two treatment letters (and the Personal Benefits letter performed best), though these differences were small and often not statistically significant. Third, I find no evidence to suggest that license holders with Philadelphia ZIP codes were more positively impacted by the City Benefits treatment than those residing outside of the city. In fact, treatment effects for all conditions were consistently larger for subjects living outside of the city, an indication that the letters are most effective for those with the largest compliance costs for in-person renewal in particular. Finally, there is (at best) limited evidence of differential treatment effects by income, though an analysis using median income in a given subject's ZIP code does hint at the possibility of larger treatment effects in higher income areas.

A big picture takeaway from this work is that sending letters to citizens to help them avoid and overcome administrative burden is a valuable exercise, but the actual content of the letter is relatively less important than sending a letter at all. Indeed, the Personal Benefits and City Benefits treatment letters were used in the hopes that their additional content would be behaviorally motivating. In truth, the added benefit from the Personal Benefit letter was small, and the City Benefits letter performed worse than the Standard letter, an effect driven largely by its relatively poor performance with those living outside the city (for whom helping the city was

clearly not a big motivator). Furthermore, it is worth noting that these letter campaigns did not encourage everyone to move online, with 60-70% of letter recipients still sticking with in-person or by-mail renewal. Thus, a practical takeaway is that increasing the salience of online services using letter campaigns is an important, if limited, tool in changing citizen behaviors and reducing administrative burden (and cost-effectiveness needs to be considered).

This work also raises some important questions for follow-up research. First, there is little evidence here to suggest that letter campaigns can help alleviate gaps in access to e-Government services caused by technological inequities. In an age of growing income inequality in many countries, it is critical that governments ensure that improvements in public service delivery do not disproportionately benefit the relatively wealthy. This has long been a critique of e-Government, and the findings in this paper offer little evidence to suggest that nudge campaigns to promote online service delivery help bridge the gaps in public service access. Admittedly, the population in this study (those renting out their property) likely does not include many who are living in poverty. Thus, more work is needed to find ways to engage the least well-off in society and make sure they are not left behind by the digitization of government services.

Second, the fact that the treatments outlined here had only modest effects on online renewal makes clear the need for stronger efforts to reduce administrative burden. It is not enough to have systems in place for online services; the "last mile" problem (Soman, 2015) is critical. The present work suggests that behavioral science and the experimental method have a key role to play, by helping governments design and test strategies that can alleviate administrative burden for citizens and help governments operate efficiently and effectively.

Notes

1. I use the term "citizen" in this paper out of convenience, to refer to those subjects to the city's regulations, and not to distinguish between those with or without national citizenship.
2. For more information on global trends in e-Government, please see the United Nations' biennial e-Government Survey, which reports on the extent to which nations have been shifting towards e-Government.
3. An important caveat here is the issue of technological inequity; in many contexts, lower-income citizens in particular lack reliable internet access (Ryan, 2018; Rideout & Katz, 2016). I return to this topic later in the paper.
4. Note that 31.5% of rental license holders in the sample (3,643 of 11,579) held multiple rental licenses, which explains the discrepancy between the number of subjects (11,579) and the number of licenses up for renewal for subjects in the study (21,460).
5. Note that, as with any experiment, the distinctions between the treatments are not always completely precise. For example, one could argue that the reduction of in-person wait times, highlighted in the City Benefits letter, could also be seen as a personal benefit of sorts (though one that would accrue to those renewing in-person).
6. Note that only property owners are eligible for housing rental licenses and licenses are issued per-unit, which is why I argue it is reasonable to assume that holding multiple licenses reflects a higher level of wealth.
7. The interaction effect specification is as follows (shown here for the binary Philadelphia Zip Code, or "PhillyZip," variable):
   $Y_i = \beta_0 + \beta_1(\text{Standard}_i) + \beta_2(\text{Personal}_i) + \beta_3(\text{City}_i) + \beta_4(\text{PhillyZip}_i) + \beta_5(\text{Standard}_i * \text{PhillyZip}_i) + \beta_6(\text{Personal}_i * \text{PhillyZip}_i) + \beta_7(\text{City}_i * \text{PhillyZip}_i) + z_i$

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