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Social norms or enforcement? A natural field experiment to improve traffic and parking fine compliance

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Social Norms or Enforcement? A Natural Field Experiment to Improve Traffic and Parking Fine Compliance

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Mathias Sinning and Yinjunjie Zhang¹

Social Norms or Enforcement? A Natural Field Experiment to Improve Traffic and Parking Fine Compliance

Abstract

Very little is known about the efficient collection of fines despite their indispensable contribution to local government budgets. This paper fills an important gap in the literature by studying the effectiveness of deterrence (enforcement) and non-deterrence (social norms) letters that aim to improve the collection of traffic and parking fines. We discuss potential mechanisms through which these letters may affect fine compliance and present results from a natural field experiment that was implemented in collaboration with the government of the Australian Capital Territory (ACT). We find that both letters increase fine payments significantly relative to a control group that did not receive a letter. The effect of the enforcement letter is stronger than that of the social norms letter. Our analysis of heterogeneous treatment effects indicates that addressing social norms does not change the behavior of young offenders, those who committed a speeding offence, those with a long outstanding debt and those with a debt above the median. In contrast, the enforcement letter is generally effective across subgroups.

JEL-Code: H26, K42, C93

Keywords: Fine compliance; natural field experiment; nudges; enforcement; social norms

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1 Introduction

Fines play a substantial role in funding municipal services (Pagano and Hoene, 2018). In 2018, fines and forfeits collected by state and local governments in the United States amounted to US\$14.8 billion.¹ The majority of fine revenue typically relates to traffic and parking violations. For example, the New York City Department of Finance processed about 20 million parking tickets with a total value of US\$994 million in 2018 (DiNapoli, 2018). Parking fines accounted for more than half of the city’s fine revenue, even though about 30 percent remained uncollected (Stringer, 2018). Despite the relevance of fines for local government budgets and a strong link between the effective enforcement of traffic laws and improved road safety outcomes (Wali et al., 2017), we still know relatively little about the efficient collection of outstanding traffic and parking fines.

This paper presents the results of a natural field experiment, implemented in collaboration with the Government of the Australian Capital Territory (ACT) to determine the effects of deterrence and non-deterrence messages on the collection of traffic and parking fines. The research contributes to a recent strand of the behavioral economics literature that focuses on the design of cost-effective interventions that “nudge” people to make better decisions without limiting their choices to improve health, wealth and happiness (Thaler and Sunstein, 2008). Nudging aims to address cognitive biases by targeting the psychological roots of human behavior.² We are particularly interested in the effectiveness of enforcement and social norms letters, which have been studied extensively in the tax compliance literature.

Traditionally, the economic literature has modelled individual decisions about tax evasion by comparing costs (which depend on the probability of being detected and the legal punishment) and benefits (Allingham and Sandmo, 1972; Yitzhaki, 1974). Inspired by this economic framework, a major strand of the experimental tax compliance literature has studied the effectiveness of deterrence interventions that aim to make the

¹Based on numbers reported in the US Census of Governments.

²Examples include present bias (O’Donoghue and Rabin, 1999), loss aversion (Gächter et al., 2009), framing (Levin et al., 1998), anchoring (Wansink et al., 1998; Scott and Lizieri, 2012) and social norms (Ariely, 2008; Cialdini, 2008; Allcott, 2011).

costs more salient. More recently, researchers have focused on analyzing moral costs of non-compliance associated with deviating from a moral standard or from the behavior of others.³ Related work predicts that taxpayers may derive utility from the provision of public goods (Cowell and Gordon, 1988), suggesting that reciprocity (Bazart and Bonein, 2014) and altruism (Andreoni, 1990; Feld and Frey, 2010) are potential mechanisms through which the provision of public goods may affect tax compliance.

Despite considerable research on tax compliance, experimental evidence on fine compliance is rather scarce.⁴ This is unfortunate because we cannot simply assume that nudges have the same effects on both tax and fine compliance. While taxpayers are aware of the relation between taxation and the provision of public goods (Rahayu et al., 2017), it may be less obvious to them how their fines will be used. Moreover, due to fine collection at a local level, there is no guarantee that individuals will pay fines in their location of residence, and therefore they may not benefit from paying fines. The individual motivation to comply may also depend on the perception of fairness (Tyler, 2006; Saunders et al., 2013). Individuals may feel they are being treated unfairly if the fine system is regressive, therefore fine non-compliance may generate lower moral costs than tax non-compliance.⁵

This paper contributes to the literature in several ways. Firstly, our field experiment is novel because it studies the effects of enforcement and social norms messages on traffic and parking fine compliance in a large-scale real-world setting. A better understanding of how different types of nudges impact fine compliance has relevance for local and state governments around the world. Secondly, we estimate heterogeneous treatment effects for subgroups that share the same observed characteristics. Heterogeneous treatment effects may inform policymakers about the need to design tailor-made nudges for certain

³See Andreoni et al. (1998) and Slemrod (2019) for general reviews on tax compliance, Luttmer and Singhal (2014) for a review on tax morale, and Mascagni (2018) and Hallsworth (2014) for reviews on tax experiments.

⁴See Section 2.2 for details.

⁵It has been argued that fines should impact offenders equally, which is not the case in a fixed-rate fine system that affects low-income offenders disproportionately (Chapman et al., 2004). Income contingent speeding fines have been used in Finland, Switzerland and the UK (<https://www.weforum.org/agenda/2018/06/in-finland-speeding-tickets-are-linked-to-your-income/>, accessed 10 January 2022).

target groups. Thirdly, it appears plausible that our findings on the effectiveness of deterrence and non-deterrence nudges exhibit a high degree of both internal and external validity. Our analysis sample consists of traffic and parking offenders in the ACT who have been non-compliant for at least six months. Therefore, our findings are particularly relevant for fine collectors who aim to collect traffic and parking fines that have been outstanding for a prolonged period.

Our findings indicate that both enforcement and social norms letters increase fine payments significantly relative to a control group that did not receive any further communication after failing to respond to an initial neutral reminder letter. The effect of the enforcement message is stronger than that of the social norms message, suggesting that social norms are somewhat less successful in promoting fine compliance. Our analysis of heterogeneous treatment effects indicates that addressing social norms does not change the behavior of young offenders and of those who committed a speeding offence.⁶ We also find that addressing social norms has no effect on individuals with a long outstanding debt (more than three years), indicating that the psychological costs of fine non-compliance are low among offenders who are non-compliant for a long time. Moreover, offenders with an outstanding debt above the median do not respond to the social norms message. It appears unlikely that income constraints are the main reason for this result because fines in our sample are relatively low (ranging from \$60 to about \$1,800 with most fines being below \$250), and because the ACT Government gives offenders the option to enter a payment plan to pay off their debt gradually.^{7,8} An alternative explanation for this result is that offenders who received a relatively high fine are more likely to perceive the regressive fine system as unfair.

The enforcement letter is effective for all major subgroups with exception of offenders who live in the ACT. The vast majority of non-compliers observed in our sample does not live in the ACT (a small jurisdiction with many commuters and interstate visitors), because offenders who do not pay their fines may lose their right to drive in the ACT.

⁶Non-compliant behavior among young individuals has been documented in the tax compliance literature (Braithwaite et al., 2019) and is broadly consistent with the well-established crime-age profile (see, e.g., Hansen, 2003; Siennick and Osgood, 2008; Sullivan, 2012; Bell et al., 2018).

⁷\$ = Australian dollar. One Australian dollar is equal to 0.72 US dollars (10 January 2022).

⁸A small number of individuals who entered a payment plan were excluded from our analysis sample.

The relatively few remaining non-compliant ACT residents in our sample appear to be a highly selected group of ‘recalcitrant’ cases (including an unknown number of foreign diplomats with immunity status) who are unwilling to comply in general. Neither the enforcement letter nor the social norms letter changes the behavior of this group of offenders. Overall, our findings highlight that enforcement messages are important for the efficient collection of fine revenue.

The remainder of this paper is structured as follows. Section 2 provides an overview of the related literature. Section 3 presents the experimental design, provides a description of the administrative records that were used in our analysis and outlines our empirical strategy. The results are presented in Section 4. Section 5 concludes.

2 Related literature

2.1 Tax compliance

The tax compliance literature has grown rapidly in recent years due to the wider availability of administrative tax records and greater interest of policymakers and academics in testing cost-effective interventions that aim to nudge individuals to pay taxes (Hallsworth, 2014). Individual decisions about tax compliance have been linked to various economic and non-economic reasons. The standard economic framework models individual decisions about tax evasion by comparing costs and benefits (Allingham and Sandmo, 1972; Yitzhaki, 1974). Because the costs of tax evasion depend on the probability of being detected and the legal punishment, a major strand of the experimental tax compliance literature focuses on testing deterrence interventions aimed at making the probability of being detected and the severity of punishment more salient. Studies that have examined the effects of deterrence interventions have typically concluded that these interventions are effective in improving tax compliance.⁹

⁹Examples include Coleman (1997), Slemrod et al. (2001), Wenzel and Taylor (2004), Wenzel (2006), Hasseldine et al. (2007), Iyer et al. (2010), Kleven et al. (2011), Fellner et al. (2013), Gangl et al. (2014), Dwenger et al. (2016), Dyreng et al. (2016), Mendoza et al. (2017) and Cranor et al. (2020). Slemrod et al. (2001) find that informing low- and middle-income earners about their selection for an audit increases their reported income, while the reported income of high-income earners with many tax evasion options declines. Mendoza et al. (2017) find that tax compliance only increases up to a certain

A second major strand of the tax compliance literature examines the moral costs of non-compliance associated with deviating from a moral standard (Erard and Feinstein, 1994; Reckers et al., 1994; Bobek and Hatfield, 2003; Torgler, 2007; Alm and Torgler, 2011) or from social norms (Elster, 1989; Myles and Naylor, 1996; Wenzel, 2004; Frey and Torgler, 2007; Traxler, 2010; Bobek et al., 2013). Experimental studies in this literature examine the effect of non-deterrence interventions on tax compliance. Many of these studies find that addressing social norms has no effect on tax compliance (Blumenthal et al., 2001; Torgler, 2004; Wenzel, 2005; Fellner et al., 2013). A meta-analysis by Antinyan and Asatryan (2020) concludes that tax morale messages are on average ineffective when compared to neutral messages. Dwenger et al. (2016) study church taxes in Germany and find that the provision of social and monetary rewards may even reduce tax compliance. In contrast, a few recent large-scale field experiments report a positive effect of social norms messages on tax revenue. Hallsworth et al. (2017), for example, find that the use of social norms letters in the UK led to an increase in payment rates. Bott et al. (2020) report that moral suasion messages increase the amount of self-reported foreign income in Norway.

The costs and benefits associated with tax compliance may be affected by other factors. From an economic perspective, taxpayers derive utility from the provision of public goods (Cowell and Gordon, 1988), suggesting that the provision of public goods may affect tax compliance through reciprocity (Bazart and Bonein, 2014) and altruism (Andreoni, 1990; Feld and Frey, 2010). The individual motivation to comply may also depend on the perception of fairness (Tyler, 2006; Saunders et al., 2013). Besley et al. (2019) find that a shift to less equalising tax measures led to a persistent decline in tax morale in the UK. Bazart and Bonein (2014) provide experimental evidence on the importance of both equity and reciprocity in tax compliance. Additional determinants of tax compliance include trust and power (Kirchler et al., 2008; Alm et al., 2012), tax regulations and interactions between taxpayers and tax authorities (Braithwaite, 2009), and various cognitive limitations such as anchoring (Maciejovsky et al., 2007), framing (Ashby and Webley, 2008), inertia (Kerr, 2012; Jones, 2012) and imperfect memory auditing level, but decreases beyond that level.

(Ericson, 2017; Gillitzer and Sinning, 2020).¹⁰

2.2 Fine compliance

Only a few studies provide experimental evidence on the effectiveness of behavioral interventions on fine compliance. Haynes et al. (2013) estimate the effects of text messages on the payment of court-ordered fines. They find that text messages are particularly effective when they address the recipient by name. Du Plessis et al. (2020) present findings from a laboratory experiment, suggesting that the provision of financial incentives (discounts for immediate payments or surcharges for late payments) increases fine payments. Our study is most closely related to Dusek et al. (2020), who use data from a large-scale natural field experiment of speeders in Czech Republic to provide evidence on the effectiveness of letters that increase the salience of penalties for late payments. They conclude that these letters are even more effective when combined with the communication of a payment deadline.

There are three important differences between our work and Dusek et al. (2020). Firstly, while Dusek et al. (2020) use enforcement letters to improve the compliance behavior of recent offenders, our enforcement letter is designed to target offenders who have not paid their fines for more than six months. Understanding the effectiveness of enforcement messages that aim to improve the collection of long outstanding debts is important for local government budgets. Secondly, we study the effectiveness of both enforcement and social norms letters. The role of social norms has been studied extensively in the tax compliance literature. To the best of our knowledge, this is the first time that a natural field experiment is used to ascertain the effectiveness of addressing social norms in the context of fine compliance. Thirdly, while Dusek et al. (2020) focus on speeders, we examine the effectiveness of letters on both traffic and parking fines. Our findings indicate that the responses of speeders may be different from those of non-speeders.

¹⁰Biddle and Arcos-Holzinger (2016) provide a more detailed discussion of the determinants of tax compliance.

3 Trial design, empirical strategy and data

3.1 Trial design

Our trial studies the repayment of outstanding debts associated with traffic and parking infringements in the ACT.¹¹ The trial was designed and implemented in collaboration with the Chief Minister, Treasury and Economic Development Directorate of the ACT Government. After receiving an infringement notice from the ACT Government, offenders have 28 days to pay their fine or manage their infringement by requesting more time, providing more information, requesting a payment plan or financial hardship waiver, seeking a review, declaring a responsible person or disputing liability. Offenders receive a reminder notice with an additional fee if they do not take action within 28 days. Offenders who ignore the reminder notice do not receive any further communication from the ACT Government regarding their outstanding debt. Non-compliant offenders may lose their right to drive in the ACT.¹² The risk of losing the right to drive may provide a stronger incentive for offenders residing in the ACT to pay their fines than for those residing elsewhere. As a consequence, only about 17 percent of the offenders in our data have ACT driver licenses.

Our analysis uses administrative records from Access Canberra, the service provider of the ACT Government. The target population was defined as the full population of traffic and parking offenders in the ACT aged 18-65 years at the time of offence, with one outstanding infringement for more than six months and less than five years as of 5 November 2017, and who (based on their driver license) either resided in the ACT or in New South Wales (NSW), the surrounding state. To simplify the data structure and to facilitate trial design and implementation, the target population was restricted to offenders with one outstanding infringement. Consequently, our analysis sample consists of offenders who are unwilling to pay one outstanding fine. Our analysis sample does not

¹¹We use the terms ‘trial’ and ‘natural field experiment’ interchangeably throughout the paper. Natural field experiments are usually defined as randomized controlled trials (RCTs) in which subjects are not aware of their participation (Czibor et al., 2019).

¹²<https://www.accesscanberra.act.gov.au/s/article/traffic-and-parking-infringements-tab-overview>, accessed 10 January 2022.

contain offenders with multiple offences consistently unwilling to comply. Despite the exclusion of offenders with multiple infringements, it is possible some offences by ACT residents were committed by foreign diplomats who may be non-compliant because they are immune from prosecution.¹³ Unfortunately, we are unable to identify this group in our data.

Both treatment letters (shown in Appendix A) contain two distinct nudge messages. One message is the subject line, the other is placed in the top right corner of each letterhead. The subject line of the enforcement letter (Treatment 1) reads “Unpaid fines don’t go away unless you take action”, making the possibility of eventual punishment more salient. This element may be characterized as *unavoidability message*. The message in the top right corner of the letterhead reads “We noticed you still have an unpaid fine. Take action today.” This message may be described as *surveillance message*. Interventions that make surveillance more salient have been shown to reduce the cheating behavior of individuals (Jansen et al., 2018).

The subject line of the social norms letter (Treatment 2) reads “Most people with overdue fines have already paid.” We refer to this message as *descriptive norms message*. The message in the top right corner of the letterhead reads “You have an overdue fine. Please do the right thing and pay now.” We refer to this message as *injunctive norms message*. Descriptive and injunctive norms messages have both been tested in the tax compliance literature. Hallsworth et al. (2017) conclude that descriptive norms appear to be more effective than injunctive norms in the context of tax compliance.

Data provided by the ACT Government include a total of 10,702 outstanding infringements. The ACT Government agreed to send up to 1,000 letters to each treatment group. The remaining cases were assigned to the control group. We received access to baseline characteristics for stratified randomization and employed the user-written Stata command `randtreat` v1.4 to obtain the following random assignment: Treatment Group 1 (Enforcement): 972 cases, Treatment Group 2 (Social Norms): 986 cases, Control Group: 8,744 cases. The letters were sent out in November 2017 after

¹³<https://www.abc.net.au/news/2019-09-23/diplomatic-drivers-ignore-parking-laws/11537306>, accessed 10 January 2022.

clearance from the Human Research Ethics Committee of the Australian National University.¹⁴ Post-trial data were made available by the ACT Government after the trial was registered with the Social Science Registry of the American Economic Association on 9 January 2018.¹⁵ We impose several sample restrictions to obtain our final analysis sample consisting of 10,404 cases (Treatment Group 1: 875 cases, Treatment Group 2: 895 cases, Control Group: 8,634).¹⁶

3.2 Data

Table 1 reports the average penalty by infringement and offence type for each of the treatment groups and the control group. Infringement types categorize offences according to how they were recorded (e.g. on camera or by a parking officer). Offence types focus on the type of offence recorded (such as parking or speeding offences). Average penalties vary considerably across infringement types, ranging from around \$110 for parking infringements to more than \$300 for other infringements. Average penalties also vary across offence types, ranging from about \$95 for parking offences to more than \$300 for red light and other offences (including license and registration offences).¹⁷ Differences in penalties between treatment and control groups are not statistically significant, except for differences in penalties between Treatment Group 2 (“Social norms”) and the Control Group for infringements recorded by point-to-point cameras. To balance out group differences, we will control for both infringement and offence types in our regression analysis.

[Table 1 about here.]

¹⁴Protocol Number 2017/783, approval date: 5 October 2017.

¹⁵<https://www.socialscienceregistry.org/trials/2611>, accessed 10 January 2022.

¹⁶Specifically, we remove one case from our analysis because the administrative fee deviates from the standard fee. We further drop 29 cases in which information about postcodes is not consistent with the State/Territory of the driver license. We remove 35 cases in which payment occurred before the letter was sent, and five cases in which information about the letter send date was missing. We also exclude offenders for one of the following reasons: they entered a payment plan (59 cases), their infringement was withdrawn (18 cases), their letter was returned to the sender (147 cases) or information about the amount paid was missing (4 cases).

¹⁷We observe 149 license offences and 86 registration offences in our data. Due to the small number of cases, we combine these categories with other offences.

Table 2 presents summary statistics of baseline characteristics. We observe that most offenders in our sample were less than 35 years old when the offence took place. Less than 40 percent of offenders are women. Red light cameras recorded almost half of all offences, while parking officers recorded about 30 percent. The majority (about 57 percent) of offences are speeding offences. Although our target population is restricted to cases in which the fine is overdue for less than five years, offences may date back to an earlier point in time. The average duration since the offence took place is about 3.4 years. The average outstanding debt (penalty plus fee) is around \$235. Only about 17 percent of the offenders in our sample have an ACT license and vehicle registration. The remaining 83 percent either do not have an ACT license and/or their vehicle is not registered in the ACT.¹⁸

The p -values in Table 2 indicate that the baseline characteristics in our sample are balanced. Exceptions are differences in other infringements between Treatment Group 1 and the Control Group, and gender differences between Treatment Group 2 and the Control Group. In our analysis, we will use the variables presented in Table 2 as control variables to account for potential imbalances in baseline characteristics.

3.3 Empirical strategy

3.3.1 Survival analysis

We study treatment effects on fine payments within a survival analysis framework to understand the payment dynamics caused by the two letters. Specifically, we estimate separate Kaplan-Meier survivor functions of outstanding fine payments for treatment and control groups. The survivor function $S(t)$ specifies the fraction of fines that remains outstanding past time t . Considering the survival of outstanding fine payments is equivalent to interpreting the payment of a fine as “failure”. We consider a set of failure times, $\tau_1, \tau_2, \dots, \tau_J$, where J is the total number of distinct uncensored failure times

¹⁸According to the Road Transport (Driver Licensing) Act 1999, the driver license must be issued by the State or Territory in which a person resides. However, ACT driver licenses only expire every five years and drivers who move to other states do not necessarily update their driver license immediately. In our analysis, we consider the States/Territories of both driver licenses and vehicle registrations. We discuss heterogeneous treatment effects for the relevant subgroups in Section 4.4.

in our data. Following Kaplan and Meier (1958), the nonparametric estimate of the survivor function for a given set of failure times may be written as

$$\hat{S}(t) = \prod_{j|\tau_j \leq t} \left(\frac{n_j - d_j}{n_j} \right),$$

where n_j is the number of outstanding cases and d_j is the number of fine payments at time τ_j . Following Kalbfleisch and Prentice (2002), we calculate the asymptotic variance of $\ln(-\ln(\hat{S}(t)))$,

$$\sigma^2(t) = \frac{\sum_{j|\tau_j \leq t} \frac{d_j}{n_j(n_j - d_j)}}{\left(\sum_{j|\tau_j \leq t} \ln\left(\frac{n_j - d_j}{n_j}\right) \right)^2},$$

to obtain a confidence interval that is bounded between 0 and 1. The confidence interval is given by $[\hat{S}(t)^{\exp(z_{\alpha/2}\hat{\sigma}^2)}, \hat{S}(t)^{\exp(-z_{\alpha/2}\hat{\sigma}^2)}]$, where $z_{\alpha/2}$ is the $(1 - \alpha/2)$ th quantile of the standard normal distribution. In the following, we will apply this framework to examine differences in failure functions between treatment and control groups. The failure function is defined as $F(t) = 1 - S(t)$. Failure functions have an intuitive interpretation in the context of our analysis because they allow us to consider the probability of fine payments at a given point in time.

3.3.2 Treatment effects estimation

We use a linear regression model of the following form to estimate treatment effects on our outcome measures of interest:

$$Y_i = \beta_0 + \beta_1 T_i + X_i \beta_2 + \varepsilon_i,$$

where Y_i refers to one of the outcome measures of offender i , T_i is a treatment indicator for the comparison of one of the treatment groups to the control group, X_i includes a set of baseline characteristics that are used as control variables to balance out differences between treatment and control groups, and ε_i is the model error term. In addition to the variables presented in Table 2, our set of control variables includes postcode fixed

effects that absorb small-scale regional variation. A complete list of control variables is provided in Appendix B.

We consider three outcome measures in our analysis: the amount paid by the end of the trial (in \$), a binary variable indicating whether or not full payment occurred by the end of the trial and a binary variable indicating whether or not full or partial payment occurred by the end of the trial. We use separate regression models with and without control variables to estimate unconditional and conditional (on X_i) treatment effects, respectively. We also present estimates of heterogeneous treatment effects for subgroups that share the same characteristics.

4 Results

4.1 Payment rates

Figure 1 depicts the Kaplan-Meier failure functions of Treatment Group 1 (the dashed line) and the Control Group (the solid line). The payment rate is defined as the fraction of partial or full payments within each group. The shaded areas in Figure 1 are the 95 percent confidence intervals around the payment rates. The failure functions reveal that about one week after the letter send date the payment rates of Treatment Group 1 are significantly higher than those of the Control Group. This finding indicates that the enforcement letter caused a significant and persistent increase in payment rates between the letter send date and the end of the trial period (about six weeks later). While the payment rate of the Control Group over the trial period is below 1 percent, more than 3 percent of the fines of Treatment Group 1 were paid partially or in full within six weeks after the letter send date.

[Figure 1 about here.]

Figure 2 compares the payment rates of Treatment Group 2 (the dashed line) to the Control Group (the solid line). The payment rates of Treatment Group 2 are significantly higher than those of the Control Group about ten days after the letter

send date. Although the social norms letter causes a significant increase in payment rates relative to the Control Group, the effect is somewhat weaker than that of the enforcement letter.¹⁹ The differential in fine payments between Treatment Group 2 and the Control Group reaches about 2 percentage points within six weeks after the letter send date.

[Figure 2 about here.]

The profiles of the Kaplan-Meier failure functions of both treatment groups indicate that the strongest increase in payment rates took place during weeks 2-4 after the letter send date. The enforcement letter led to a particularly strong increase in payment rates during this period (see Figure 1). The corresponding increase in payment rates resulting from the social norms letter is weaker (see Figure 2). Both profiles are almost completely flat after about one month, indicating that most payments caused by the letters occurred within a relatively short time after the send date.

4.2 Treatment effects

The estimated treatment effects are presented in Table 3. We find that the enforcement letter increases average fine payments by almost \$5 by the end of the trial. The enforcement letter also increases the payment rate of full fine payments by more than 2 percentage points, and that of partial or full fine payments by more than 3 percentage points. Compared to the baseline average payment rate of about 0.4 percent for partial and full payments, the effects on payment rates are equivalent to a 6-8-fold increase.

The corresponding effects of the social norms letter are somewhat smaller. The social norms letter increases fine payments by about \$3.50 by the end of the trial. The effects of addressing social norms on full fine payments and on partial or full fine payments are just below 2 percentage points. These effects are equivalent to a 4.5-fold increase in the baseline average payment rate for partial and full payments. All coefficients are statistically significant at a 1 percent level.

¹⁹Due to the relatively small size of the two treatment group samples, our analysis focuses on the comparison of each of the two treatment groups to the Control Group.

[Table 3 about here.]

Including the baseline characteristics as covariates in our regression model does not qualitatively affect our results. After controlling for baseline characteristics, our regression results are almost unchanged, confirming that the random assignment of cases to treatment and control groups removed most imbalances in baseline characteristics.

We also compare the two treatment groups to each other. Due to the low statistical power associated with the direct comparison of treatment groups, we do not present these results in the paper. We find the effect of the enforcement letter on the likelihood of making partial or full payments is 1.2 percentage points larger in the model without covariates, and 1.8 percentage points larger in the model with covariates. These numbers imply that, compared to the 3.5 percentage point average payment rate of the enforcement letter, the social norms letter is 34-50 percent less effective than the enforcement letter. These estimates are statistically significant at a 15 and 10 percent level, respectively.

The corresponding results for the amount paid and the probability of full payment are not statistically significant. However, the signs of these estimates consistently point to the effectiveness of the enforcement letter relative to the social norms letter. Therefore, although the estimated parameters are imprecisely measured, they suggest the enforcement letter is more effective than the social norms letter.

4.3 Effects heterogeneity

We present the most interesting heterogeneous treatment effects in Figures 3 and 4.²⁰ Specifically, we estimate heterogeneous treatment effects by age (18-35 years vs. 36-65 years), offence type (speeding vs. non-speeding), duration since the offence took place (1-3 years vs. 4+ years), outstanding debt at the beginning of the trial (debt below vs. above the median) and state of residence (based on driver license and vehicle registration). Each bar in Figures 3 and 4 reports a subgroup-specific treatment effect on one of the outcome measures. The 95 percent confidence intervals are depicted as

²⁰We summarize the results of our complete analysis of heterogeneous treatment effects in Section 4.4.

lines around the point estimates. The p -values associated with the point estimates are presented next to each bar. Both figures report heterogeneous treatment effects on the amount paid (Column (1)), on full payment (Column (2)) and on partial and full payment (Column (3)).

Figure 3 reveals that the enforcement letter is generally effective for all subgroups in our sample, except for offenders who live in the ACT (based on both driver license and vehicle registration). Because non-compliant offenders may lose their right to drive in the ACT, the fraction of offenders with an ACT driver license and vehicle registration in our sample is only around 17 percent (see Table 2). It is possible these offenders constitute a highly selected group unwilling to comply in general.

[Figure 3 about here.]

Figure 4 presents the corresponding effects of the social norms letter on fine compliance. We find that addressing social norms has no significant effect on the behavior of young offenders (18-35 years). Non-compliant behavior among young individuals has been documented in the context of tax compliance. Braithwaite et al. (2019) argue that non-compliance among young Australian taxpayers is a consequence of the weakening tax-paying culture across generations. Fine non-compliance among young offenders is also consistent with the well-established crime-age profile. Several studies provide evidence of a strong crime-age pattern in various settings, with crime peaking in the late teens and declining afterwards (see, e.g., Hansen, 2003; Siennick and Osgood, 2008; Sullivan, 2012; Bell et al., 2018).

We also find no effect of social norms on fine compliance behavior of speeders. About three quarters of cases grouped in the speeding category are recorded by red light cameras, indicating that many offenders speed at major intersections.²¹ Given the potential threat to the lives of others associated with this type of infringement, it is possible that offenders in this category may also disregard social norms more generally. In contrast, about three quarters of cases in the non-speeding category are parking offences, which rarely threaten the well-being of others.

²¹Being recorded by a red light camera does not necessarily imply a red light offence. Only around 6 percent of offences in our sample are red light offences (see Table 2).

We further observe heterogeneity with regards to the number of years since the offence took place. Specifically, the social norms letter improves tax compliance if the offence took place within three years before the trial. In contrast, the letter is ineffective if the offence took place at an earlier point in time. A possible reason for this finding is that the perceived likelihood of having to pay the fine after being non-compliant for several years is extremely low. While the enforcement letter can change this perception, addressing social norms does not achieve this outcome.

[Figure 4 about here.]

Another interesting pattern emerges when we study the effectiveness of the social norms letter by debt levels. While offenders respond to social norms if their outstanding debt is below the median, they are much less responsive if their outstanding debt is above the median. (The effect of addressing social norms on partial or full payment of offenders with an outstanding debt above the median is significant but the effect on the amount paid is insignificant.) A potential explanation for this finding is that fairness concerns may play a role in shaping behavioral responses of offenders. By nudging offenders to compare themselves to others, the social norms letter may amplify feelings of unfair treatment. These feelings may be particularly strong among low-income offenders who are disproportionately affected in a fixed-rate fine system.

We find that offenders residing in the ACT (based on driver licence and vehicle registration) do not respond to the social norms letter. This finding is consistent with the insignificant effect of the enforcement letter on ACT residents who seem to constitute a highly selected group of non-compliant offenders, potentially including a sizeable number of foreign diplomats.

4.4 Additional results

We estimate heterogeneous treatment effects for all subgroups listed in Table 2. Our findings reveal that the age effects presented in Figure 3 are driven by 26-35 and 46-55 year olds, while the age effects presented in Figure 4 are driven by 36-45 year olds, indicating a non-linear relationship between age and fine compliance. The insignificant

effects of the oldest age group (56-65 year olds) may be due to the relatively small sample size (around 730 observations). We also find both letters improve fine compliance of both male and female offenders. The effects on female offenders are somewhat stronger but the differences are not statistically significant.

Treatment effects by infringement type reveal that the effects of both treatments are mainly attributable to cases recorded by red light cameras or parking officers (as opposed to point-to-point cameras, other cameras and other types of recording), which together record about 80 percent of all infringements. We also estimate heterogeneous treatment effects for subgroups within the sample of non-speeders and find that the effects of the enforcement letter may be explained by standard parking offences (such as not paying or overstaying in a parking zone), while the effects of the social norms letter are due to other parking offences (such as parking in a ‘no parking’ zone).

The effects of both treatments for the subgroup of more recent offences are mainly attributable to offences that took place two years before the trial, while the effects of the enforcement letter for the subgroup of older offences are driven by offences that took place five years before the trial. Within the group of offenders with an outstanding fine below the median, the effects of social norms are attributable to the lowest quartile, supporting the hypothesis that the social norms letter may be ineffective if offenders perceive the fixed-fine system as unfair.

Finally, we split the sample of offenders from other (non-ACT) license and/or vehicle registration states into three subgroups: offenders with an ACT driver license and a non-ACT vehicle registration, offenders with a non-ACT/NSW driver license and an ACT vehicle registration, and offenders with a non-ACT/NSW driver license and a non-ACT vehicle registration.²² We find that the effects of the two letters on offenders from other (non-ACT) license and/or vehicle registration states are driven by the group of offenders with a non-ACT/NSW driver license and a non-ACT vehicle registration, confirming that offenders who in all likelihood do not reside in the ACT (and with no connection to the ACT, neither holding an ACT driver license nor ACT vehicle

²²Our sample consists of offenders with driver licenses from the ACT or NSW. Non-ACT vehicle registrations may be from other parts of Australia.

registration) are responsive to both letters. By contrast, the effects of the two letters on the subgroups with an ACT driver license and/or an ACT vehicle registration are not statistically significant. Therefore, even though our data do not contain information about the actual location of residence, our estimates point to a strong link between the responsiveness of offenders and their location of residence.

4.5 Cost-benefit analysis

It is useful to compare the estimated effects of the two treatments to the costs of the intervention. We summarize the costs and benefits of our trial in Table 4. We observe that a few members of the Control Group paid their outstanding fines during the trial period even though they did not receive a treatment letter. On average, members of the Control Group paid \$1.03 over the duration of the trial. The average fine payment of members of Treatment Group 1 is \$5.95. Members of Treatment Group 2 paid on average \$4.54. We multiply these numbers by 10,404 (the total number of cases in our analysis sample) to obtain the total fine revenue that would have been collected if all cases had received no treatment letter (\$10,716), the enforcement letter (\$61,904) or the social norms letter (\$47,234).

[Table 4 about here.]

We compare the potential revenue to the potential cost associated with each scenario. We define the potential net revenue as the additional revenue that would have been collected if all offenders had received the treatment minus the cost of sending the letters. We assume that the total cost of sending a letter is \$1.15. Based on this, the potential net revenue resulting from sending the enforcement letter to all offenders is \$39,223. The potential net revenue resulting from sending the social norms letter is \$24,553. Put differently, for each dollar spent on sending enforcement letters to offenders, the average amount collected is \$3.77. The corresponding amount associated with sending social norms letters is \$2.36.

5 Conclusions

Despite the relevance of fines for local government budgets, we know very little about the effectiveness of nudges on fine compliance. This paper provides first evidence on the effects of deterrence (enforcement) and non-deterrence (social norms) messages on the collection of traffic and parking fines in the ACT, using data from a natural field experiment. Although considerable research examines the effects of deterrence and non-deterrence messages on tax compliance, we have no reason to expect these messages have the same effects on fine compliance. Our analysis contributes to the literature by studying the effects of enforcement and social norms letters on traffic and parking fine compliance in a large-scale real-world setting. Because our analysis focuses on offenders who have been non-compliant for at least six months, the findings presented in this paper are particularly relevant for fine collectors aiming to collect traffic and parking fines that have been outstanding for a prolonged period.

We find both enforcement and social norms letters significantly improve fine compliance relative to a control group that does not receive any further communication after failing to respond to an initial reminder. Sending a letter including enforcement messages increases the average amount paid by about \$5, and the probability of making a partial or full payment by about 3 percentage points. Sending a letter including social norms messages increases the average amount paid by about \$3.50, and the probability of making a partial or full payment by about 2 percentage points. Our analysis of heterogeneous treatment effects reveals that addressing social norms does not improve the behavior of young offenders, those who committed a speeding offence, those with a long outstanding debt and those with a debt above the median. In contrast, the enforcement letter is generally effective for all subgroups except for a highly selected group of offenders residing in the ACT who are non-compliant despite facing the possibility of losing their right to drive.

Tables and figures

TABLE 1: PENALTIES BY INFRINGEMENT AND OFFENCE TYPE

	Control			Enforcement			Social norms		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Infringement type									
Red light camera	232.66	78.14	4,143	233.66	101.58	408	233.90	96.87	429
Point-to-point camera	214.68	49.53	265	207.25	46.35	20	200.14	26.44	21
Other camera infringement	248.73	121.50	753	260.83	185.36	82	234.87	52.37	71
Parking	109.25	35.88	2,694	113.47	42.90	264	110.95	37.26	275
Other	345.18	226.20	779	350.61	215.36	101	315.35	144.40	99
Offence type									
Speeding	229.85	112.76	4,947	234.10	140.82	495	226.72	92.23	515
Parking (not paid or overstayed)	95.29	8.77	1,348	95.10	8.59	132	95.90	8.11	144
Other parking	123.23	45.93	1,346	131.84	54.23	132	127.48	48.25	131
Red light	342.39	43.68	471	339.42	40.55	50	334.39	45.17	49
Other	342.28	146.77	522	354.97	162.22	66	344.55	151.89	56

Note: p -values refer to the comparison of means between treatment and control groups.

TABLE 2: BASELINE CHARACTERISTICS

	Control			Enforcement			Social norms		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Age									
18-25	0.218	0.413	8,634	0.223	0.416	875	0.223	0.417	895
26-35	0.323	0.468	8,634	0.336	0.473	875	0.339	0.473	895
36-45	0.229	0.420	8,634	0.214	0.410	875	0.230	0.421	895
46-55	0.153	0.360	8,634	0.155	0.363	875	0.134	0.341	895
56+	0.077	0.267	8,634	0.072	0.259	875	0.074	0.261	895
Female	0.332	0.471	8,634	0.360	0.480	875	0.377	0.485	895
Infringement type									
Red light camera	0.480	0.500	8,634	0.466	0.499	875	0.479	0.500	895
Point-to-point camera	0.031	0.172	8,634	0.023	0.150	875	0.023	0.151	895
Other camera infringement	0.087	0.282	8,634	0.094	0.292	875	0.079	0.270	895
Parking	0.312	0.463	8,634	0.302	0.459	875	0.307	0.462	895
Other	0.090	0.287	8,634	0.115	0.320	875	0.111	0.314	895
Offence type									
Speeding	0.573	0.495	8,634	0.566	0.496	875	0.575	0.495	895
Parking (not paid or overstayed)	0.156	0.363	8,634	0.151	0.358	875	0.161	0.368	895
Other parking	0.156	0.363	8,634	0.151	0.358	875	0.146	0.354	895
Red light	0.055	0.227	8,634	0.057	0.232	875	0.055	0.228	895
Other	0.060	0.238	8,634	0.075	0.264	875	0.063	0.242	895
Number of years since offence	3.35	1.80	8,634	3.36	1.73	875	3.36	1.72	895
Penalty + fee	234.68	120.37	8,634	243.07	139.44	875	234.01	109.94	895
ACT license and registration	0.172	0.377	8,634	0.176	0.381	875	0.168	0.374	895

Note: p -values refer to the comparison of means between treatment and control groups.

FIGURE 1: PAYMENT RATES (KAPLAN-MEIER FAILURE ESTIMATES):
ENFORCEMENT VS. CONTROL

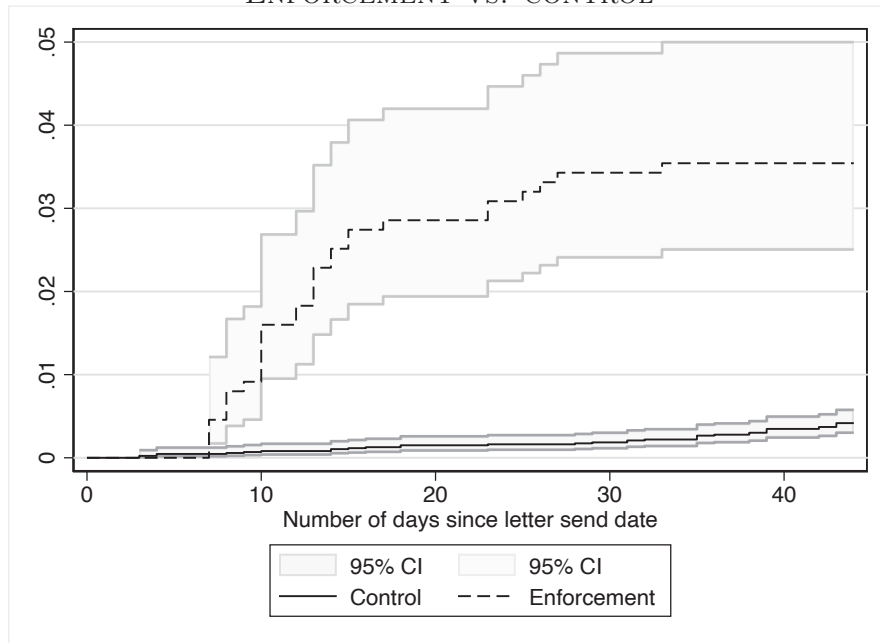


FIGURE 2: PAYMENT RATES (KAPLAN-MEIER FAILURE ESTIMATES):
SOCIAL NORMS VS. CONTROL

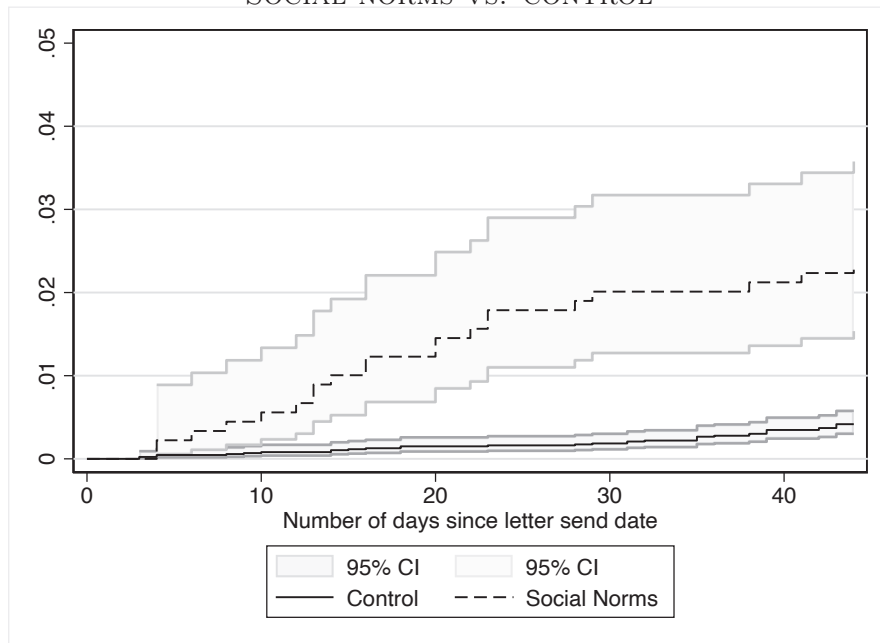


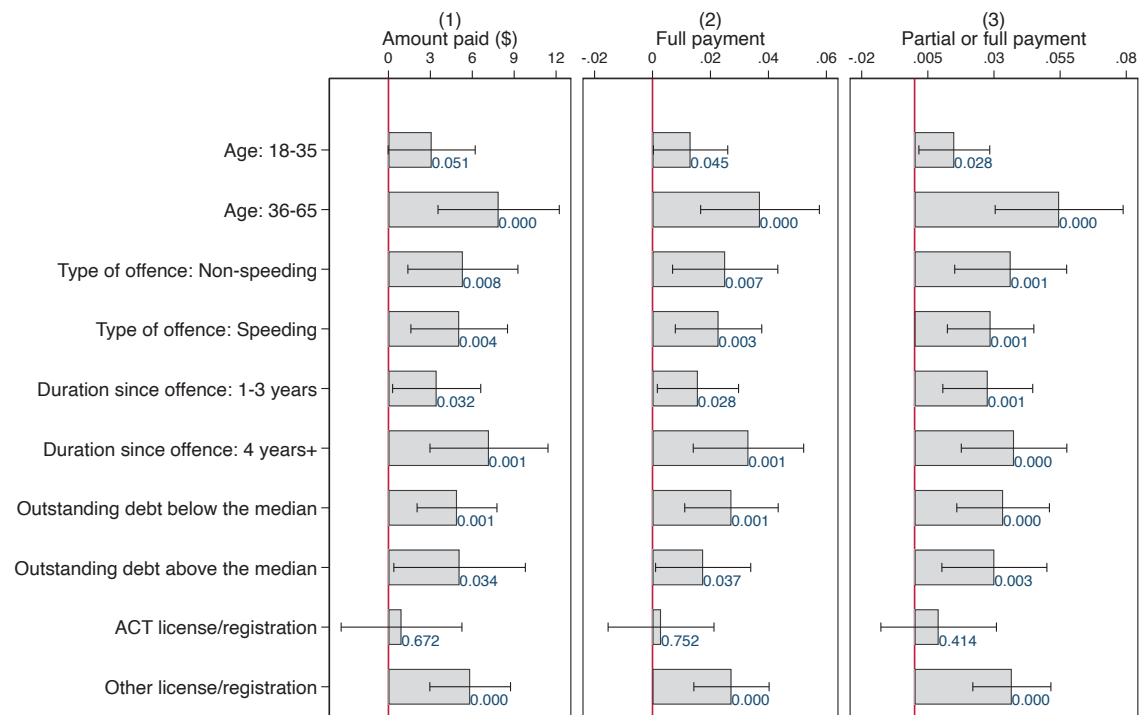
TABLE 3: TREATMENT EFFECTS ON FINE PAYMENT BY END OF TRIAL

	Enforcement			Social norms		
	Amount paid (\$) (1)	Full payment (2)	Partial or full payment (3)	Amount paid (\$) (4)	Full payment (5)	Partial or full payment (6)
Model without covariates	4.915** (1.232) [9,509]	0.022** (0.005) [9,509]	0.031** (0.006) [9,509]	3.505** (1.112) [9,529]	0.017** (0.005) [9,529]	0.019** (0.005) [9,529]
Model with covariates	4.992** (1.264) [9,509]	0.023** (0.006) [9,509]	0.032** (0.006) [9,509]	3.462** (1.165) [9,529]	0.017** (0.005) [9,529]	0.019** (0.005) [9,529]

Note: Robust standard errors in parentheses. Number of observations in brackets. The set of covariates includes age, gender, infringement type, offence type, number of years since offence, penalties, fees and postcode (based on driver license information).

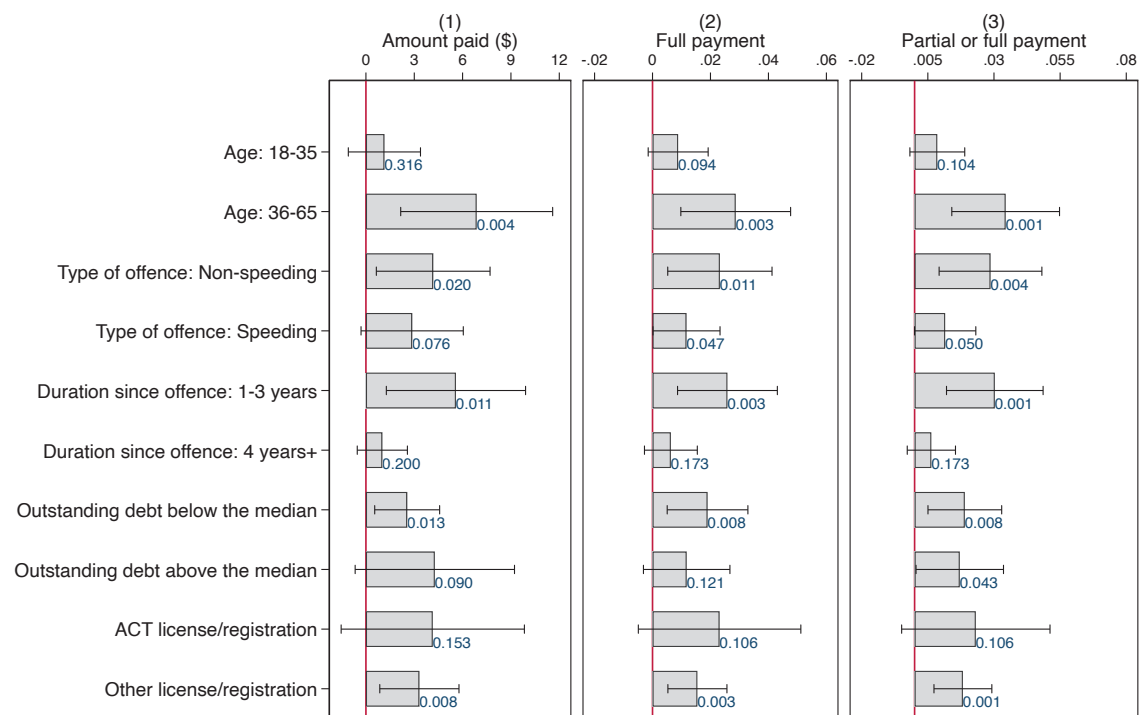
* $p < 0.05$, ** $p < 0.01$.

FIGURE 3: HETEROGENEOUS TREATMENT EFFECTS: ENFORCEMENT MESSAGE



Note: Each bar represents a treatment effect estimate. 95 percent confidence intervals are depicted as lines around the point estimates. The p -values associated with the point estimates are presented next to each bar.

FIGURE 4: HETEROGENEOUS TREATMENT EFFECTS: SOCIAL NORMS MESSAGE



Note: Each bar represents a treatment effect estimate. 95 percent confidence intervals are depicted as lines around the point estimates. The p -values associated with the point estimates are presented next to each bar.

TABLE 4: COST-BENEFIT ANALYSIS

	(1) Control	(2) Enforcement	(3) Social Norms
Average amount paid (\$)	1.03	5.95	4.54
Number of cases	8,634	875	895
Total revenue (\$)	8,906	5,203	4,060
Potential revenue* (\$)	$10,404 \times 1.03$	$10,404 \times 5.95$	$10,404 \times 4.54$
	=10,716	=61,904	=47,234
Potential net revenue** (\$)		$61,904 - 10,716$	$47,234 - 10,716$
		$-10,404 \times 1.15$	$-10,404 \times 1.15$
		=39,223	=24,553

Note: * The potential revenue refers to the amount that would have been collected if all 10,404 cases had received (1) no letter, (2) the enforcement letter or (3) the social norms letter. ** The potential net revenue of a treatment is the additional revenue that would have been collected if all cases had received the treatment minus the cost of sending the letters (assumption: \$1.15 per letter).

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Appendix A – Treatment Letters

Treatment 1: Enforcement Letter



ACT
Government



We noticed you still have an unpaid fine. Take action today.

Unpaid <<Type_proper>> Infringement



<<Given_names_proper>> <<Surname_proper>>
<<POSTAL_ADDRESS_LINE_1>>
<<POSTAL_ADDRESS_LINE_2>>
<<POSTAL_ADDRESS_LINE_3>>

Registration Number

Key details

<<REGO_NBR>>

Infringement Number

<<INF_NUMBER>>

Amount Due

\$<<AMOUNT_DUE>>

Letter issue date

<<LETTER_DATE>>

Dear <<Given_names_proper>> <<Surname_proper>>

You still have an overdue fine of \$<<AMOUNT_DUE>> for the below offence.

Unpaid fines don't go away unless you take action.

Payment options are listed below or for more information visit act.gov.au/unpaidfines.



Your Offence Details

1. Infringement number: <<INF_NUMBER>>
2. Vehicle registration: <<REGO_NBR>>
3. Offence date: <<OFFENCE_DATE>>
4. Offence description: <<OFFENCE_DESC>>
5. Offence location: <<OFFENCE_LOCN>>

Your payment options



Online

Go to act.gov.au/unpaidfines and select pay an infringement online to make payment by Visa or Mastercard.



Biller code: 343533

Login to your financial institutions online banking service and select BPAY. You will need to enter the Biller Code and the above Infringement Notice Number as the reference number.



Bill pay code: 0286

Call **13 18 16** and follow the prompts. Enter the above Infringement Notice number as the reference number. Payment can be made with Visa or Mastercard. The National Relay Service is available for the hearing impaired on **13 36 77**.

Treatment 2: Social Norms Letter



You have an overdue fine. Please do the right thing and pay now.

Unpaid <<Type_proper>> Infringement



<<Given_names_proper>> <<Surname_proper>>
<<POSTAL_ADDRESS_LINE_1>>
<<POSTAL_ADDRESS_LINE_2>>
<<POSTAL_ADDRESS_LINE_3>>

Key details	
Registration Number	<<REGO_NBR>>
Infringement Number	<<INF_NUMBER>>
Amount Due	\$<<AMOUNT_DUE>>
Letter issue date	<<LETTER_DATE>>

Dear <<Given_names_proper>> <<Surname_proper>>

You still have an overdue fine of \$<<AMOUNT_DUE>> for the below offence.

Most people with overdue fines have already paid.

Payment options are listed below or for more information visit act.gov.au/unpaidfines.



Your Offence Details

1. Infringement number: <<INF_NUMBER>>
2. Vehicle registration: <<REGO_NBR>>
3. Offence date: <<OFFENCE_DATE>>
4. Offence description: <<OFFENCE_DESC>>
5. Offence location: <<OFFENCE_LOCN>>

Your payment options



Online

Go to act.gov.au/unpaidfines and select pay an infringement online to make payment by Visa or Mastercard.



Biller code: 343533

Login to your financial institutions online banking service and select BPAY. You will need to enter the Biller Code and the above Infringement Notice Number as the reference number.



Bill pay code: 0286

Call **13 18 16** and follow the prompts. Enter the above Infringement Notice number as the reference number. Payment can be made with Visa or Mastercard. The National Relay Service is available for the hearing impaired on **13 36 77**.

Appendix B – List of Variables

Outcome variables

- Amount of fine payment (in \$)
- Payment in full (Yes/No)
- Payment in partial or full (Yes/No)

Covariates

- Age
- Gender
- Infringement type
- Offence type
- Number of years since offence
- Penalty (in \$)
- Fee (in \$)
- Postcode (based on driver license information)