

TTPI

Tax and Transfer Policy Institute

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

TTPI - Working Paper 4/2021 March 2021

Mathias Sinning

Tax and Transfer Policy Institute, Crawford School of Public Policy,
Australian National University, RWI & IZA

Yinjunjie Zhang

Tax and Transfer Policy Institute, Crawford School of Public Policy,
Australian National University

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 Codes: H26, H32, K42, C93.

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

**We thank Nathan Deutscher, Sarah Dong, Uwe Dulleck, Christian Gillitzer, Christopher Hoy, Ralf Steinhauser and Benno Torgler for helpful comments and gratefully acknowledge the financial support from the Australian Research Council (LP160100810). All correspondence to Mathias Sinning, Crawford School of Public Policy, College of Asia and the Pacific, JG Crawford Building #132, Lennox Crossing, The Australian National University, Canberra ACT 2601
E-mail: mathias.sinning@anu.edu.au, Tel: +61 26125 0567.*

Tax and Transfer Policy Institute
Crawford School of Public Policy
College of **Asia and the Pacific**
+61 2 6125 9318
tax.policy@anu.edu.au

The Australian National University
Canberra ACT 0200 Australia
www.anu.edu.au

The Tax and Transfer Policy Institute (TTPI) is an independent policy institute that was established in 2013 with seed funding from the federal government. It is supported by the Crawford School of Public Policy of the Australian National University.

TTPI contributes to public policy by improving understanding, building the evidence base, and promoting the study, discussion and debate of the economic and social impacts of the tax and transfer system.

The Crawford School of Public Policy is the Australian National University's public policy school, serving and influencing Australia, Asia and the Pacific through advanced policy research, graduate and executive education, and policy impact.

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 examines the effects of deterrence and non-deterrence messages on the collection of traffic and parking fines, using data from a natural field experiment, which was implemented in collaboration with the government of the Australian Capital Territory (ACT). Our work 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 costs more salient. More recently, researchers have focused on analyzing moral costs of non-compliance

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).

associated with the deviation 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 the considerable amount of research on tax compliance, experimental evidence on fine compliance is rather scarce.⁴ This is unfortunate because we cannot simply assume that tax compliance and fine compliance are determined by the same underlying mechanisms. While many taxpayers are aware of the relation between paying taxes and the provision of public goods (Rahayu et al., 2017), it may be less obvious to them how their fine payments will be used. Moreover, due to the collection of fines at a local level, there is no guarantee that individuals will pay fines in their location of residence, and therefore they will not necessarily 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 that they are being treated unfairly if the fine system is regressive, and therefore fine non-compliance may generate lower moral costs than tax non-compliance.⁵ Taken together, we have no reason to expect that nudges to improve tax compliance will have the same effects on fine compliance.⁶

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 the effectiveness of different types of nudges on traffic and parking fine compliance is important for local and state governments around the world. Secondly, we provide an overview of the related literature and discuss potential mechanisms through which enforcement and

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.

⁴Exemptions include Haynes et al. (2013), Du Plessis et al. (2020) and Dusek et al. (2020). See 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 13 January 2021).

⁶We provide an overview of the tax and fine compliance literature in Section 2.

social norms messages may affect fine compliance. So far, very little is known about the underlying mechanisms that are responsible for the effects of nudges on fine compliance. Thirdly, our findings regarding the effectiveness of deterrence and non-deterrence nudges exhibit a high degree of both internal and external validity. Our analysis sample includes 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 of time.

The findings from our field experiment indicate that both enforcement and social norms letters increase traffic and parking fine payments significantly relative to a control group that did not receive a 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.⁷ Our analysis of heterogeneous treatment effects indicates that addressing social norms does not change the behavior of young offenders and those who committed a speeding offence. Non-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).

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 period. 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.^{8,9} 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.

⁷Although both treatments have a significant effect, we cannot exclude the possibility that the observed treatment effects are driven by reminder effects to some degree.

⁸\$ = Australian dollar. One Australian dollar is equal to 0.78 US dollars (13 January 2021).

⁹A small number of individuals who entered a payment plan were excluded from our analysis sample.

The enforcement letter is effective for all major subgroups with exception of offenders who live in the ACT. Offenders who do not pay their fines may lose their right to drive in the ACT (a small jurisdiction with many commuters and interstate visitors), and therefore the vast majority of non-compliers observed in our analysis sample does not live in the ACT. The relatively few remaining non-compliant ACT residents in our sample appear to be a highly selected group of ‘recalcitrant’ cases who are unwilling to comply in general. Neither the enforcement letter nor the social norms letter can change the behavior of this group of offenders, which includes an unknown number of foreign diplomats who often do not pay their fines because they are immune from prosecution by local authorities under the Vienna convention.¹⁰ Overall, our findings highlight the importance of enforcement messages 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 and discusses potential mechanisms through which enforcement and social norms messages may affect traffic and parking fine compliance. Section 3 presents the experimental design, outlines our empirical strategy and provides a description of the administrative records that were used in our analysis. The results are presented in Section 4. Section 5 concludes.

2 Related literature and potential mechanisms

2.1 Tax compliance literature

The tax compliance literature has grown rapidly in recent years due to the wider availability of administrative tax records, the increased use of natural field experiments and an increased 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 a number of 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

¹⁰Unfortunately, we are unable to identify foreign diplomats in our data.

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 that aim to make 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.¹¹

A second major strand of the tax compliance literature examines the moral costs of non-compliance associated with the deviation 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 no effect of addressing social norms 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 a significant increase in payment rates. Bott et al. (2020) report that moral suasion messages significantly increase the amount of self-reported foreign income in Norway.

The costs and benefits associated with tax compliance may be affected by a number of 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 de-

¹¹Examples 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 auditing level, but decreases beyond that level.

pend 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 the tax authority (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 (Ericson, 2017; Gillitzer and Sinning, 2020).¹²

2.2 Fine compliance literature

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, which suggest 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

¹²Biddle and Arcos-Holzinger (2016) provide a more detailed discussion of the determinants of tax compliance.

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.

2.3 Potential mechanisms

The economic literature on tax evasion suggests that the probability of being detected and the legal punishment are the main mechanisms through which enforcement messages affect fine compliance. In the context of our analysis, the probability of being detected seems to be irrelevant because the local authority knows about outstanding fines. However, according to the ACT government, offenders with a long outstanding fine may lose their right to drive, suggesting that the perceived probability of being detected driving without a valid license matters.¹³

Although we are unable to quantify the detection probability of license offences in the driver population, it is still useful to speculate about its approximate size. We observe that our analysis sample of 10,404 observations only includes 149 fines associated with a license offence, indicating that the detection probability is 1.4 percent ($149/10,404=0.014$). We have no reason to expect that the detection probability in the overall driver population is vastly different, even though our analysis sample is not representative of this population. As a consequence, it appears likely that the perceived probability of being detected driving without a valid license is also very low. The aim of our enforcement letter is to increase the perceived detection probability by making it more salient that even long outstanding debts do not go away.

The tax morale literature identifies a number of motives for tax compliance. Luttmer and Singhal (2014) consider five broadly defined potential mechanisms through which

¹³The Access Canberra webpage for traffic and parking infringements explains that suspension actions will commence if offenders take no action by the due date of the reminder notice. The webpage states that “You may not be able to drive or operate your vehicle” (https://www.accesscanberra.act.gov.au/app/answers/detail/a_id/1271/~/traffic-and-parking-infringements, accessed 13 January 2021).

tax morale could operate: (1) intrinsic motivation, (2) reciprocity, (3) peer effects and social influences, (4) cultural factors and (5) information imperfections and deviations from utility maximization. Luttmer and Singhal (2014) define intrinsic motivation as an additional term in the utility function that increases with tax payments, which captures “feelings of pride and positive self-image that are often associated with honesty and the fulfillment of civic duties, and altruism towards others” (p.155). They also consider feelings of guilt or shame resulting from tax non-compliance as a form of intrinsic motivation.¹⁴ In the context of our analysis, the effectiveness of addressing social norms will depend on whether the social norms communicated through our letter will coincide with the personal norms associated with the intrinsic motivation to comply.

Reciprocity may be a relevant mechanism for offenders who live in the ACT because they may receive something in return for paying a fine (through the provision of public goods). If reciprocity matters, then we would expect our treatments to be more effective for offenders who live in the ACT than for those who do not. Luttmer and Singhal (2014) also consider perceptions of fairness as an element of their broad definition of reciprocity. Perceptions of fairness may be highly relevant in the context of fine compliance. In particular, fixed-fine systems may be perceived as unfair, especially among low-income offenders. Unfortunately, we do not observe the income of offenders in our data but we are able to differentiate between low and high fines. If the perception of fairness matters, then we would expect offenders who received a high fine to be less likely to respond to our social norms letter than offenders who received a low fine. In this case, feelings of being treated unfairly would counteract or offset feelings of guilt or shame associated with non-compliance. At the same time, our enforcement letter should have a similar effect on offenders with high and low fines because it does not address moral aspects of fine compliance.

Peer effects and social influences are the main mechanisms through which our social norms letter is expected to affect fine compliance. If this mechanism matters, then we should see a significant effect of the social norms letter on fine compliance. We are unable

¹⁴Dulleck et al. (2016) measure psychic stress using heart rate variability in a laboratory experiment and provide evidence of a positive correlation between psychic stress and tax compliance, highlighting the relevance of moral sentiments for tax compliance.

to study cultural factors because the baseline characteristics in our data do not permit inferences about the cultural background of offenders. Finally, deviations from a fully rational model of tax compliance may be due to imperfect information or misperceptions about relevant parameters (including the detection probability and the legal punishment). They may also be a result of imperfect memory. If biases of this type matter, then our treatments should contribute to reducing them.

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.¹⁵ The trial was designed and implemented in collaboration with the Treasury 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 ('business as usual'). Non-compliant offenders may lose their right to drive in the ACT after the due date of the reminder notice.¹⁶ The risk of losing the right to drive may provide a stronger incentive for offenders residing in the ACT to pay their traffic and parking fines than for those residing elsewhere. As a consequence, only about 17 percent of the offenders in our data have driver licenses that were issued in the ACT.

Our analysis is based on administrative records from Access Canberra, the service provider of the ACT government. The target population of the trial was defined as the

¹⁵We 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).

¹⁶https://www.accesscanberra.act.gov.au/app/answers/detail/a_id/1271/~/traffic-and-parking-infringements, accessed 13 January 2021.

full population of traffic and parking offenders in the ACT aged 18-65 years at the time of offence, who had 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 state surrounding the ACT. The target population was restricted to offenders with one outstanding infringement to simplify the data structure and to facilitate trial design and implementation. As a consequence, our analysis sample includes offenders who are either unwilling to pay one outstanding fine or who may have simply forgotten to pay. By contrast, our analysis sample does not include offenders with multiple offences who are consistently unwilling to comply. Despite the exclusion of offenders with multiple infringements from the trial, it is possible that some offences by ACT residents were committed by foreign diplomats.¹⁷ Unfortunately, we are unable to identify this group in our data.

The treatment letters that were sent to offenders are shown in Appendix A. The enforcement letter (Treatment 1) contains two types of messages. The first message informs offenders that the fine collection authority is aware of the outstanding fine. We refer to this message as “surveillance message”. Interventions that make surveillance more salient have been shown to reduce the cheating behavior of individuals (Jansen et al., 2018). The second message informs offenders that their fine will not go away unless they take action, thereby making the possibility of eventual punishment more salient. We refer to this element of the enforcement letter as “unavoidability message”. The social norms letter (Treatment 2) also contains two types of messages. A “descriptive norms message” points out that most people with overdue fines have already paid, while an “injunctive norms message” asks people to do the right thing by paying their fine. 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.

The administrative records include a total of 10,702 separate outstanding infringements. The ACT government agreed to send up to 1,000 letters to each treatment group.

¹⁷<https://www.abc.net.au/news/2019-09-23/diplomatic-drivers-ignore-parking-laws/11537306>, accessed 13 January 2021.

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 (5 April 2017) 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 ethics clearance was obtained from the Human Research Ethics Committee of the Australian National University (Protocol Number 2017/783, approval date: 5 October 2017). 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 2018.¹⁸

We impose a number of sample restrictions to obtain our final analysis sample. Specifically, 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). The resulting analysis sample includes a total of 10,404 cases (Treatment Group 1: 875 cases, Treatment Group 2: 895 cases, Control Group: 8,634).

3.2 Empirical strategy

3.2.1 Survival analysis

We begin by studying 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

¹⁸<https://www.socialscienceregistry.org/trials/2611>, accessed 13 January 2021.

times, $\tau_1, \tau_2, \dots, \tau_J$, where J is the total number of distinct uncensored failure times 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.

3.2.2 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. A complete list of control

variables is provided in Appendix B.¹⁹ 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. Our parameter of interest is the average treatment effect on the treated, β_1 . We use separate regression models with and without control variables to estimate unconditional and conditional (on X_i) treatment effects, respectively. In addition to the overall treatment effects, we also present estimates of heterogeneous treatment effects for subgroups that share the same characteristics. We present the treatment effect estimates in Section 4 together with a range of robustness checks.

3.3 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 that was 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).²⁰ Differences in penalties between treatment and control groups are not statistically significant, with exception of differences in penalties between Treatment Group 2 (“Social norms”) and the Control Group for infringements recorded by point-to-point cameras. To balance out differences between treatment and control groups, we will control for both infringement and offence types in our regression analysis.

[Table 1 about here.]

¹⁹In addition to the variables presented in Table 2, our conditional regression model also includes postcode fixed effects that absorb small-scale regional variation.

²⁰We 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 includes summary statistics of baseline characteristics of treatment and control groups. The numbers in Table 2 reveal the majority of 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.²¹ 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.²²

[Table 2 about here.]

The p -values in Table 2 indicate that our sample is balanced in terms of baseline characteristics. 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. We will also estimate 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

²¹About 700 offences took place between 6 and 19 years before the trial. We discuss the impact of excluding these offences from our analysis in Section 4.4.

²²According 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.

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.²³ 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 much 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 period after the send date.

²³Due to the relatively small size of the two treatment group samples, we do not have enough statistical power for a direct comparison of the two treatment letters to each other. Differences between the two treatments are largely insignificant. Therefore, our analysis focuses on the comparison of each of the two treatment groups to the Control Group.

4.2 Treatment effects

The estimates obtained from the linear regression model 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.

[Table 3 about here.]

Including the baseline characteristics presented in Table 2 as covariates in our regression model does not affect our results qualitatively. 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.

4.3 Effects heterogeneity

The overall average treatment effect estimates presented in Table 3 indicate that social norms messages are not as effective as enforcement messages in the context of fine compliance. A number of factors may be responsible for this result. To gain a better understanding of the underlying mechanisms through which social norms and enforcement messages may affect fine compliance, we estimate heterogeneous treatment effects for subgroups that share the same baseline characteristics.

Figures 3 and 4 present selected heterogeneous treatment effects of the enforcement

message.²⁴ Specifically, we estimate heterogeneous treatment effects by age (18-35 years vs. 36-65 years), the type of offence (speeding vs. non-speeding), the duration since the offence took place (1-3 years vs. 4+ years), the outstanding debt at the beginning of the trial (debt below vs. above the median) and the 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 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)).

The treatment effects presented in Figure 3 reveal that the enforcement letter is generally effective for all subgroups with exception of offenders who live in the ACT (based on both driver license and vehicle registration). Because offenders who do not pay their fines may lose their right to drive in the ACT, the fraction of offenders with an ACT driver license and vehicle registration in our analysis sample is only around 17 percent (see Table 2). It is possible that these offenders constitute a highly selected group that is unwilling to comply in general. Some offences by ACT residents may be attributed to foreign diplomats in Canberra who do not have to pay traffic and parking fines because of their immunity status. Unfortunately, we are unable to investigate this issue further because we cannot identify foreign diplomats in our data.

[Figure 3 about here.]

The results presented in Figure 3 suggest that the enforcement letter increases the salience of unavoidability. The surveillance message reminds offenders that the fine collection authority is keeping track of their outstanding debt. At the same time, non-compliant offenders residing in the ACT, who have continued driving without experiencing any negative consequences for a prolonged period, do not change their behavior after receiving a letter that does not threaten any real action.

²⁴We focus on the most interesting heterogeneous treatment effects in this section. We summarize the findings of our complete analysis of heterogeneous treatment effects in Section 4.4.

Figure 4 presents the corresponding heterogeneous treatment 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). In other words, the overall effect of the social norms letter on fine payments is driven by older offenders (36-65 years). Non-compliant behavior among young individuals has also 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. A considerable amount of research provides 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).

The deviations of social norms messages from personal norms may also be responsible for the ineffectiveness of the social norms letter on 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.²⁵ 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.

We also find 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 more than three years is extremely low. While the enforcement letter is able to 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

²⁵Being recorded by a red light camera does not necessarily imply a red light offence. Only around 6 percent of offences in our analysis sample are red light offences (see Table 2).

letter by the level of debt. While offenders respond to the social norms letter if their outstanding debt is below the median, they are much less responsive if their outstanding debt is above the median. (The effect of the social norms letter 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.) This finding suggests 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 being treated unfairly. These feelings may be particularly strong among low-income offenders who are being affected disproportionately in a fixed-rate fine system.

We find that offenders residing in the ACT (based on their 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 relevant number of foreign diplomats who do not have to pay traffic and parking fines because of their immunity status.

Overall, our findings highlight the importance of enforcement messages for the efficient collection of fine revenue. Although addressing social norms does improve fine compliance, the social norms letter is less effective than the enforcement letter. Moreover, while the enforcement letter is generally effective for all subgroups (with exception of offenders residing in the ACT), the social norms letter does not affect 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 addition to offenders residing in the ACT). Differential effects between the two letters suggest that the treatments are more than just reminders because the two letters would have been equally effective (or ineffective) in the case of a pure reminder effect.

4.4 Robustness checks

We conduct a number of robustness checks to validate our results. In Table 3, we report unconditional and conditional (on baseline characteristics) treatment effect estimates and conclude that controlling for baseline characteristics leaves our estimates virtually un-

changed. Because the baseline characteristics used in our analysis are correlated with each other, we examine the impact of gradually adding sets of baseline characteristics to the conditional model. The resulting estimates do not differ qualitatively from the estimates presented in Table 3.

Moreover, our target population was restricted to cases in which fine payments were overdue for at least six months and up to five years before the trial. However, there are 676 cases in which the offence took place more than five years before the trial. To study the impact of these cases on our results, we exclude them from our analysis sample and re-estimate the treatment effects presented in Table 3. We find that while this sample restriction increases the estimated treatment effects slightly, it does not affect our results qualitatively.

Figures 3 and 4 focus on heterogeneous treatment effects of selected subgroups but we are able to 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 that the relationship between age and fine compliance is non-linear. 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 that both letters improve fine compliance of both male and female offenders. The effects on female offenders are generally somewhat stronger but the differences are not statistically significant.

Heterogeneous 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 paid or overstayed 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 offenders with an outstanding fine below the median, the effects of the social norms letter are attributable to the lowest quartile, supporting the hypothesis that the social norms letter may be ineffective if offenders feel that the fixed-fine system is treating them unfairly.

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.²⁶ 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 who have no connection to the ACT by either holding an ACT driver license or an ACT vehicle 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 include 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 letter. On average, members of the Control Group paid about \$1 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)

²⁶Our target population only includes offenders with driver licenses from the ACT or NSW. Non-ACT vehicle registrations may be from other parts of Australia.

to obtain the total fine revenue that could have been collected if all cases had received (1) no letter, (2) the enforcement letter or (3) the social norms letter. In the absence of the intervention, the ACT Government would have collected \$10,716. The potential fine revenue that could have been raised by sending the enforcement letter to all offenders is \$61,904. The corresponding potential fine revenue resulting from sending the social norms letter to all offenders is \$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, we find that 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. Similarly, spending a dollar on sending social norms letters raises about \$2.36.

5 Conclusions

Despite the relevance of fines for local government budgets, we know very little about the motivations behind 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 Australian Capital Territory (ACT), using data from a natural experiment. A considerable amount of research examines the effects of deterrence and non-deterrence messages on tax compliance but there are good reasons to expect that tax compliance and fine compliance are not determined by the same underlying mechanisms.

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.

We provide an overview of the related literature and discuss potential mechanisms through which enforcement and social norms messages may affect fine compliance. Our analysis exhibits a high degree of internal and external validity. 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 who aim to collect traffic and parking fines that have been outstanding for a prolonged period of time.

We find that both enforcement and social norms letters improve fine compliance significantly relative to a control group that does not receive a letter. 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 the social norms letter 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 with exception of a highly selected group of ‘recalcitrant’ offenders who reside in the ACT and are non-compliant despite facing the possibility of losing their right to drive. We discuss potential mechanisms that may be responsible for these results.

Tables and figures

TABLE 1: PENALTIES BY INFRINGEMENT AND OFFENCE TYPE

	Control			Enforcement			<i>p</i> -value	Social norms			
	Mean	SD	<i>N</i>	Mean	SD	<i>N</i>		Mean	SD	<i>N</i>	<i>p</i> -value
Infringement type											
Red light camera	232.66	78.14	4,143	233.66	101.58	408	0.847	233.90	96.87	429	0.797
Point-to-point camera	214.68	49.53	265	207.25	46.35	20	0.483	200.14	26.44	21	0.024
Other camera infringement	248.73	121.50	753	260.83	185.36	82	0.562	234.87	52.37	71	0.068
Parking	109.25	35.88	2,694	113.47	42.90	264	0.122	110.95	37.26	275	0.471
Other	345.18	226.20	779	350.61	215.36	101	0.812	315.35	144.40	99	0.072
Offence type											
Speeding	229.85	112.76	4,947	234.10	140.82	495	0.514	226.72	92.23	515	0.474
Parking (not paid or overstayed)	95.29	8.77	1,348	95.10	8.59	132	0.802	95.90	8.11	144	0.395
Other parking	123.23	45.93	1,346	131.84	54.23	132	0.077	127.48	48.25	131	0.333
Red light	342.39	43.68	471	339.42	40.55	50	0.623	334.39	45.17	49	0.233
Other	342.28	146.77	522	354.97	162.22	66	0.543	344.55	151.89	56	0.915

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

TABLE 2: BASELINE CHARACTERISTICS

	Control			Enforcement				Social norms			
	Mean	SD	<i>N</i>	Mean	SD	<i>N</i>	<i>p</i> -value	Mean	SD	<i>N</i>	<i>p</i> -value
Age											
18-25	0.218	0.413	8,634	0.223	0.416	875	0.741	0.223	0.417	895	0.707
26-35	0.323	0.468	8,634	0.336	0.473	875	0.426	0.339	0.473	895	0.339
36-45	0.229	0.420	8,634	0.214	0.410	875	0.295	0.230	0.421	895	0.936
46-55	0.153	0.360	8,634	0.155	0.363	875	0.864	0.134	0.341	895	0.111
56+	0.077	0.267	8,634	0.072	0.259	875	0.577	0.074	0.261	895	0.712
Female	0.332	0.471	8,634	0.360	0.480	875	0.099	0.377	0.485	895	0.009
Infringement type											
Red light camera	0.480	0.500	8,634	0.466	0.499	875	0.444	0.479	0.500	895	0.976
Point-to-point camera	0.031	0.172	8,634	0.023	0.150	875	0.146	0.023	0.151	895	0.180
Other camera infringement	0.087	0.282	8,634	0.094	0.292	875	0.528	0.079	0.270	895	0.408
Parking	0.312	0.463	8,634	0.302	0.459	875	0.527	0.307	0.462	895	0.769
Other	0.090	0.287	8,634	0.115	0.320	875	0.025	0.111	0.314	895	0.062
Offence type											
Speeding	0.573	0.495	8,634	0.566	0.496	875	0.680	0.575	0.495	895	0.888
Parking (not paid or overstayed)	0.156	0.363	8,634	0.151	0.358	875	0.679	0.161	0.368	895	0.712
Other parking	0.156	0.363	8,634	0.151	0.358	875	0.692	0.146	0.354	895	0.444
Red light	0.055	0.227	8,634	0.057	0.232	875	0.753	0.055	0.228	895	0.980
Other	0.060	0.238	8,634	0.075	0.264	875	0.107	0.063	0.242	895	0.804
Number of years since offence	3.35	1.80	8,634	3.36	1.73	875	0.894	3.36	1.72	895	0.794
Penalty + fee	234.68	120.37	8,634	243.07	139.44	875	0.086	234.01	109.94	895	0.863
ACT license and registration	0.172	0.377	8,634	0.176	0.381	875	0.760	0.168	0.374	895	0.744

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

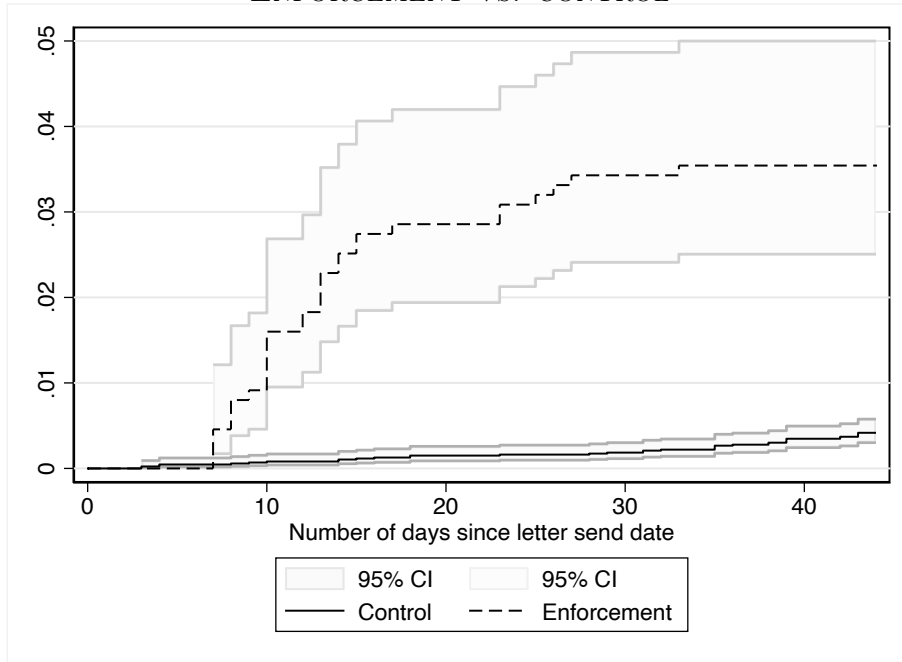


FIGURE 2: PAYMENT RATES (KAPLAN-MEIER FAILURE ESTIMATES):
SOCIAL NORMS VS. CONTROL

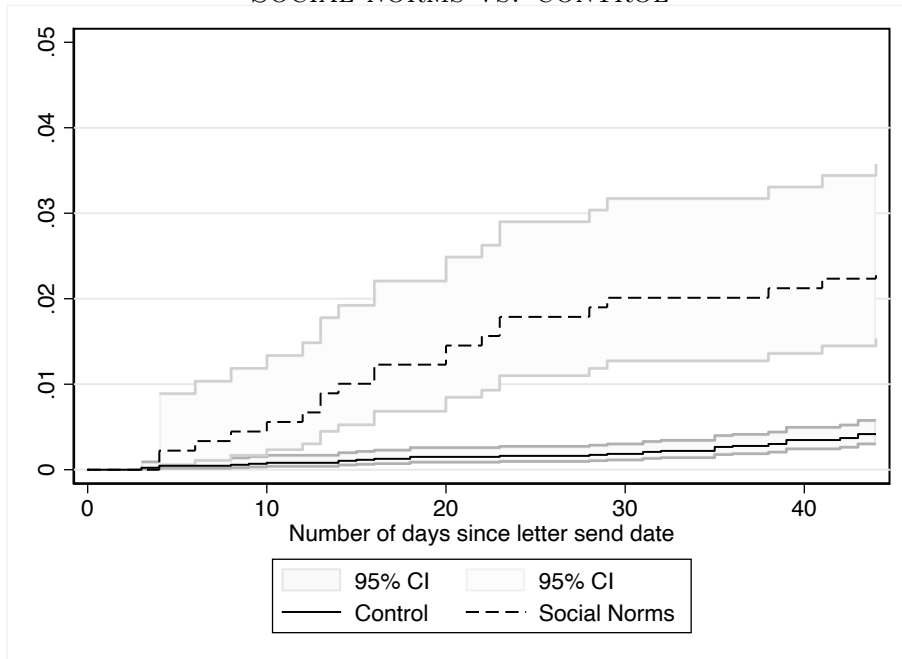


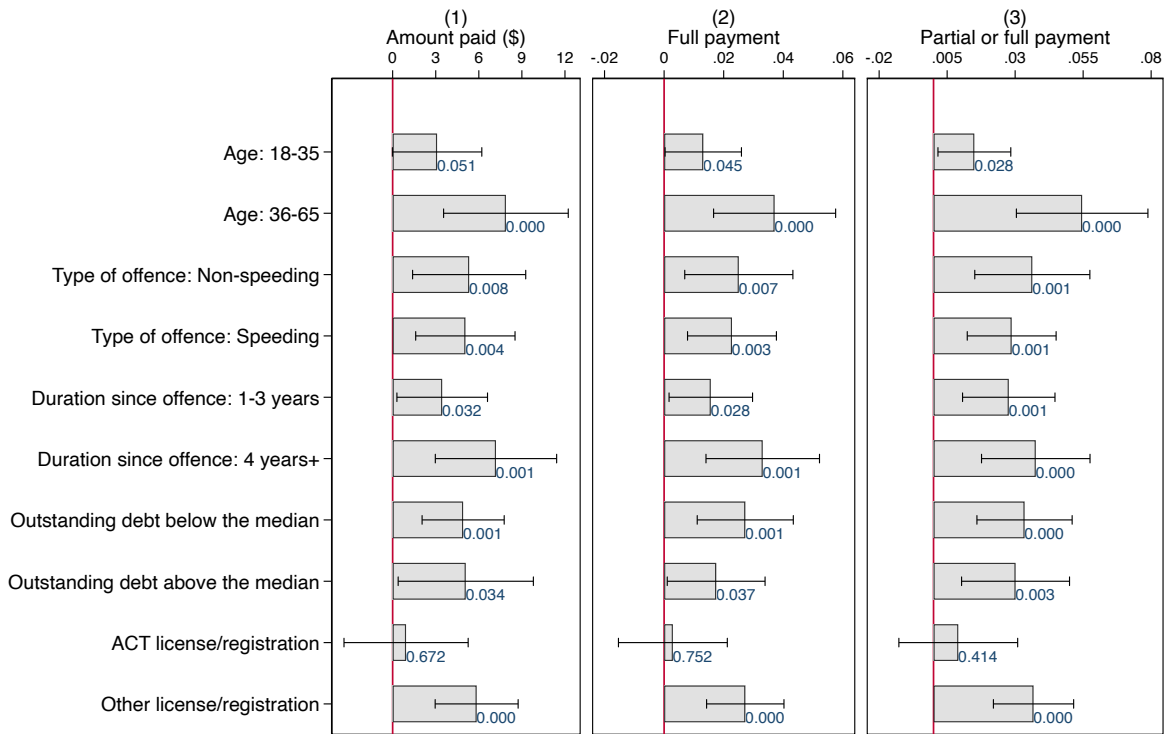
TABLE 3: TREATMENT EFFECTS ON FINE PAYMENT BY END OF TRIAL

	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).

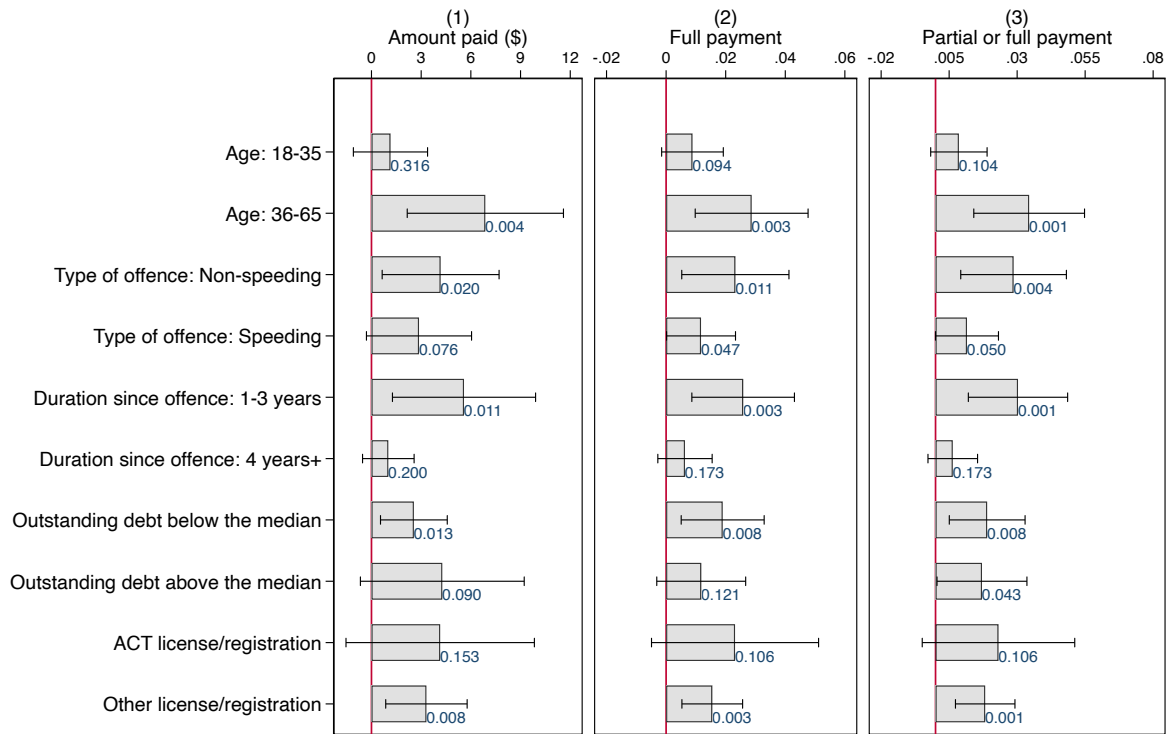
* $p < 0.05$, ** $p < 0.01$.

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).

References

- Allcott, H., “Social Norms and Energy Conservation,” *Journal of Public Economics*, 2011, 95 (5), 1982–2095.
- Allingham, M. G. and A. Sandmo, “Income Tax Evasion: A Theoretical Analysis,” *Journal of Public Economics*, 1972, 1 (3-4), 323–338.
- Alm, J. and B. Torgler, “Do Ethics Matter? Tax Compliance and Morality,” *Journal of Business Ethics*, 2011, 101, 635–651.
- , E. Kirchler, and S. Muehlbacher, “Combining Psychology and Economics in the Analysis of Compliance: From Enforcement to Cooperation,” *Economic Analysis and Policy*, 2012, 42 (2), 133–151.
- Andreoni, J., “Impure Altruism and Donations to Public Goods: A Theory of Warm-Glow Giving,” *Economic Journal*, 1990, 100 (401), 464–477.
- , B. Erard, and J. Feinstein, “Tax Compliance,” *Journal of Economic Literature*, 1998, 36 (2), 818–860.
- Antinyan, A. and Z. Asatryan, “Nudging for Tax Compliance: A Meta-Analysis,” CESifo Working Paper No. 8500, 2020.
- Ariely, D., *Predictably Irrational*, New York: Harper Collins, 2008.
- Ashby, J. S. and P. Webley, “‘But Everyone Else is Doing it’: A Closer Look at the Occupational Taxpaying Culture of One Business Sector,” *Journal of Community and Applied Social Psychology*, 2008, 18 (3), 194–210.
- Bazart, C. and A. Bonein, “Reciprocal Relationships in Tax Compliance Decisions,” *Journal of Economic Psychology*, 2014, 40, 83–102.
- Bell, B., R. Costa, and S. J. Machin, “Why Does Education Reduce Crime,” Technical Report, CEPR Discussion Paper No. DP13162, 2018.
- Besley, T., A. Jensen, and T. Persson, “Norms, Enforcement, and Tax Evasion,” Technical Report, NBER Working Paper No. 25575, 2019.
- Biddle, N. and L. Arcos-Holzinger, “Behavioural Insights of Tax Compliance: An Overview of Recent Conceptual and Empirical Approaches,” Technical Report, Tax and Transfer Policy Institute Working Paper No. 8/2016, 2016.
- Blumenthal, M., C. Christian, J. Slemrod, and M. G. Smith, “Do Normative Appeals Affect Tax Compliance? Evidence from a Controlled Experiment in Minnesota,” *National Tax Journal*, 2001, 54 (1), 125–138.
- Bobek, D. D., A. M. Hageman, and C. F. Kelliher, “Analyzing the Role of Social Norms in Tax Compliance Behavior,” *Journal of Business Ethics*, 2013, 115 (3), 451–468.

- **and R. C. Hatfield**, “An Investigation of the Theory of Planned Behavior and the Role of Moral Obligation in Tax Compliance,” *Behavioral Research in Accounting*, 2003, 15 (1), 13–38.
- Bott, K. M., A. W. Cappelen, E. O. Sørensen, and B. Tungodden**, “You’ve Got Mail: A Randomized Field Experiment on Tax Evasion,” *Management Science*, 2020, 66 (7), 2801–2819.
- Braithwaite, V.**, *Defiance in Taxation and Governance: Resisting and Dismissing Authority in a Democracy*, Edward Elgar Publishing, 2009.
- , **M. Smart, and M. Reinhart**, *Why Young People Are Less Compliant on Tax: Enduring or Transient Defiance?*, The Australian National University, Regulatory Institutions Network (RegNet), 2019.
- Chapman, B., A. Freiberg, J. Quiggin, and D. Tait**, “Using the Tax System to Collect Fines,” *Australian Journal of Public Administration*, 2004, 63 (3), 20–32.
- Cialdini, R. B.**, *Influence: Science and Practice*, Harper Collins, 2008.
- Coleman, S.**, “Income Tax Compliance: A Unique Experiment in Minnesota,” *Government Finance Review*, 1997, 13 (2), 11–16.
- Cowell, F. A. and J. P. F. Gordon**, “Unwillingness to Pay: Tax Evasion and Public Good Provision,” *Journal of Public Economics*, 1988, 36 (3), 305–321.
- Cranor, T., J. Goldin, T. Homonoff, and L. Moore**, “Communicating Tax Penalties to Delinquent Taxpayers: Evidence from a Field Experiment,” *National Tax Journal*, 2020, 73, 331–360.
- Czibor, E., D. Jimenez-Gomez, and J. A. List**, “The Dozen Things Experimental Economists Should Do (More of),” *Southern Economic Journal*, 2019, 86 (2), 371–432.
- DiNapoli, T. P.**, “Selected Aspects of Parking Violations Operations to Collect Fines and Fees,” Report, 2018.
- Du Plessis, S., B. Hartig, A. Jansen, and K. Siebrits**, “Improving Payment of Traffic Fines with Financial Incentives: Discounts vs. Penalties,” *Transportation Research Part F*, 2020, 74, 298–306.
- Dulleck, U., J. Fooker, C. Newton, A. Ristl, M. Schaffner, and B. Torgler**, “Tax Compliance and Psychic Costs: Behavioral Experimental Evidence Using a Physiological Marker,” *Journal of Public Economics*, 2016, 134, 9–18.
- Dusek, L., N. Pardo, and C. Traxler**, “Salience, Incentives, and Timely Compliance: Evidence from Speeding Tickets,” Technical Report, Discussion Papers of the Max Planck Institute for Research on Collective Goods 2020/9, 2020.

- Dwenger, N., H. Kleven, I. Rasul, and J. Rincke**, “Extrinsic and Intrinsic Motivations for Tax Compliance: Evidence from a Field Experiment in Germany,” *American Economic Journal: Economic Policy*, 2016, 8 (3), 203–232.
- Dyreng, S. D., J. L. Hoopes, and J. H. Wilde**, “Public Pressure and Corporate Tax Behavior,” *Journal of Accounting Research*, 2016, 54 (1), 147–186.
- Elster, J.**, “Social Norms and Economic Theory,” *Journal of Economic Perspectives*, 1989, 3, 99–117.
- Erard, B. and J. S. Feinstein**, “The Role of Moral Sentiments and Audit Perceptions in Tax Compliance,” *Public Finance*, 1994, 49, 70–89.
- Ericson, K. M.**, “On the Interaction of Memory and Procrastination: Implications for Reminders, Deadlines, and Empirical Estimation,” *Journal of the European Economic Association*, 2017, 15 (3), 692–719.
- Feld, L. P. and B. S. Frey**, “Tax Evasion and the Psychological Contract,” in James Alm, Jorge Martinez-Vazquez, and Benno Torgler, eds., *Developing Alternative Frameworks for Explaining Tax Compliance*, Abingdon, UK: Routledge, 2010, pp. 74–94.
- Fellner, G., R. Sausgruber, and C. Traxler**, “Testing Enforcement Strategies in the Field: Threat, Moral Appeal and Social Information,” *Journal of the European Economic Association*, 2013, 11 (3), 634–660.
- Frey, B. S. and B. Torgler**, “Tax Morale and Conditional Cooperation,” *Journal of Comparative Economics*, 2007, 35, 136–159.
- Gächter, S., H. Orzen, E. Renner, and C. Starmer**, “Are Experimental Economists Prone to Framing Effects? A Natural Field Experiment,” *Journal of Economic Behavior and Organization*, 2009, 70 (3), 443–446.
- Gangl, K., B. Torgler, E. Kirchler, and E. Hofmann**, “Effects of Supervision on Tax Compliance: Evidence from a Field Experiment in Austria,” *Economics Letters*, 2014, 123 (3), 378–382.
- Gillitzer, C. and M. Sinning**, “Nudging Businesses to Pay their Taxes: Does Timing Matter?,” *Journal of Economic Behavior and Organization*, 2020, 169, 284–300.
- Hallsworth, M.**, “The Use of Field Experiments to Increase Tax Compliance,” *Oxford Review of Economic Policy*, 2014, 30 (4), 658–679.
- , **J. A. List, R. D. Metcalfe, and I. Vlaev**, “The Behavioralist as Tax Collector: Using Natural Field Experiments to Enhance Tax Compliance,” *Journal of Public Economics*, 2017, 148, 14–31.
- Hansen, K.**, “Education and the Crime-Age Profile,” *The British Journal of Criminology*, 2003, 43 (1), 141–168.

- Hasseldine, J., P. Hite, S. James, and M. Toumi**, “Persuasive Communications: Tax Compliance Enforcement Strategies for Sole Proprietors,” *Contemporary Accounting Research*, 2007, *24* (1), 171–194.
- Haynes, C., D. P. Green, R. Gallagher, P. John, and D. J. Torgerson**, “Collection of Delinquent Fines: An Adaptive Randomized Trial to Assess the Effectiveness of Alternative Text Messages,” *Journal of Policy Analysis and Management*, 2013, *32* (4), 718–730.
- Iyer, G. S., P. M. J. Reckers, and D. L. Sanders**, “Increasing Tax Compliance in Washington State: A Field Experiment,” *National Tax Journal*, 2010, *63* (1), 7–32.
- Jansen, A.M., E. Giebels, T. J. L. van Rompay, and M. Junger**, “The Influence of the Presentation of Camera Surveillance on Cheating and Pro-Social Behavior,” *Frontiers in Psychology*, 2018, *9*, 1–12.
- Jones, D.**, “Inertia and Overwithholding: Explaining the Prevalence of Income Tax Refunds,” *American Economic Journal: Economic Policy*, 2012, *4* (1), 158–185.
- Kalbfleisch, J.D. and R.L. Prentice**, *The Statistical Analysis of Failure Time Data*, New York: John Wiley & Sons, 2002.
- Kaplan, Edward L and Paul Meier**, “Nonparametric Estimation from Incomplete Observations,” *Journal of the American Statistical Association*, 1958, *53* (282), 457–481.
- Kerr, J.**, “Tax Return Simplification: Risk Key Engagement, A Return to Risk?,” *eJournal of Tax Research*, 2012, *10* (2), 465–482.
- Kirchler, E., E. Hoelzl, and I. Wahl**, “Enforced Versus Voluntary Tax Compliance: The “Slippery Slope” Framework,” *Journal of Economic Psychology*, 2008, *29* (2), 210–225.
- Kleven, H. J., M. B. Knudsen, C. T. Kreiner, S. Pedersen, and E. Saez**, “Unwilling or Unable to Cheat? Evidence from a Tax Audit Experiment in Denmark,” *Econometrica*, 2011, *79* (3), 651–692.
- Levin, I. P., S. L. Schneider, and G. J. Gaeth**, “All Frames are Not Created Equal: A Typology and Critical Analysis of Framing Effects,” *Organizational Behavior and Human Decision Processes*, 1998, *76* (2), 149–188.
- Luttmer, E. F. P. and M. Singhal**, “Tax Morale,” *Journal of Economics Perspectives*, 2014, *28* (4), 149–168.
- Maciejovsky, B., E. Kirchler, and H. Schwarzenberger**, “Misperception of Chance and Loss Repair: On the Dynamics of Tax Compliance,” *Journal of Economic Psychology*, 2007, *28* (6), 678–691.

- Mascagni, Giulia**, “From the Lab to the Field: A Review of Tax Experiments,” *Journal of Economic Surveys*, 2018, 32 (2), 273–301.
- Mendoza, J. P., J. Wielhouwer, and E. Kirchler**, “The Backfiring Effect of Auditing on Tax Compliance,” *Journal of Economic Psychology*, 2017, 62, 284–294.
- Myles, G. D. and R. A. Naylor**, “A Model of Tax Evasion with Group Conformity,” *European Journal of Political Economy*, 1996, 12, 49–66.
- O’Donoghue, T. and M. Rabin**, “Doing it Now or Later,” *American Economic Review*, 1999, 89 (1), 103–124.
- Pagano, Michael A. and Christopher W. Hoene**, “City Budgets in an Era of Increased Uncertainty – Understanding the Fiscal Policy Space of Cities,” Technical Report, Brookings Metropolitan Policy Program Report, 2018.
- Rahayu, Y. N., M. Setiawan, E. A. Troena, and Sudjatno**, “The Role of Taxpayer Awareness, Tax Regulation and Understanding in Taxpayer Compliance,” *Journal of Accounting and Taxation*, 2017, 9 (10), 139–146.
- Reckers, P. M. J., D. L. Sanders, and S. L. Roark**, “The Influence of Ethical Attitudes on Taxpayer Compliance,” *National Tax Journal*, 1994, 47 (4), 825–836.
- Saunders, B., A. Eriksson, G. Lansdell, and M. Brown**, “An Examination of the Impact of Unpaid Infringement Notices on Disadvantaged Groups and the Criminal Justice System – Towards a Best Practice Model,” Technical Report, Criminal Justice Research Consortium Final Report, 2013.
- Scott, P. J. and C. Lizieri**, “Consumer House Price Judgments: New Evidence on Anchoring and Arbitrary Coherence,” *Journal of Property Research*, 2012, 29 (1), 49–68.
- Siennick, S. and D. Osgood**, “A Review of Research on the Impact on Crime of Transitions to Adult Roles,” in A. M. Liberman, ed., *The Long View of Crime: A Synthesis of Longitudinal Research*, New York: Springer, 2008, pp. 161–190.
- Slemrod, J.**, “Tax Compliance and Enforcement,” *Journal of Economic Literature*, 2019, 57 (4), 904–954.
- , **M. Blumenthal, and C. Christian**, “Taxpayer Response to an Increased Probability of Audit: Evidence from a Controlled Experiment in Minnesota,” *Journal of Public Economics*, 2001, 79 (3), 455–483.
- Stringer, S. M.**, “City of New York Comprehensive Annual Financial Report for the Fiscal Year Ended June 30, 2018,” Report, 2018.
- Sullivan, C. J.**, “Change in Offending Across the Life Course,” in Francis T. Cullen and Pamela Wilcox, eds., *The Oxford Handbook of Criminological Theory*, Oxford: Oxford University Press, 2012.

- Thaler, R. and C. Sunstein**, *Nudge: Improving Decisions about Health, Wealth and Happiness*, New Haven: Yale University Press, 2008.
- Torgler, B.**, “An Alternative Tax Policy Strategy? Evidence from a Controlled Field Experiment in Switzerland,” *Economics of Governance*, 2004, 5 (3), 235–253.
- , *Tax Compliance and Tax Morale – A Theoretical and Empirical Analysis*, Cheltenham, UK: Edward Elgar, 2007.
- Traxler, C.**, “Social Norms and Conditional Cooperative Taxpayers,” *European Journal of Political Economy*, 2010, 26 (1), 89–103.
- Tyler, T. R.**, *Why People Obey the Law*, Princeton and Oxford: Princeton University Press, 2006.
- Wali, B., A. Anwaar, S. Iqbal, and A. Hussain**, “Effectiveness of Enforcement Levels of Speed Limit and Drink Driving Laws and Associated Factors – Exploratory Empirical Analysis Using a Bivariate Ordered Probit Model,” *Journal of Traffic and Transportation Engineering*, 2017, 4 (3), 272–279.
- Wansink, B., R. J. Kent, and S. J. Hoch**, “An Anchoring and Adjustment Model of Purchase Quantity Decisions,” *Journal of Marketing Research*, 1998, 35 (1), 71–81.
- Wenzel, M.**, “An Analysis of Norm Processes in Tax Compliance,” *Journal of Economic Psychology*, 2004, 25 (2), 213–218.
- , “Misperception of Social Norms about Tax Compliance: From Theory to Intervention,” *Journal of Economic Psychology*, 2005, 26 (6), 862–883.
- **and N. Taylor**, “An Experimental Evaluation of Tax-Reporting Schedules: A Case of Evidence-Based Tax Administration,” *Journal of Public Economics*, 2004, 88 (12), 2785–2799.
- Wenzel, Michael**, “A Letter from the Tax Office: Compliance Effects of Informational and Interpersonal Justice,” *Social Justice Research*, 2006, 19 (3), 345–364.
- Yitzhaki, S.**, “Income Tax Evasion: A Theoretical Analysis,” *Journal of Public Economics*, 1974, 3 (2), 201–202.