Salience and Timely Compliance: Evidence from Speeding Tickets *

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Abstract

This paper studies the enforcement of fines, in particular, the effects of simplification and salience nudges on timely payments. In a randomized controlled trial, we add cover letters to 80,000 payment notifications for speeding. The letters increase the salience of the payment deadline, the late penalty, or both. Emphasizing only the deadline is not effective. Stressing the late penalty significantly and persistently increases payment rates. The effect is largest if both parameters are made salient. The most effective treatment yields a net revenue gain that covers approximately 25% of the labor costs of the ticket administration personnel. A survey experiment documents how the salience nudges alter prior (mis)perceptions about the communicated parameters. The survey results rationalize the differential effects of the treatments and, together with the evidence from the RCT, offer a broader framework for explaining why certain nudges are effective in some contexts but fail in others.

JEL Classification: K42, H26, D80.

Keywords: Enforcement; fines; timely compliance; salience; nudges; deadlines; RCT.

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1 Introduction

Numerous public sector entities face challenges in enforcing the payment of fines, service fees, or public utility bills. While a significant strand of research focuses on tax enforcement (Slemrod, 2019), the enforcement of non-tax payments remains understudied. This is particularly striking when it comes to fines, which are increasingly ever more prevalent and gain in budgetary significance for many jurisdictions (Piehl and Williams, 2010). Lofstrom and Raphael (2016) estimate that U.S. local, county, and state governments collected $15.3 billion in fine and forfeiture revenue in 2012. Makowsky (2019) notes that traffic tickets make up for more than 7% of Chicago's total revenues.

Yet, enforcing fines is very costly, as they typically involve many individuals paying, on average, relatively small amounts. The city of Berlin, for instance, issued 4.2 million traffic tickets with an average fine of slightly more than €25 per ticket in 2018; 75% were paid on time. Similar payment rates are reported for, e.g., Chicago (67%) and New South Wales (70%).[1] In NYC, only 60% of parking tickets are paid upon the first notice (Heffetz *et al.*, 2021). Failure to meet the payment deadline implies sizable administrative costs related to additional enforcement actions (follow-up notifications, court hearings, etc.; Menendez *et al.*, 2019). These follow-up enforcement measures, in turn, translate into massive costs for individuals (e.g., escalating penalties, court costs, driving license suspensions). The latter disproportionately fall on low-income households, who are typically less likely to pay the initial fine on time (Harris *et al.*, 2010; Kessler, 2020; Mello, 2021). Achieving higher rates of timely payments would thus reduce administrative as well as private costs and could mitigate the distributional harm caused by unpaid fines.

One approach to increase the rate of timely payments are nudges and behavioral science interventions more broadly. Such interventions have been widely studied in tax compliance (Pomeranz and Vila-Belda, 2019) and, more rarely, in other enforcement domains (e.g. Linos *et al.*, 2020; Szabó and Ujhelyi, 2015). While some of these studies delivered promising results, there is a growing body of evidence documenting 'nudges that fail' (Sunstein, 2017). In fact, a recent meta-study of tax compliance trials finds that tax morale nudges are, on average, ineffective (Antinyan and Asatryan, 2019).[2] Luttmer and Singhal (2014) stress that we lack a coherent understanding of why such nudges increase compliance in some contexts but fail in others.

The present paper studies behavioral interventions that aim at increasing timely payment of fines. In doing so, we also want to explain why our interventions are (or are not) effective. In a randomized control trial (RCT), we first study the impact of different salience nudges on timely compliance with payment notifications for speeding. The RCT covers the universe of speeding tickets processed by an enforcement authority in the suburbs of Prague, Czech Republic. Any driver caught speeding by an automated speed camera system receives a notification demanding the payment of a fine (between approximately $40 and $80) by a given deadline (within 15 days). Delayed or incomplete payments trigger additional enforcement measures that are costly for the ticketed individuals (in terms of late penalties) and the authority alike (administrative costs).

[1] These numbers were obtained from: Statistical Yearbook of Berlin (2019), Woodstock Institute (2018, p.8) and Jochelson (1995, p.3), respectively.

[2] The authors further report that deterrence messages are, on average, effective but yield small effects. More generally, DellaVigna and Linos (2020) show that large-scale trials of US' nudge units find smaller effects than published, academic studies.

Similar to other domains where official payment notifications are regulated by numerous legal constraints, the notification used by the authority is a formalistic legal text. Two important parameters, the payment deadline and the penalty for late payments, are hidden or only vaguely mentioned in the lengthy text. To ease processing of the complex text and to increase the salience of the two parameters, we simplified the presented information by adding a one-page cover letter. We randomly added three different letters that emphasized the payment deadline, the late penalty for missing it, or both attributes. The control group received only the basic notification. The pre-registered trial (see Dusek *et al.*, 2017) was conducted between 2017 and 2019 and encompassed nearly 80,000 speeding tickets.

The results from the RCT show, firstly, that increasing the salience of the deadline alone has no significant effect on the rate of timely payments. Secondly, emphasizing the late penalty produces a 1pp (percentage point) increase in payment compliance. Relative to the control group (78%), this corresponds to a 1.2% higher rate of timely payments. The third cover letter, which increases the salience of the deadline and the late penalty, raises compliance by 2pp or 2.6%. The effect is significantly larger than the one from solely stressing the late penalty. Moreover, the effect is persistent over time. This is remarkable, as the authority takes additional enforcement measures which target non-compliant speeders once the payment deadline has passed. Hence, the treatment effects shrink over time. As compared the control group, our most effective cover letter nonetheless yields a 1.6pp (or 2%) higher payment rate even 100 days after the initial notification was delivered. Despite a seemingly small effect size, a cost-benefit analysis shows that adding this cover letter is a highly cost-effective policy instrument.

Next we try to understand why increasing the salience of the deadline yields different results than emphasizing the late penalty. To approach this question, we first model the response to a notification where the payment deadline and the costs of missing it are not fully salient. By making these parameters salient, our treatments alter agents' prior (mis)perceptions and, in turn, influence payment behavior. The predicted treatment effects depend on the initial distribution of the priors and the direction in which the salience nudges alter them. Perceiving a higher late penalty or a tighter deadline would increase timely compliance. The results from the RCT suggest that the deadline treatment failed to shift priors in the 'right' direction, whereas the penalty treatments did increase the perceived costs of non-compliance.

To test these interpretations empirically, we quantify the distribution of and the treatments' impact on prior perceptions in a survey experiment. The survey exposed respondents to the payment notification and, randomly, to one of the cover letters from the RCT. The results confirm our model-based interpretation. Most subjects in the control group underestimate the penalty for missing the deadline. Emphasizing the late penalty corrects these misperceptions and, in turn, strengthens the incentive to pay on time. At the same time, most subjects anticipate the correct deadline; among respondents with misperceptions, a similar shares under- and overestimate the deadline length. Making the actual deadline salient thus has limited and opposing effects on perceptions which, in terms of behavioral consequences, cancel each other. The evidence thus offers a coherent explanation for the different results from our trial and provides an insight into the underlying mechanisms behind the (in)effectiveness of the different salience nudges.

2 Related Literature and Contributions

Our study contributes to the literature on behaviorally informed law enforcement policies. We document that providing simplified, salient information about late penalties has persistently positive effects on payment rates. The result, which complements recent evidence on the value of salience for reducing failure to appear for court (Fishbane *et al.*, 2020), mirrors similar findings on the enforcement of taxes (Pomeranz and Vila-Belda, 2019; Slemrod, 2019), housing codes (Linos *et al.*, 2020) or waste collection regulations (Dur and Vollaard, 2019). Our results indicate that the impact of a deterrence nudge can be amplified by jointly making the payment deadline and the consequences of missing it more salient. This might constitute an attractive and cost-effective strategy to increase timely payments in other domains.

The latter observation also contributes to the emerging research evaluating nudges in fine enforcement. Haynes *et al.* (2013) and Sinning and Zhang (2021), who focus on selected samples of individuals with unpaid fines, both document positive effects of deterrent text messages or letters. A closely related paper examines the effect of reminder letters on the payment of parking tickets: Heffetz *et al.* (2021) find larger short-term but no long-term effects on payment compliance. This difference to our persistent effects might reflect differences in the information content and the target samples: our cover letters provided clarifying information and were sent to all ticketed violators; Heffetz et al.'s letters were sent after the initial ticket, as reminders for non-responsive individuals. We thus differ from all these studies by explicitly targeting timely, pre-deadline payments rather than the ex-post collection of fines and late fees among the non-compliant population.

Together with Heffetz *et al.* (2021), our study is among the few that explicitly examine deadlines in an enforcement context. Given that deadlines are central parameters of payment notifications and many administrative processes (including tax filing, see Rees-Jones and Taubinsky, 2016; Slemrod *et al.*, 1997), the role of deadlines in timely compliance has received surprisingly little attention. The results from our RCT indicate that highlighting a deadline is not necessarily effective. The survey evidence offers an explanation: in our setting, most individuals correctly anticipated the 15- day deadline. This might also explain the difference to De Neve *et al.* (2021), who find a positive tax compliance effect of simplified reminder messages with deadlines.[3] In a context where most people overestimate the deadline length, emphasizing a short deadline may indeed be effective.

The observation that the impact of salience nudges hinges on the context-specific distribution of prior expectations in a given population (and a nudge's impact on these priors) offers a general framework for thinking about why certain interventions – such as social norm nudges – yield decidedly mixed results (Luttmer and Singhal, 2014): depending on the distribution of priors, a given message (such as "90% pay their taxes on time") might either increase or decrease priors (e.g., about others' compliance behavior). In turn, the nudge could either strengthen or weaken the incentives for timely compliance. Contextual differences in the distribution of priors can therefore explain why a given message might work in some settings (e.g. Bott *et al.*, 2020; Hallsworth *et al.*,

[3]The setting in De Neve *et al.* (2021), who study tax compliance among late-filers in Belgium, differs from ours in numerous ways. In addition to context, sample and outcome, we *add* a cover letter to a convoluted payment notification whereas De Neve et al. *replace* a reminder (that communicated many different deadlines) with a simple message: 'submit your return within 14 days'.

2017) but fail to increase compliance in others (e.g. Castro and Scartascini, 2015; Fellner *et al.*, 2013).[4]

3 Institutional Background

We study the payment of speeding tickets issued by a local authority in Ricany, Czech Republic. The town serves as the administrative center for a larger suburban area south-east of Prague. The authority manages 29 speed camera systems, out of which 24 were installed during the second half of 2018. The fully automated camera systems, which cover road sections with speed limits of 50km/h (26 cameras) and 40km/h (3 cameras), measure each vehicle's average speed in zones of several hundred meters. The enforcement authority then automatically processes the data on cars found to be speeding above a given cutoff.[5]

As in many other settings (Traxler *et al.*, 2018), the fines for speeding are stepwise increasing in speed. A ride recorded at less than 20km/h above the speed limit (but above a certain enforcement cutoff) is handled as a minor speeding offense. During our sample period, minor speeding was punished by fines ranging between 500 and 900 CZK (approx. $25–40 or up to 3% of the average monthly wage). Speeding at between 20 and 40km/h above the limit, which is classified as intermediate speeding offense, was subject to fines between 1,100 and 1,900 CZK (approx. $50–87).[6] Speeding at more than 40km/h above the limit triggers a very different enforcement procedure (and higher penalties). Such speeding offenses (which are very rarely observed) are not covered in our analysis.

Authorities send payment notifications – officially titled 'summons to pay a prescribed amount' (subsequently called 'speeding tickets') – to the registered address of the vehicle's owner either by regular mail or by e-mail.[7] If the owner pays the stipulated fine within 15 days of receiving the notification, the case is closed. If the full fine is not paid by the deadline, the authority initiates a trial-like process. This typically begins 1–2 months after the initial notification and triggers further legal notifications, (e-)mails and phone calls. The car owner may be found liable for a violation committed with his car, raising the total payment due (the initial fine plus a late fee) to 1,500–2,500 CZK ($70–115) for minor speeding and to 2,500–5,000 CZK ($115–230) for intermediate offenses. Within these ranges, the authority has full discretion in determining the exact payment. The car owner may also be identified as the driver and could then, in addition, be punished by demerit points.

A key feature of the institutional set-up – which is also observed in other enforcement contexts (e.g. De Neve *et al.*, 2021; Fishbane *et al.*, 2020) – is the poor communication of key parameters

[4]Evidence supporting this argument is provided by Fellner *et al.* (2009). They report that priors and heterogenous treatment effects are correlated with local compliance rates. Their social norm message has a positive [negative] effect when local compliance is low [high], yielding a null result on average.

[5]Cameras placed at the entry and at the exit points of a road section record cars' number plates together with a precise time stamp. Using the travel time between the entry and exit points, the average speed is computed. Emergency vehicles like ambulances and police cars are later excluded from the automated enforcement process. Beyond this exemption and unlike in other studies (see, e.g., Makowsky and Stratmann, 2009), there is no scope for discretion by police officers. See Appendix B and Dusek and Traxler (2021) for further institutional details.

[6]The variation in the fines is discussed in Appendix B. An earlier version of this manuscript included an RDD that exploited the discontinuities in fines (Dusek *et al.*, 2020).

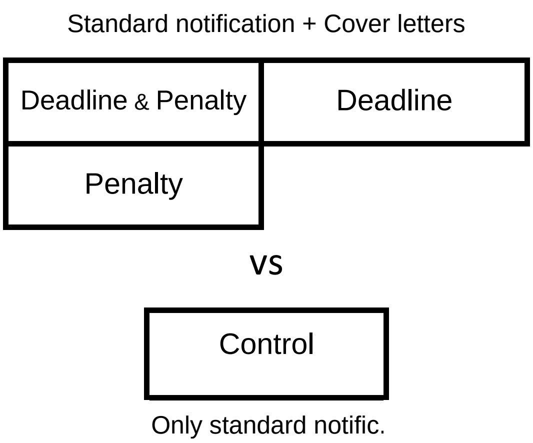
[7]The electronic mail is sent through an official e-governance platform called 'databox'. Almost all companies and some private individuals make use of this service.

in the payment notification. The text is highly convoluted and formalistic, full of legal terms and relatively lengthy (691 words, see Appendix C.2). It contains numerous legal extracts and information about the exact time, date and location of the traffic violation. The payment deadline is poorly communicated and, in particular, the consequences of missing the deadline are not properly explained; the text only states the vague phrase "*the office will continue investigating the offense*". Knowledge of administrative law is needed to properly understand that non-compliance implies that the authority will initiate the trial-like process, governed by a different legal procedure, with various possible outcomes. Despite being explicitly stated, the salience of the payment deadline might be compromised, too, by the plethora of legal formalities in the text. The interventions from our RCT try to raise the salience of the payment deadline and the late penalty.

4 Randomized Controlled Trial

Given the formalistic nature of the payment notification, behavioral science insights suggest that simplification of the communication might be a promising strategy to increase timely compliance.[8] We therefore test whether the timely payment of fines can be increased by simplifying communication and raising the salience of relevant parameters of the enforcement regime. In cooperation with the enforcement authority, we randomly assigned speeding offenders to four different groups. The *control* (C) group received only the standard notification without any cover letter. Three treatment groups received a cover letter on top of the notification. These cover letters were brief and simple: depending on the treatment, they contained between 44 and 74 words (in contrast to the 691 words in the standard notification) to convey the main information. The treatments aimed at increasing the salience of the payment deadline, the consequences of missing it, or both.

Figure 1: Experimental design



Each cover letter briefly informed the recipient that she is summoned to pay a fine for speeding. The *Deadline* (D) treatment asked to "*Please pay the amount in full … **within 15 days** after receiving this summons.*" The *Penalty* (P) treatment emphasized the consequences of non-compliance: "*If you do not pay the whole amount the office will continue investigating the*

[8] To quote from the 'Make it Easy' advice in the UK Behavioral Insights Team's EAST framework: "Simplify messages. Making the message clear often results in a significant increase in response rates to communications" (Service *et al.*, 2014, p.4). See, among many others, also Sunstein (2013).

offense. The amount that you will potentially have to pay ***may be as high as 2,500 CZK***".[9] The *Deadline & Penalty* (*D&P*) treatment combined both of these two texts.

Our experimental design, which is summarized in Figure 1, can be interpreted as an incomplete 2×2 factorial design. As the authority refused to send out 'plain' cover letters (that would neither emphasize the penalty nor the deadline), there is no treatment cell with such a letter. The comparison of outcomes between the control and treatment groups will thus capture the joint effect of simplification and increasing the salience of the late penalty, the deadline, or both.[10]

4.1 Predictions

How will our interventions affect payment decisions? To answer this question, let us briefly discuss the underlying choice problem.[11] After receiving a payment notification that stipulates a fine f, a speeder might either pay now – bearing some opportunity costs – or postpone the decision to the next day. Postponing the payment beyond a deadline T implies that the payment obligation raises to $f + K$, where $K > 0$ captures the expected late penalty (late fee plus the costs of potential demerit points). Given these parameters, a rational individual would only pay the fine as long as the opportunity costs are below a certain cutoff. This cutoff is shaped by the option value of postponing the payment or, more intuitively, the opportunity to 'wait and see'. The latter option is constrained by the deadline. The closer the deadline, the higher is the pressure to pay.[12]

As noted above, the legal notification is unclear on the late penalty K. The exact payment deadline T might get lost in the long text, too. Speeders might therefore hold misperceptions of these two parameters – a presumption, which is empirically examined in Section 6. We expect our treatments to alter these (mis-)perceptions. The P and $D\&P$ treatments should affect perceptions regarding the late penalty. Analogously, the D and $D\&P$ treatments should impact the perceived length of the deadline. Changing these perceptions, in turn, should influence the decision if and when to pay. One can formally derive the following predictions (see Appendix D):

1. Treatments P and $D\&P$ will increase [decrease] the rate of timely payments if the cover letters increase [decrease] the perceived late penalty.
2. Treatments D and $D\&P$ will increase the rate of timely payments if the cover letters decrease the perceived length of the deadline.

The intuition for the first prediction follows a simple deterrence logic: if the treatments make speeders find out that the late penalty is larger than otherwise expected, this increases the perceived pressure to pay before the deadline (and, vice verse, lowers it for individuals who would have expected larger late penalty). The intuition behind the second prediction relates to the fact that a tighter deadline reduces the scope for postponing the payment (i.e., it lowers the

[9] Bold font was also used in the actual cover letter (see Appendix C for the full text). For intermediate speeding offenses (with speeds of 20–40km/h above the limit), the latter part would read "...as high as 5,000 CZK".

[10] De Neve *et al.* (2021) isolate 'pure' simplification effects. While these authors replace letters from tax authorities with more simple ones, the legal framework of our context prevented us from replacing the standard notification.

[11] A formal exposition of the framework, which follows Altmann *et al.* (2017), is provided in Appendix D.

[12] More technically speaking: the closer the deadline, the lower the option value. Right on the day of the deadline it becomes quite costly not to pay (as $K > 0$). From the perspective of a rational speeder it might thus become optimal to pay, even for relatively high opportunity costs.

option value of not paying today). As long as the D and the $D\&P$ treatment makes speeders realize that the deadline length is shorter than otherwise expected, this raises the pressure to pay. Hence, timely compliance should increase. The case of an underestimation of the deadline is theoretically more complex and the outcomes are ambiguous.[13]

Our predictions highlight that the treatments' impact crucially depend on the distribution of prior (mis)perceptions as well as the direction in which the salience nudges alter these perceptions. We could, for instance, observe null results for a treatment because (i) it failed to alter priors, (ii) prior expectations were already fully in line with the communicated information, or (iii) there are roughly equal-sized groups of speeders who over- and under-estimate a parameter. (In the latter case, our interventions would produce heterogenous effects that offset each other.) After examining the results from the RCT, Section 6 empirically examines these different interpretations.

4.2 Sample and Implementation

Between November 2017 and August 2019 we randomly assigned N = 78,882 speeding tickets to one of our four treatments. During the expansion of the camera system in the second half of 2018, there was a glitch. Due to a programming error, speeding offenses recorded between August and November 2018 were randomized among only three treatments (C, D, and P), with no single observation for the $D\&P$ treatment. After correction, tickets were again randomly assigned to all four treatments. To re-balance the number of observations per treatment, we over-proportionally allocated cases to the $D\&P$-treatment for several months.[14]

For each speeding violation we observe, among other characteristics, the date and time of the speeding offense, the vehicle's speed, the level of the fine, the date the ticket was sent and received and the date when the fine was eventually paid. The average speed of ticketed offenses is nearly 65km/h (15km/h above the limit). After being sent, it takes about 5 days for an average ticket to be received by the car owner. Around 45% of offenses are committed by company-owned vehicles, which means that the tickets are sent (typically electronically) to the company the car is registered to. The rest are privately owned vehicles. It is important to note that the bulk of our observations come from low severity offenses. Only 6% of offenses are of medium severity. Finally, note that around 10% of cars received two (or more) speeding tickets during our sample period. We independently randomized each offense, such that the treatment sequences are random, too.

As a consequence of the implementation issues mentioned above, our treatments are not fully balanced over time and space (between speed cameras). The latter point is also reflected in Table 1. In the $D\&P$-treatment, fewer observations are from the initial five speed cameras. F-tests indicate several additional imbalances. This is due to the average characteristics of the offenses observed during the time period when the $D\&P$ treatment was over-weighted in the randomization (see above). During this time period, the speed cameras recorded slightly more company cars (who also

[13] In addition to our two main predictions, there is also scope for an interaction effect: the effect of the $D\&P$ treatment on payment rates might be larger than the sum of the effects from the D- and the P-treatment, whenever both treatments work into the same direction. If drivers underestimate the late-pay penalty and overestimate the deadline length, we could, in principle, observe a positive interaction. Appendix D provides a more detailed, formal discussion of these predictions.

[14] Specifically, the probabilities of assigning an offense to the C, D, P and the $D\&P$ treatment were set at 20, 15, 15, and 50%, respectively. These proportions were maintained until May 2019. Between May and August 2019, we reverted to equal assignment probabilities of 25% per treatment.

Table 1: RCT – Summary statistics and balancing tests

	Full Sample	Control	Deadline	Penalty	Deadl& Penalty	F-Test[(a)]	F-Test[(b)]
Initial Cameras	0.230	0.231	0.241	0.242	0.208	0.000	—
	(0.421)	(0.422)	(0.428)	(0.428)	(0.406)		
Speed (km/h)	64.53	64.52	64.49	64.59	64.54	0.342	0.973
	(5.115)	(5.230)	(5.252)	(5.170)	(4.808)		
Fine (CZK)	836.3	836.6	837.0	837.3	834.5	0.653	0.152
	(245.4)	(248.3)	(246.0)	(246.7)	(240.7)		
Low Severity Offense	0.940	0.937	0.939	0.937	0.946	0.000	0.816
	(0.238)	(0.243)	(0.240)	(0.243)	(0.226)		
Number Plate: Prague	0.482	0.482	0.480	0.487	0.478	0.351	0.575
	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)		
Number Plate: Central Bohemia	0.271	0.272	0.268	0.268	0.274	0.439	0.648
	(0.444)	(0.445)	(0.443)	(0.443)	(0.446)		
Company Car	0.458	0.449	0.454	0.461	0.467	0.002	0.074
	(0.498)	(0.497)	(0.498)	(0.498)	(0.499)		
Sent Electronically	0.400	0.392	0.398	0.401	0.409	0.004	0.137
	(0.490)	(0.488)	(0.489)	(0.490)	(0.492)		
Weekend	0.377	0.377	0.375	0.377	0.379	0.899	0.988
	(0.485)	(0.485)	(0.484)	(0.485)	(0.485)		
Sent-Received (days)	5.040	5.067	5.030	4.989	5.070	0.596	0.663
	(6.662)	(6.790)	(6.139)	(6.696)	(6.960)		
Number of tickets	78,882	20,399	19,025	19,012	20,446		
Number of cars	72,502	18,720	17,571	17,562	18,649		

Notes: Sample mean (with standard errors in parentheses) by treatment. The last two columns present the p-values from F-Tests of treatment balance: in (a) we run linear regressions with $x_i = \beta_0 + \beta_1 \mathrm{D}_i + \beta_2 \mathrm{P}_i + \beta_3 \mathrm{D\&P}_i + \varepsilon_i$ and then test the H0: $\beta_1 = \beta_2 = \beta_3 = 0$. In (b) we augment the regressions by including sending-week and speed camera fixed effects.

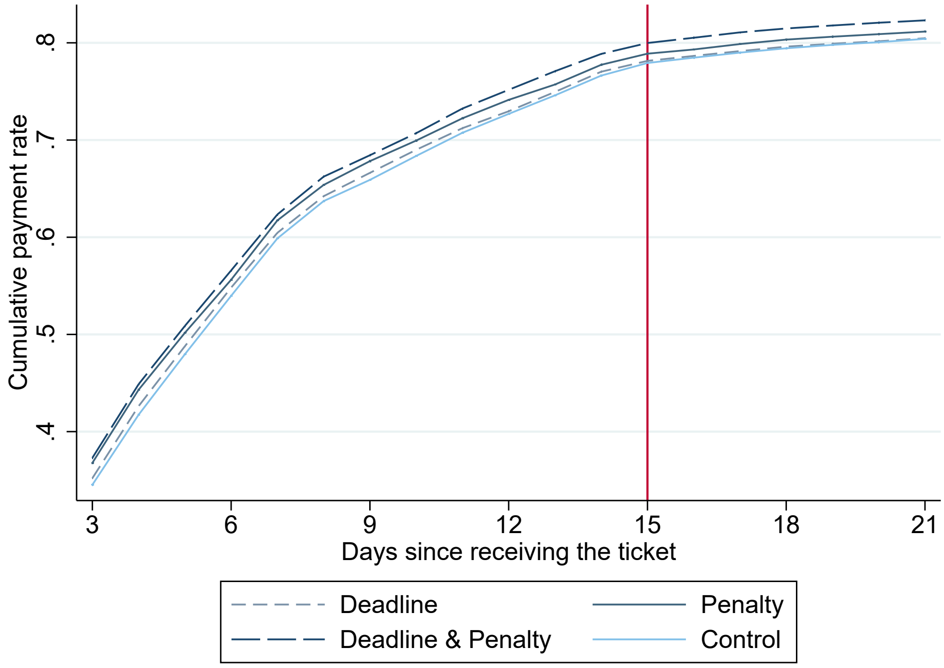
receive their tickets electronically) and more low-severity offenses. However, the imbalances vanish once we condition on time and space: after including sending-week and speed camera fixed effects, the second set of F-tests reported in the last column of Table 1 looks much more reassuring. Our estimations below account for the imperfect randomization by including not only a large vector of observable characteristics but also a full set of sending-week and speed camera dummies. We will see that the imbalances do not seem to influence any of our results.

5 Main Results

Figure 2 presents the cumulative payment rate across treatment conditions over the first 21 days after receiving the notification.[15] The figure reveals small but systematic treatment differences. The payment rates in treatment D are hardly distinguishable from those observed in the control group. By the 15- day deadline, 77.9% have paid the full amount in the control group. Treatment D increases this rate by a mere 0.2pp. Treatments P and $D\&P$, in contrast, produce a visibly positive effect: after just 3 days, payment rates are 2pp higher than in the control group. During days 6–15, the $D\&P$-treatment effect remains at this level but the P treatment effect shrinks. Within the 15- day period, the two treatments induce a 2.0pp (+2.6%) and 0.9pp (+1.2%) higher payment rate, respectively.

[15] Appendix Figure A.1 covers responses between days 5 – 100. The time axis of Figure 2 starts at day 3, which allows displaying responses rates in the range between 40–80%. This facilitates the visualisation of treatment differences. Moreover, fluctuation of cumulative responses during the first days are somewhat more noisy.

Figure 2: RCT – Cumulative response rates by treatment



Notes: The figure illustrates, for each treatment, the cumulative payment rates (full amount) during the first 21 days after receiving the notification. The payment deadline (15 days) is indicated by the red vertical line.

Next we estimate the treatment effects on the probability of paying within different time periods. We run linear probability model (LPM) estimates of the equation

$$\text{Pay}_{i,\tau} = \beta_{0,\tau} + \beta_{1,\tau}\text{Deadline}_i + \beta_{2,\tau}\text{Penalty}_i + \beta_{3,\tau}\text{Deadline\&Penalty}_i + X_i\gamma_\tau + \varepsilon_{i,\tau}, \tag{1}$$

where $\text{Pay}_{i,\tau}$ is a dummy indicating whether the payment was made in full within $\tau = \{7,\ 15,\ 30,\ 100\}$ days after receiving the notification. The treatment effects on the outcome variables are captured by the β-coefficients. We control for X_i, a vector of car and offense characteristics, which, as discussed above, includes sending-week and speed camera zone fixed effects.

The estimates from Table 2 confirm the descriptive evidence from above. The D treatment has a positive but imprecisely estimated effect on payments during the first 7 days. The treatment's effect on the rate of pre-deadline payments is statistically insignificant. Column (4) documents a point estimate of +0.27pp (with an upper bound of the 95%-confidence interval of 1.0pp). The penalty treatment P raises the rate of pre-deadline payments by around 1pp and the interacted $D\&P$-treatment by 2pp. F-tests indicate that both effects are significantly larger than the effect from the D-treatment.

These results are consistent with the predictions from Section 4.1 for the case where (i) the P and the $D\&P$ treatment correct priors that tend to underestimate (rather than overestimate) the late penalty. The insignificant effect of the D treatment is more difficult to interpret. As discussed above, the intervention could be ineffective if most drivers correctly perceive the deadline length; hence, there would be little scope for the treatment to alter perception. Alternatively, the treatment could have produced offsetting effects in different subgroups (with priors that over- and

Table 2: RCT – Treatment effects on payments (LPM estimates)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Pay-7days		**Pay-15days**		Pay-30days		Pay-100days	
Deadline (β_1)	0.58	0.63	0.22	0.27	0.02	0.12	0.00	0.12
	(0.49)	(0.48)	(0.41)	(0.39)	(0.38)	(0.36)	(0.37)	(0.35)
Penalty (β_2)	1.85***	1.87***	0.96**	0.93**	0.71*	0.73**	0.50	0.54
	(0.49)	(0.48)	(0.42)	(0.40)	(0.39)	(0.37)	(0.37)	(0.35)
Deadline & Penalty	2.46***	2.38***	2.06***	2.02***	1.78***	1.78***	1.75***	1.59***
(β_3)	(0.49)	(0.50)	(0.42)	(0.41)	(0.39)	(0.38)	(0.37)	(0.36)
Constant (β_0)	59.88***	—	77.93***	—	81.55***	—	83.50***	—
	(0.39)		(0.37)		(0.36)		(0.35)	
Controls & FEs	N	Y	N	Y	N	Y	N	Y
F-Tests (p-values):								
$\beta_1 = \beta_2$	0.010	0.011	0.074	0.096	0.077	0.099	0.180	0.229
$\beta_1 = \beta_3$	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
$\beta_2 = \beta_3$	0.224	0.326	0.011	0.009	0.008	0.007	0.001	0.005
$\beta_3 = \beta_1 + \beta_2$	0.962	0.860	0.144	0.158	0.064	0.085	0.022	0.070

Notes: The table presents LPM estimates of equation (1) with alternative dependent variables. The dependent variable is an indicator for payment of the full amount within $\tau = \{7, 15, 30, 100\}$ days after receiving the notification. Specifications 2, 4, 6 and 8 contain dummies for the different speed cameras and the week the speeding ticket was sent as well as a vector of control variables. These controls account for the level of the fine, the severity of the speeding offense, the measured speed, whether the ticket was sent by regular (vs. electronic) mail, whether the vehicle is owned by a company, the region where the car is registered, the day of the week and the hour of the day when the offense took place, as well as the number of days between the offense and when the ticket was received. The number of observations for all specifications is 78,882. The estimated coefficients (β_0–β_3) and the corresponding standard errors (in parentheses) are multiplied by 100 and can be interpreted as percentage point values. Standard errors are clustered at the vehicle level. ***/**/* indicate significance at the 1%/5%/10%-level, respectively.

under-estimate the true deadline). Section 6 offers survey evidence which allows us to discriminate among these different interpretations.

Finally, note that the $D\&P$-treatment has a significantly stronger impact than the P-treatment ($p \approx 0.01$; see the F-tests reported in Columns 3 and 4, Table 2). This suggests that adding emphasis to the deadline increases compliance when the late penalty is made salient, too. This observation is consistent with the idea of a positive interaction from jointly increasing the salience of the deadline and the late penalty (see fn. 13). Based on the estimates reported in Table 2, however, we cannot reject that the effect size of the $D\&P$-treatment equals the sum of the D- and the P- treatments – either for the 7 - day or the 15- day outcome window (Columns 1–4). For the latter case, the F-test of the H0: $\beta_3 = \beta_1 + \beta_2$ yields $p \approx 0.15$.[16] This also implies that we cannot reject $\beta_3 - \beta_2 = \beta_1$: jointly making the deadline and late penalty salient has a larger but statistically indistinguishable effect from emphasizing only the deadline.

5.1 Robustness and Extensions

How robust are these findings? First, it is reassuring to note that the estimates are virtually unaffected when we add controls. Hence, the imbalances associated with the imperfect implementation of the RCT seem to have little influence on average treatment effects. Second, when we consider payments for different outcome periods (with τ smaller or larger than the deadline T), we observe – consistently with Figure 2 – stronger treatment effects within one week and

[16] F-tests for outcome periods beyond the deadline indicate significant differences (Table 2, Columns 5–8). Note, however, that payments in the post deadline period are difficult to interpret (see below).

smaller effects on cumulative payment rates within 30 or 100 days. It is important to emphasize, however, that payments in the post-deadline period are very difficult to interpret because they are shaped by additional enforcement activities (which are largely unobserved in our data). This caveat is certainly relevant for the 100 -day period, but also applies to the 30 day window: occasionally, the authority reaches out to a non-compliant car owner via phone or mail after just three weeks. Hence, any additional enforcement effort beyond the notification naturally works towards reducing the treatment effects. We nevertheless observe a persistently positive effect of the $D\&P$-treatment. Even 100 days after the delivery of the payment notification – and after up to 85 days of post-deadline enforcement actions – the payment rate in this treatment is 1.6–1.7pp (+2%) higher than in the control group (Columns 7 and 8, Table 2).[17] We return to discussing the implications of this persistency – which are remarkably similar to the dynamic effects reported in De Neve *et al.* (2021) – in Section 5.2. Finally, we also examined different corrections for multiple hypothesis testing (List *et al.*, 2019; Romano and Wolf, 2005). The results from this sensitivity analysis suggest that the inference from Table 2 remains qualitatively robust when we account for multiple testing (see Table A.1).

We next studied partial (rather than full) payment of fines. It turns out that 99.9% of all observed payments cover the full amount. We therefore obtain very similar estimates to those reported above (see Panel A, Table A.2). Put differently, the treatments work by turning non-paying speeders into paying ones (rather than turning partial into full payments). We also examined whether the repeated treatment of car owners with multiple tickets influences our results. When we replicate the LPM estimates for a sample with just one ticket per car (the first treatment), the estimates remain again almost unchanged (see Panel B, Table A.2).

We also conducted a duration analysis to explore the exact timing of payments. In particular, we estimated hazard models with and without time-varying treatment effects. The results, which are reported in Table A.3 in the Appendix, corroborate our findings from above. Consistently with Figure 2, the duration analysis documents equally strong, positive effects from the P- and the $D\&P$-treatments during the first 7 days after receiving a speeding ticket. During days 8–15, the hazard rate in the $D\&P$-treatment (i.e., the probability of paying the fine conditional on not having paid before) remains roughly 6% above the corresponding rate in the control group (see Columns (3b) and (4b), Table A.3). For the D-treatment, in contrast, there is no difference in conditional payment rates during this period. Hence, it is the payment decisions in the pre-deadline week that lift the effect size of the $D\&P$-treatment above the P-treatment. The estimates further show that the treatment effects are concentrated in the pre-deadline period: after day 15, there are no statistically significant differences in hazard rates.[18]

In an additional step, we assessed the heterogeneity of the effects. Running our main LPM estimates (with full payments within 15 days as the dependent variable) on various sub-samples, we detect little heterogeneity. Only for the $D\&P$-treatment do we observe a significantly stronger treatment effect on private car owners compared to company cars (+3pp vs. +1pp; see Table A.4). A very similar pattern is observed for speeding tickets delivered by regular versus electronic mail. Given that almost all companies receive speeding tickets via e-mail (see fn. 7) and almost all

[17] The constant reported in Column (7) of Table 2 reveals a 100-day payment rate of 83.5% (in the control group). Compared to other domains, this is a high collection rate (see Fig. 2.2 in Piehl and Williams, 2010).

[18] The estimation results hardly differ between Cox proportional hazard and complementary log-log models (Sueyoshi, 1995); see Table A.3.

private owners receive them via regular mail, we cannot pin down whether the form of delivery or the type of receiver drives this heterogeneity. Ortega and Scartascini (2020), who experimentally vary the way in which taxpayers with outstanding tax debt are approached, find that e-mails have a stronger impact on payment rates than letters. If this finding were to generalize to our context, it would imply that the observed pattern mainly reflects lower responsiveness of corporations than private car owners.

Finally, we examined whether the estimated treatment effects vary over time. Comparing tickets that were sent early or late within a given calendar month, we do not detect any systematic differences relative to the average treatment effects reported above. This suggests that short run liquidity constraints, which could be tied to pay check intervals, do not seem to be main drivers of non-compliance. This might reflect that this region is relatively well off (many ticketed drivers are local) and that in our sample, a 15- day payment deadline allows for a reasonable time to adjust to negative income shocks.

5.2 Cost-benefit analysis

The results from the RCT indicate that increasing the salience of the late penalty has a statistically significant but quantitatively small effect on timely compliance.[19] From a public management perspective, it is important to understand the cost-benefit tradeoff implied by the estimated effects. The first part of this subsection thus assesses the fiscal cost and benefits to the local authority.[20]

The first benefit from increasing payment compliance comes from saving the public authorities' resources spent on enforcement. As mentioned in Section 3, the administrators follow-up with additional enforcement steps if a ticket is not paid on time; they compile and send further legal notifications (often more than one) and may communicate with the car owners via e-mail, phone, or in person. These administrative steps take about 15 minutes per ticket when offenders comply quickly after the first follow-up step (and much longer for protracted cases). Accounting for the labor costs of the administrators – the average hourly labor costs of an administrator are about 200 CZK – the costs for processing an unpaid ticket thus amount to at least 50 CZK. In turn, the increase in timely payments caused by the $D\&P$ cover letter (+2.06pp) translates into a reduction of at least 1.03 CZK in administrative costs per ticket.

A second, direct fiscal benefit is given by the gains in collected revenues. These gains are comprised, on the one hand, by the treatment-induced increase in the probability of ultimately collecting any payment, pre-deadline or post-deadline. On the other hand, the authority also loses a fraction of the late fees from the drivers who would have paid post-deadline but were induced by the treatment to pay pre-deadline. Let us discuss these two components in more detail.

The treatments' effects on ultimate payments are observable in principle but we cannot directly estimate them. The RCT ended in August 2019 and our data-set records payments made until December. The final payment outcomes, however, might take more than one year to materialize. Analyzing data from the start of our trial nevertheless indicates that non-compliance

[19] Note that the effect size is consistent with results from RCTs testing behavioral strategies to enforce tax payments (see Antinyan and Asatryan, 2019).

[20] The additional input parameters of the analysis – the information on the processing time of follow-up enforcement, the labor costs of administration, etc. – were obtained from the traffic authorities in Ricany.

within 100 days (the longest time window used in our analysis) is a good predictor for long-run non-compliance: for 9 out of 10 tickets that are unpaid within 100 days (and for which we are able to observe a one-year outcome period), there is no payment recorded any time after the first 100 days. We therefore use the estimated treatment effects on (full) payments within 100 days to approximate the revenue gains.

By increasing the fraction of drivers who pay the fine f by the deadline, the authority also foregoes revenue K from the drivers who would have ultimately paid after the deadline. The combined effect of an increase in ultimate payments and a reduction in post-deadline payments can be computed directly from the *D&P* treatment's effects on the ultimate payments (as captured by the coefficient β_3^{100} from eq. 1) and the payments by the deadline (β_3^{15}). The change in revenues, which is derived in Appendix E, is given by

$$\Delta R = \beta_3^{100} f + (\beta_3^{100} - \beta_3^{15})K. \tag{2}$$

Intuitively, the first term denotes the increase in the basic fines ultimately collected. The second denotes a loss (since, according to our estimate, $\beta_3^{15} > \beta_3^{100}$) of the late fee K not collected by the drivers induced to pay by 15 days already. We then quantify the change in revenue straightforwardly by substituting the appropriate values into equation (2): The estimates from columns (3) and (7) in Table 2 for the effect sizes, and, since f and K vary between observations, the empirical mean values of f (830 CZK) and K (870 CZK).[21] The result of this exercise implies a revenue gain of around 11.83 CZK per ticket. Together with the savings in enforcement costs (1.03 CZK, see above), the *D&P* cover letter thus yields a fiscal benefit of approximately 12.86 CZK per ticket.

We now turn to the fiscal costs of the intervention. Note first that the fixed costs for the necessary adjustment in the software were negligible.[22] Hence, the costs primarily consist of the marginal costs of printing and sending the cover letters. Here one has to note that 40% of tickets are sent electronically (see Table 1); for these cases, the marginal costs are zero. For the remaining 60%, the costs are at most 0.4 CZK (paper and printing; sending costs are unaffected). The treatment cover letter thus costs at most 0.24 CZK on average.

Summing up the fiscal benefits and costs, the *D&P* treatment yields a net fiscal gain of 11.62 CZK (approx. 50 cents) per ticket on the margin. Adding the cover letter is thus highly cost effective from a fiscal perspective. While its magnitude appears small, the ratio of marginal fiscal benefits over costs is well above 50. This latter result is mainly due to the near-zero costs, mirroring one of the key arguments in favour of nudging (see, e.g., Benartzi *et al.* 2017). However, the fiscal benefits are significant in the aggregate from the local authority's perspective, too. As the camera systems generate roughly 42,000 tickets per year, this would translate – if scaled up across all tickets – into net annual benefits of roughly 528,000 CZK for the authority. This sum covers approximately one quarter of the annual costs of employees involved in ticket administration at the authority. In light of these findings, the authority has in fact started to adopt our most effective cover letter. Since June 2020, it gets attached to all tickets.

[21] While the fine f is observed for all observations, we observe K only for a (non-random) subset of 5,267 speeding tickets that were not paid in time and for which the data contain information on the total amount due ($f + K$).

[22] The software generates the notifications automatically, inserting the appropriate values (e.g., fines based on the input variables, in particular, the measured speed). The randomization merely required adding an extra layer of alternatives to the generating process.

Welfare discussion. So far, we have focused on the fiscal impact of the treatment. A comprehensive welfare analysis of the salience letters needs to consider additional channels. Note first that the increase in collected revenues (11.83 CZK per ticket) represents a mere transfer between car owners and the authority. Hence, only the savings in enforcement costs (1.03 CZK) and the costs of the letters (0.24 CZK) enter the calculus of social benefits and costs. This leaves us with a social gain of 0.79 CZK per ticket. Second, the treatment impacts car owners and their choices in numerous, welfare-relevant ways. Paying earlier, for instance, implies that some decision makers bear higher opportunity costs (see Appendix D). These opportunity costs might (similar as the direct, monetary costs) affect low-income households more strongly (Kessler, 2020; Mello, 2021). In a welfare analysis that accounts for inequality this would reduce potential social gains.[23]

At the same time one has to note that our treatments correct misperceptions about the costs of non-compliance. The increase in timely compliance thus means that car owners avoid the (for some, surprisingly) costly follow-up enforcement process. In fact, it is plausible that the cost of the follow-up enforcement is higher for drivers than for the authority; it is certainly not a routine experience for them. In addition, the cover letter may be valuable in its own right. Our survey (which is introduced below) shows that 57% of respondents find the information provided in the *D&P* treatment 'somehow useful' and 21% find it 'very useful'.[24] To the extent that the cover letters facilitate the processing of information, the treatment may also reduce the time spent deciphering the content of the legal notification. These information-processing benefits are not limited to the drivers whose behavior is altered by the treatment but to many more (as the survey suggests, 78% of drivers). The intervention might therefore reduce non-trivial compliance costs (see, e.g. Evans, 2003).

A quantification of these different channels and a fully-fledged (behavioral) welfare analysis is beyond the scope of this paper, in large part due to the lack of relevant measurements. However, two implications should be clear from our discussion. On the one hand, the intervention is welfare-improving as long as the net welfare impact on car owners is non-negative (or, in money-metric terms, larger than -0.79 CZK per ticket). On the other hand, any net welfare gain would, most likely, be much smaller than what is suggested by the mere fiscal cost-benefit analysis.

6 Survey Experiment

The main results from our RCT, in particular, the positive effects of the *D*- and the *D&P*-treatments, are consistent with our predictions under certain distributions of prior misperceptions. We conducted a survey experiment in order to further gauge into these misperceptions and to explain why the *P*-treatment failed to increase timely compliance.

We were not able to survey speeders from our RCT. Instead, we worked with a sample of $N =$ 1,609 individuals aged 18 or above and holding a driving license. These individuals were recruited online from the Czech National Panel, a panel of respondents that is representative of the Czech population.[25] Survey participants were on average 43 years old and half of them were females.

[23] Recall from Section 5.1 that we do not find any evidence on varying payment rates or treatment effects within calendar months, suggesting that responses from cash-constrained, poor individuals do not drive our findings.

[24] These responses resemble those documented by Allcott and Kessler (2019), who evaluate the welfare implications of home energy reports.

[25] The panel is maintained by three professional survey providers. Our survey was administered by one of these providers, NMS Market Research. Further information is available at www.narodnipanel.cz.

Consistently with random treatment assignment, all observable characteristics are balanced across treatments (see Appendix Table A.5).

Participants were first exposed to a hypothetical scenario description, which explained that they were detected speeding. Participants were then randomly assigned to either the control group or one of the three treatments. Based on this assignment, they were presented with speeding tickets with exactly the same text and graphical layout as the actual ticketed car owners in our RCT: the standard notification (control group) or one of the three cover letters followed by the standard notification (treatment groups). Thereafter (and without the opportunity to return to the text of the notification or the cover letter) participants were asked, among others, about their perceptions regarding the deadline and the penalty for missing it.

Perceptions about the deadline. Perceptions about the deadline were assessed with a question asking "when do you think you have to pay the full amount of the fine?". The four response options were within 7, 15, 30, or 60 or more days after receiving the notification. Using binary response dummies as dependent variables, we estimate linear probability models that follow the structure of equation (1). Table 3 presents the results. The data allow us to examine the prior beliefs in the control group: 69% correctly expect a 15- day deadline (Col. 3) and there is only a modest level of misperceptions: about 13% underestimate and 18% overestimate the deadline length. Hence, despite the formalistic structure of the notification, the deadline (which is mentioned repeatedly in the notification; see Appendix C.2) seemed sufficiently salient to a clear majority of survey participants.

Table 3: Survey – Treatment effects on deadline perceptions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Responses:	within 7 days		within 15 days		within 30 days		within 60+ days	
Deadline (β_1)	-0.086***	-0.088***	0.169***	0.171***	-0.078***	-0.077***	-0.005	-0.005
	(0.020)	(0.020)	(0.029)	(0.029)	(0.023)	(0.023)	(0.007)	(0.007)
Penalty (β_2)	-0.028	-0.029	-0.016	-0.015	0.051*	0.052*	-0.007	-0.007
	(0.023)	(0.023)	(0.033)	(0.033)	(0.028)	(0.028)	(0.007)	(0.007)
Deadline & Penalty	-0.073***	-0.073***	0.148***	0.148***	-0.076***	-0.075***	-0.000	-0.000
(β_3)	(0.020)	(0.020)	(0.029)	(0.029)	(0.023)	(0.023)	(0.008)	(0.008)
Constant (β_0)	0.131***	0.163***	0.691***	0.620***	0.166***	0.194***	0.012**	0.023*
	(0.017)	(0.028)	(0.023)	(0.044)	(0.019)	(0.037)	(0.006)	(0.013)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
F-Tests (p-values):								
$D = P$	0.002	0.001	0.000	0.000	0.000	0.000	0.656	0.732
$D = D\&P$	0.394	0.343	0.421	0.377	0.909	0.913	0.503	0.453
$P = D\&P$	0.020	0.021	0.000	0.000	0.000	0.000	0.270	0.270

Notes: The table presents linear probability model estimates of equations following the following structure: $T7_i = \beta_0 + \beta_1 \text{Deadline}_i + \beta_2 \text{Penalty}_i + \beta_3 \text{Deadline\&Penalty}_i + X_i\gamma + \varepsilon_i$, where $T7_i$ indicates that subject i responded 'within 7 days'. The constant, β_0, indicates the share of subjects who gave this response in the control treatment. The treatment effects are captured by the coefficients β_1, β_2 and β_3, respectively. X_i is a vector of control variables: age, gender, and education dummies. N = 1,609. Robust standard errors in parentheses. ***/**/* indicate significance at the 1%/5%/10%-level, respectively.

Notwithstanding, the survey data document that the D and $D\&P$ treatments consistently altered these (mis)perceptions. The two cover letters which make the 15- day deadline more salient increased the number of correct responses by 17pp and 15pp, respectively (Col. 3). The P treatment, in contrast, has no effect. The estimates document that the increase in correct perceptions is achieved by an equally pronounced decline in the share of respondents that underestimate (Col. 1) and in the share of those overestimating the deadline length (Col. 5).[26]

These findings narrow down the possible interpretations of the D treatment's ineffectiveness in the RCT. The survey indicates, first, that a vast majority holds correct perceptions regarding the deadline. Second, among the few that holds misperceptions, an equal shares of people under- and over-estimate the deadline length. The intervention 'corrects' both of these misperceptions, which implies opposing effects that offset each other on aggregate (compare Section 4.1).

Perceptions about the late penalty. Most respondents are well aware that not paying the fine before the deadline implies higher costs. In the control treatment, 81% expect an increase in the payment obligation (Col. 1, Table 4). The P- and $D\&P$-treatments, which highlight the late penalty, significantly increased this share by 6pp and 9pp, respectively (Col. 1 and 2). In contrast, the D treatment, which emphasized only the deadline, had no significant effect.

Table 4: Survey – Treatment effects on late fee perceptions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Responses	Expect higher costs		$\leq$ 2000 CZK		2500 CZK		$\geq$ 3000 CZK	
Deadline (β_1)	0.007	0.005	0.063*	0.058*	-0.039*	-0.037*	-0.025	-0.021
	(0.027)	(0.027)	(0.035)	(0.035)	(0.020)	(0.021)	(0.034)	(0.034)
Penalty (β_2)	0.065**	0.064**	-0.295***	-0.298***	0.423***	0.423***	-0.127***	-0.125***
	(0.026)	(0.026)	(0.033)	(0.033)	(0.030)	(0.030)	(0.032)	(0.032)
Deadline & Penalty	0.091***	0.090***	-0.339***	-0.342***	0.467***	0.467***	-0.127***	-0.125***
(β_3)	(0.024)	(0.024)	(0.032)	(0.031)	(0.029)	(0.029)	(0.032)	(0.032)
Constant (β_0)	0.812***	0.834***	0.530***	0.477***	0.111***	0.131***	0.359***	0.391***
	(0.019)	(0.033)	(0.025)	(0.045)	(0.016)	(0.036)	(0.024)	(0.044)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
F-Tests (p-values):								
D = P	0.024	0.022	0.000	0.000	0.000	0.000	0.001	0.001
D = D&P	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.001
P = D&P	0.242	0.238	0.127	0.126	0.208	0.206	0.999	0.992

Notes: The table presents linear probability model estimates of equations following the structure from eq. (1). $N = 1{,}609$. The dependent variable in Columns (1) – (2) is a dummy indicating that a subject responded *yes* to the question *'If you do not pay the full amount of the fine by the deadline, would you expect to pay a higher fine?'*. Columns (3) – (8) are based on a subsequent question regarding the expected total amount due, including the late fee (i.e., $f + K$). The dependent variable in Columns (3) and (4) captures responses indicating *1,500*, *2,000* CZK, as well as responses of subjects that answered *'no'* when asked if they would expect a higher fine if they did not pay by the deadline. Columns (5) – (6) indicate responses of *2500* CZK and Columns (7) – (8) pair responses with *3,000*, *3,500*, *4,500* and *more than 4,500* CZK. Control variables include age, gender, and education dummies. Robust standard errors in parentheses. ***/**/* indicate significance at the 1%/5%/10%-level, respectively.

We next explore responses to the question "what would be the total amount you would eventually have to pay?".[27] The data document a pronounced level of misperceptions of the amount of post-deadline payment obligations (see the constant term in Col. 3, 5 and 7, Table 4). Only 11% of respondents have a correct perception (Col. 5) and a larger share of respondents (53%) underestimate the costs of missing the deadline (Col. 3). The P and $D\&P$ treatments have a strong impact on these perceptions. The share of respondents expecting a payment of 2,500 CZK rises (from a baseline of 11%) by 42pp and 47pp, respectively (Col. 5). The shift in perceptions is primarily due to a 30pp to 34pp drop in underestimations (Col. 3) and much less by a drop in overestimations (−13pp, Col. 7). Similar effects are observed for the survey

[26] These results remain virtually unchanged if we include control variables. This pattern is reassuring and consistent with successful randomization.

[27] The question does not directly refer to the late penalty K but asks about $f + K$. This reflects that both the notification and our cover letters refer to the total payment obligation ($f + K$) rather than the difference (K).

participants' expectations regarding demerit points, an additional element of the late penalty: in the baseline treatment, 32% expect to get demerit points for missing the deadline. In the P and $D\&P$ treatments, this rate increases by 30pp (see Table A.6 in the Appendix).[28]

To wrap up, the evidence indicates that the P and $D\&P$ treatments seem to work via a perceptual deterrence channel (Apel, 2013). Reading the standard notification leaves speeders with sizable misperceptions of the late penalty, with a majority underestimating the late penalty. The two cover letters thus induce *higher* expected costs of missing the deadline and, in turn, increase timely compliance.

7 Concluding Discussion

This paper has studied the timely payment of fines from speeding tickets. We first presented the results from an RCT, which evaluates the impact of simplifying cover letters. The letters either increased the salience of a payment deadline, the penalty for late payments, or both. Emphasizing only the deadline does not yield any increase in payment rates. Stressing the late penalty increases timely compliance by about 1.2%. Jointly communicating the deadline and the penalty raises timely payments by 2.6%. The latter treatment's impact is persistent over at least 100 days. To narrow down the interpretation of these findings, we then reported complementary evidence from a survey experiment. The survey reveals modest and approximately symmetric over- and underestimations of the deadline length. Making the deadline salient has small and opposing effects on priors which offset in the aggregate. In contrast, under-estimations of the late penalty are much more prevalent. Increasing the salience of the late penalty thus raises the perceived costs of non-compliance and – in line with a simple theoretical framework – increases the incentive to pay on time.

A cost-benefit analysis showed that our interventions – in particular, the letter that emphasizes both the late penalty and the payment deadline – are a highly cost-effective way of improving the collection of fines. Adding the cover letter reduces the caseload of the follow-up enforcement process (saving administrative costs) and directly increases revenues, as it persistently increases payments. Summing up all fiscal benefits and costs, our most successful treatment yields a net revenue gain of roughly 50 cents per ticket. The total gains would cover approximately 25% of the costs of the ticket administration personnel. In light of these findings, the authority has in fact implemented our most successful cover letter as a permanent measure.

Simplifications of legal notifications that increase the salience of certain pieces of information are becoming more and more popular. Our findings offer a cautionary reminder that the effectiveness of such nudges hinges on their power to effectively shift perceptions in the target population in the 'desired' direction. The ability to do so depends on the initial distribution of relevant priors. Authorities or project teams might first want to examine these distribution and pre-test a nudge's impact on different perceptions. This could avoid wasting resources in underpowered RCTs that test many different nudges with limited promise. Simple survey experiments may thus help to optimize interventions and identify those that are most promising in a given context.

[28] For this variable, we further observe an interesting correlation: within the control group, those who overestimate the deadline length are also more likely not to expect demerit points for missing the deadline. This provides a possible explanation for the positive interaction effect observed for the $D\&P$ treatment.

These arguments also speak to questions regarding the external validity of our findings. The evidence from the RCT and the survey experiment point to the mechanism behind the observed treatment effects: people update their perceptions and respond accordingly. There is hardly a reason to think why this mechanism would not be relevant in other settings. The size and direction of the treatment effects in a particular setting are, however, shaped by the prior perceptions. These priors, in turn, might depend on details of legal notifications as well as numerous institutional, cultural, and economic factors. While priors differ between contexts, it is reassuring to note that the impact our late penalty nudge quantitatively and qualitatively mirrors findings from several other enforcement domains. Our results show that one can increase the impact of such nudges by also highlighting payment deadlines. It is up to future research to test this idea in other settings.

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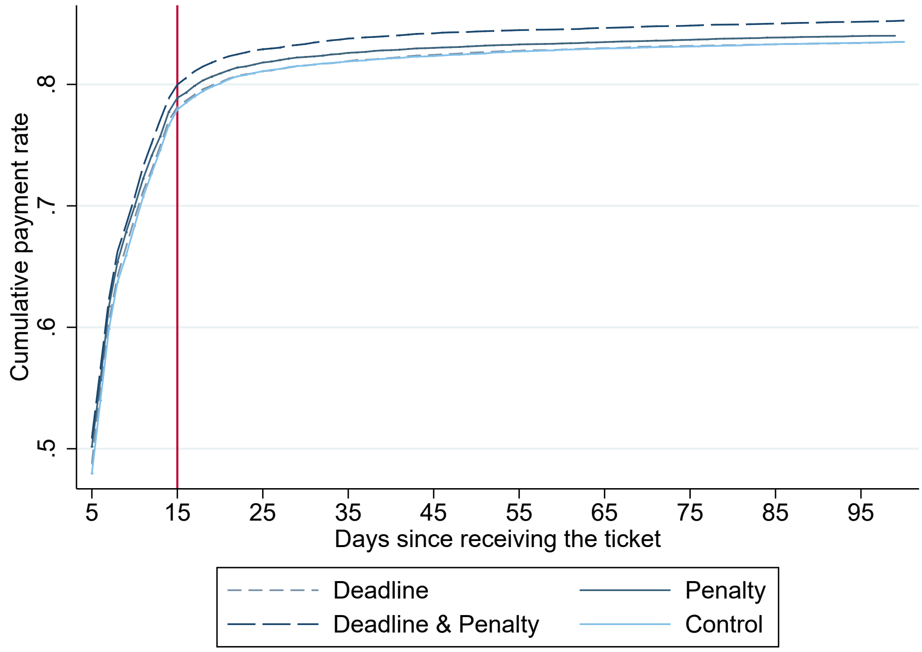
A Appendix: Additional Figures and Tables

A.1 Randomized Controlled Trial

Figure A.1: RCT – Cumulative response rates by treatment



Notes: The figure illustrates cumulative payment rates for the different experimental groups during the first 100 days after receiving the notification. The payment deadline (15 days) is indicated by the red vertical line.

Table A.1: RCT – Treatment Effects with Multiple Hypothesis Testing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Pay-7days		**Pay-15days**		Pay-30days		Pay-100days	
Deadline (β_1)	0.58	0.63	0.22	0.27	0.02	0.12	0.00	0.12
	(0.238)	(0.188)	(0.593)	(0.494)	(0.951)	(0.747)	(0.996)	(0.732)
	[0.453]	[0.144]	[0.788]	[0.505]	[0.993]	[0.758]	[0.998]	[0.758]
	{0.465}		{0.801}		{0.994}		{0.995}	
Penalty (β_2)	1.85	1.87	0.96	0.93	0.71	0.73	0.50	0.54
	(0.000)	(0.000)	(0.021)	(0.019)	(0.068)	(0.050)	(0.180)	(0.125)
	[0.000]	[0.000]	[0.030]	[0.004]	[0.081]	[0.011]	[0.174]	[0.037]
	{0.000}		{0.116}		{0.284}		{0.581}	
Deadline & Penalty (β_3)	2.46	2.38	2.06	2.02	1.78	1.78	1.75	1.59
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
	{0.000}		{0.000}		{0.000}		{0.000}	
Constant (β_0)	59.88	—	77.93	—	81.55	—	83.50	—
Comparison of treatment effects (p-values, using correction from List *et al.* 2019):								
$\beta_1 = \beta_2$	{0.061}		{0.332}		{0.354}		{0.581}	
$\beta_1 = \beta_3$	{0.000}		{0.000}		{0.000}		{0.000}	
$\beta_2 = \beta_3$	{0.521}		{0.034}		{0.028}		{0.002}	
Controls & FEs	N	Y	N	Y	N	Y	N	Y

Notes: The table re-prints the LPM point-estimates from Tab. 2. Dependent variable is an indicator for a payment of the full amount within $\tau = \{7, 15, 30, 100\}$ days. Specifications 2, 4, 6 and 8 contain control variables. The number of observations for all specifications is $78,882$. The estimated coefficients (β_0–β_3) are multiplied by 100 and can be interpreted as percentage point values. In addition to the estimated treatment effects, the table presents three different sets of p-values:

(1) The (round brackets) contain the basic p-values based on robust standard errors, clustered at the vehicle level but without accounting for multiple testing.

(2) In [squared brackets], we report p-values for the Romano-Wolf multiple hypothesis correction (Romano and Wolf, 2005, 2016), implemented with the `rwolf` package from Clarke *et al.* (2019) (5000 bootstraps). Note that this step-down procedure (which controls the familywise error rate but – different to and thus more powerful than, e.g., Bonferroni or Holm corrections – considers the dependence structure of the test statistics by re-sampling from the original data) allows to account for clustering.

(3) Finally, the {curly brackets} contain the p-values from the multiple testing correction proposed by List *et al.* (2019) (i.e., results obtained from the `mhtexp` package, again with 5000 bootstraps). The later package allows to include tests for pairwise treatment comparisons and the corresponding p-values are reported in the lower panel of the table. Note, however, that the package does neither account for clustered standard errors nor does it allow to add controls. Hence, these corrections are only available for specifications 1, 3, 5 and 7.

Table A.2: RCT – Robustness and extensions (LPM estimates)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Controls & FEs	N	Y	N	Y	N	Y	N	Y
Panel A. Any Payment								
	AnyPay-7days		**AnyPay-15days**		AnyPay-30days		AnyPay-100days	
Deadline (β_1)	0.0062	0.0067	0.0025	0.0029	-0.0003	0.0006	-0.0005	0.0007
	(0.0049)	(0.0048)	(0.0041)	(0.0039)	(0.0038)	(0.0036)	(0.0036)	(0.0033)
Penalty (β_2)	0.0186***	0.0187***	0.0095**	0.0091**	0.0062	0.0062*	0.0039	0.0042
	(0.0049)	(0.0048)	(0.0041)	(0.0040)	(0.0038)	(0.0036)	(0.0036)	(0.0034)
Deadline & Penalty	0.0245***	0.0238***	0.0201***	0.0199***	0.0161***	0.0163***	0.0152***	0.0132***
(β_3)	(0.0049)	(0.0050)	(0.0042)	(0.0041)	(0.0038)	(0.0037)	(0.0037)	(0.0035)
Constant (β_0)	0.5993***	—	0.7802***	—	0.8249***	—	0.8473***	—
	(0.0039)		(0.0037)		(0.0035)		(0.0034)	
Number of Obs.	78,882	78,882	78,882	78,882	78,882	78,882	78,882	78,882
Panel B. Full Payment – Only one (the first) Observation per Car								
	Pay-7days		**Pay-15days**		Pay-30days		Pay-100days	
Deadline (β_1)	0.0028	0.0037	-0.0015	-0.0011	-0.0040	-0.0031	-0.0031	-0.0019
	(0.0055)	(0.0053)	(0.0045)	(0.0042)	(0.0041)	(0.0039)	(0.0039)	(0.0036)
Penalty (β_2)	0.0174***	0.0182***	0.0079*	0.0078*	0.0045	0.0048	0.0031	0.0037
	(0.0054)	(0.0053)	(0.0044)	(0.0042)	(0.0041)	(0.0038)	(0.0039)	(0.0036)
Deadline & Penalty	0.0244***	0.0227***	0.0213***	0.0208***	0.0180***	0.0177***	0.0178***	0.0157***
(β_3)	(0.0053)	(0.0056)	(0.0043)	(0.0043)	(0.0039)	(0.0040)	(0.0037)	(0.0037)
Constant (β_0)	0.6246***	—	0.8065***	—	0.8432***	—	0.8628***	—
	(0.0038)		(0.0031)		(0.0029)		(0.0027)	
Number of Obs.	62,782	62,782	62,782	62,782	62,782	62,782	62,782	62,782

Notes: The table presents LPM estimates of equations following the structure of (1). The dependent variable in *Panel A* is an indicator for *any payment* (including incomplete payments below the prescribed fine) within $\tau = \{7, 15, 30, 100\}$ days. *Panel B* considers again the main outcome variable (full payment) but only includes one observation per car (i.e., the first time a car is treated). Hence, the number of observations reduces to 62,782 cars (= tickets). In all panels, specifications 2, 4, 6 and 8 contain dummies for the week the speeding ticket was sent and a vector of control variables (compare Table 2). Standard errors are clustered at the vehicle level in Panel A. Panel B reports robust standard errors. ***/**/* indicates significance at the 1%/5%/10%-level, respectively.

Table A.3: RCT – Duration analysis (time until payment)

	(1)	(2)	(3a)	(4a)	(3b)	(4b)	(3c)	(4c)	(3d)	(4d)
Panel A. Cox estimations										
	time-invariant		0–7 Days		8–15 Days		16–30 Days		31+ Days	
Deadline	1.011	1.016	1.024*	1.029**	0.997	1.003	0.923*	0.930	1.034	1.044
	(0.010)	(0.010)	(0.013)	(0.013)	(0.020)	(0.020)	(0.042)	(0.043)	(0.090)	(0.090)
Penalty	1.038***	1.042***	1.055***	1.058***	1.023	1.027	0.957	0.959	0.908	0.910
	(0.011)	(0.011)	(0.013)	(0.014)	(0.021)	(0.021)	(0.044)	(0.044)	(0.083)	(0.082)
Deadline & Penalty	1.071***	1.064***	1.083***	1.071***	1.059***	1.057***	0.995	1.008	1.091	1.113
	(0.011)	(0.012)	(0.014)	(0.014)	(0.022)	(0.021)	(0.046)	(0.046)	(0.097)	(0.098)
Controls	N	Y	N	Y	N	Y	N	Y	N	Y
Panel B. Cloglog estimations										
	time-invariant		0–7 Days		8–15 Days		16–30 Days		31+ Days	
Deadline	1.001	1.009	1.025*	1.030**	0.996	1.004	0.918*	0.926	1.035	1.046
	(0.012)	(0.013)	(0.014)	(0.014)	(0.022)	(0.022)	(0.045)	(0.045)	(0.091)	(0.092)
Penalty	1.018	1.022	1.057***	1.061***	1.025	1.030	0.954	0.957	0.908	0.910
	(0.013)	(0.013)	(0.014)	(0.014)	(0.023)	(0.023)	(0.046)	(0.047)	(0.083)	(0.083)
Deadline & Penalty	1.060***	1.066***	1.086***	1.073***	1.064***	1.063***	0.995	1.010	1.091	1.114
	(0.014)	(0.015)	(0.015)	(0.015)	(0.024)	(0.023)	(0.049)	(0.049)	(0.098)	(0.099)
Controls	N	Y	N	Y	N	Y	N	Y	N	Y

Notes: The table reports estimated hazard ratios (together with standard errors, clustered at the car level) based on the Cox proportional hazard model (Panel A) and complementary log-log regressions ('Cloglog', Panel B), respectively. Specifications (1) and (2) estimate time-invariant treatment effects on the timing of payments. (For the Cox model, this is based on an equation with the structure $h(t) = h_0(t)exp(\beta_0 + \beta_1\text{Deadl} + \beta_2\text{Penalty} + \beta_3\text{Deadl\& Penalty} + \mathbf{X}\gamma') + \varepsilon)$. Specifications (3) and (4), in contrast, present estimates for time-varying treatment effects on the hazard rate during days 0–7 , 8–15, 16–30, and more than 30 days after receiving the notification. Hence, the different columns (3a–3d) [and, analogously, for (4a–4d)] present the coefficients from one given estimation. (The estimation equation is $h(t) = h_0(t)exp(\beta_0 + \beta_1^1\text{Deadl}^{D0-7} + \beta_1^2\text{Deadl}^{D8-15} + \beta_1^3\text{Deadl}^{D16-30} + \cdots + \beta_2^1\text{Penalty}^{D0-7} + \cdots + \beta_3^1\text{Deadl\& Penalty}^{D0-7} + \cdots + \mathbf{X}\gamma') + \varepsilon$.) Columns (3a) and (3b), for instance, report treatment-specific hazard ratios for the first and second week after receiving the ticket, respectively. Analogously to the LPM estimates, specifications 2 and 4 contain dummies for the different speed camera zones and the week the speeding ticket was sent, and the full set of control variables (see Table 2). The number of observations for all specifications is $78,882$ speeding tickets with the timing of the full payment observed over 60 days. $^{***}/^{**}/^{*}$ indicate significance at the 1%/5%/10%-level, respectively.

Table A.4: RCT – Heterogeneity analysis (LPM estimates)

	(1)	(2)	(3)	(4)	(5)	(6)
Interaction with:	company car		e-mail delivery		local number plate	
Deadline	0.0001	0.0022	0.0015	0.0023	-0.0027	-0.0021
	(0.0055)	(0.0052)	(0.0052)	(0.0049)	(0.0057)	(0.0054)
Penalty	0.0099*	0.0090*	0.0075	0.0073	0.0057	0.0070
	(0.0055)	(0.0052)	(0.0052)	(0.0049)	(0.0057)	(0.0055)
Deadline & Penalty	0.0291***	0.0311***	0.0253***	0.0280***	0.0182***	0.0173***
	(0.0056)	(0.0053)	(0.0053)	(0.0051)	(0.0057)	(0.0055)
Deadline × Interaction	0.0048	0.0011	0.0022	0.0009	0.0102	0.0099
	(0.0083)	(0.0080)	(0.0085)	(0.0082)	(0.0082)	(0.0079)
Penalty × Interaction	-0.0002	0.0006	0.0058	0.0049	0.0082	0.0050
	(0.0084)	(0.0080)	(0.0086)	(0.0083)	(0.0083)	(0.0080)
Deadline & Penalty	-0.0178**	-0.0234***	-0.0105	-0.0190**	0.0047	0.0062
× Interaction	(0.0084)	(0.0080)	(0.0086)	(0.0082)	(0.0084)	(0.0079)
Interaction Term	-0.0161**	0.0120	-0.0259***	-0.0381***	-0.0207***	-0.0149**
	(0.0075)	(0.0092)	(0.0079)	(0.0099)	(0.0074)	(0.0073)
Constant	0.7865***	—	0.7894***	—	0.7892***	—
	(0.0044)		(0.0041)		(0.0044)	
Controls & FEs	no	yes	no	yes	no	yes
Observations	78,882	78,882	78,882	78,882	78,882	78,882

Notes: The table presents LPM estimates that build upon the structure of equation (1), but interact each treatment dummy with a binary interaction term: an indicator for (i) cars owned by corporations (incl. single-person businesses organized as limited liability partnerships; columns 1–2), for (ii) speeding tickets sent via electronic mail (*data box*, see fn. 7; columns 3–4), and for (iii) cars with a 'local' number plate (from Central Bohemia; columns 5–6). Standard errors, clustered at the car level, are in parentheses. ***/**/* indicate significance at the 1%/5%/10%-level, respectively.

A.2 Survey Experiment

Table A.5: Survey – Descriptive statistics

	Control	Deadline	Penalty	Deadline & Penalty	Total
Age	43.51	43.52	43.74	43.86	43.66
	(15.03)	(13.99)	(13.80)	(14.29)	(14.28)
Male	0.510	0.523	0.481	0.500	0.503
	(0.501)	(0.500)	(0.500)	(0.501)	(0.500)
Apprenticeship education	0.381	0.450	0.406	0.405	0.410
	(0.486)	(0.498)	(0.492)	(0.491)	(0.492)
Elementary school education	0.0842	0.0628	0.0529	0.0756	0.0690
	(0.278)	(0.243)	(0.224)	(0.265)	(0.254)
High school education	0.324	0.339	0.355	0.329	0.337
	(0.469)	(0.474)	(0.479)	(0.471)	(0.473)
University or higher education	0.210	0.148	0.186	0.190	0.184
	(0.408)	(0.356)	(0.390)	(0.393)	(0.388)
city of 100,000 + inhabitants	0.223	0.206	0.219	0.227	0.219
	(0.417)	(0.405)	(0.414)	(0.419)	(0.414)

Notes: Sample size is *N=1,609*. Standard errors in parentheses.

Table A.6: Survey – Treatment effects on expectations of addition of demerit points

	(1)	(2)	(3)	(4)	(5)	(6)
Responses:	Yes		No		Maybe	
Deadline (β_1)	0.015	0.018	-0.072**	-0.076**	0.057**	0.058**
	(0.033)	(0.033)	(0.035)	(0.035)	(0.026)	(0.027)
Penalty (β_2)	0.308***	0.309***	-0.300***	-0.301***	-0.008	-0.008
	(0.034)	(0.034)	(0.033)	(0.033)	(0.024)	(0.024)
Deadline & penalty	0.310***	0.311***	-0.298***	-0.299***	-0.012	-0.012
(β_3)	(0.033)	(0.033)	(0.033)	(0.033)	(0.024)	(0.024)
Constant (β_0)	0.324***	0.287***	0.535***	0.567***	0.141***	0.146***
	(0.023)	(0.045)	(0.025)	(0.046)	(0.017)	(0.033)
F-Tests (p-values):						
$D = P$	0.000	0.000	0.000	0.000	0.014	0.013
$D = D\&P$	0.000	0.000	0.000	0.000	0.008	0.007
$P = D\&P$	0.955	0.964	0.938	0.935	0.859	0.868
Controls	-	Yes	-	Yes	-	Yes

Notes: The table presents LPM estimates following the structure of equation (1). The dependent variable in Columns (1) – (2) is a dummy indicating that an individual responded *yes* to the question *'If you do not pay the full amount of the fine by the deadline, would you expect to be added demerit points within the demerit point system?'*. The dependent variable in Columns (3) – (4) captures responses indicating *no*. Columns (5) – (6) indicate responses of *maybe*. Control variables include age, gender, and education dummies. N = 1,609. Robust standard errors in parentheses. ***/**/* indicate significance at the 1%/5%/10%-level, respectively.

B Appendix: Institutional Details

Details on Fines. Until July 2018, minor speeding was punished by a fine of 900 CZK (approx. \$40 or 3% of the average monthly wage). Speeding at between 20 and 40km/h above the limit is classified as an *intermediate speeding* offense and was, until July 2018, subject to a fine of 1,900 CZK (approx. \$80). During the second half of 2018, when new speed cameras were installed, the fine structure was gradually adjusted. During the following months, there was considerable variation in fine amounts, both within and between speed cameras.[1] Since 2019, minor offenses have been fined at 700 CZK for speeding by less than 12km/h above the limit and 900 CZK for speeding by 12–20km/h above the speed limit. Intermediate offenses have been fined at 1,500 CZK and 1,900 CZK, respectively, for speeding by 20–26km/h and 26–40km/h above the limit. A summary of the fine structure is provided in Table B.1.

As a concession to prevent appeals, the measured speed is rounded down to the next integer and then reduced by 3 km/h. The speed levels reported in Table B.1 refer to this 'adjusted speed'. (Our analysis consistently uses the accurately measured speed rather than the adjusted values.)

Table B.1: Fine structure

Offense category	Speed (above speed limit)	Fines pre 2018/7	Fines 2018/7–12	Fines since 2019/1
Minor speeding	< 12km/h	900 CZK	500–700 CZK	700 CZK
	12 – 20km/h	900 CZK	700–900 CZK	900 CZK
Intermed. speeding	20 – 26km/h	1,900 CZK	1,100–1,900 CZK	1,500 CZK
	26 – 40km/h	1,900 CZK	1,400–1,900 CZK	1,900 CZK

[1] For some cameras zones, the authority imposed fines of 500–700 CZK for minor offenses. At other zones, it used fines of 1,100 or 1,400 CZK for intermediate offenses.

C Appendix: Cover letters and notifications

C.1 Cover letters

The texts used in the different cover letters was the following (English translation):

Deadline (D) treatment:

Dear Sir/Madam,

We summon you to pay the prescribed amount for a speeding violation. We encourage you to carefully read the information contained in the attached pages and take appropriate action.

Please pay the amount in full and make sure it is credited to the city's account **within 15 days** after receiving this summons.

The city office of Ricany, legal division, department of fines

Penalty (P) treatment:

Dear Sir/Madam,

We summon you to pay the prescribed amount for a speeding violation. We encourage you to carefully read the information contained in the attached pages and take appropriate action.

If you do not pay the whole amount the office will continue investigating the offense. The amount that you will potentially have to pay **may be as high as CZK 2,500**.[2] In addition, the driver may be **added points** within the demerit point system.

The city office of Ricany, legal division, department of fines

Deadline & Penalty ($D\&P$) treatment:

Dear Sir/Madam,

We summon you to pay the prescribed amount for a speeding violation. We encourage you to carefully read the information contained in the attached pages and take appropriate action.

Please pay the amount in full and make sure it is credited to the city's account **within 15 days** after receiving this summons.

If you do not pay the whole amount the office will continue investigating the offense. The amount that you will potentially have to pay **may be as high as CZK 2,500**.[3] In addition, the driver may be **added points** within the demerit point system.

The city office of Ricany, legal division, department of fines

C.2 Standard notification

The following pages present the legal notification sent to all car owners in our RCT (English translation):

[2] For intermediate speeding offenses (i.e., speeding at more than 20km/h above the limit), this part reads 'as high as CZK 5,000'.

[3] This part is also adjusted for intermediate speeding offenses (see previous footnote).

Docket number: XXXX Proceedings number: XXXX

The town authority of Ricany

Legal division,

Office of speeding cameras and vehicle weights

Contact official: name, phone Car operator: name, address

Date:

Summons for the payment of a prescribed amount under § 125h, paragraph 1, of Act No. 361/2000 Coll. on the Road Traffic and Amendments to Other Laws, as subsequently amended.

The town authority of Říčany, legal division, department of fines, as the town authority of a municipality with extended jurisdiction, competent to the administrative proceedings under provisions of section **§ 125h, paragraph 1, of Law No. 361/2000** on Road Traffic and on the Amendments to Other Laws, as subsequently amended (hereinafter "road traffic law"), **summons** the operator of the vehicle with license plate ####### (hereinafter "vehicle"), with which road traffic law was breached on **03.01.2016** at **14:57** on Říčanská street (a segment situated between Kolovratská and Březinova streets, a stretch of 335,360 metres) in the municipality of Říčany in the direction from Voděrádky,

for the payment of the amount

of **900 Kč** (nine hundred Czech korunas) to the bank account 35-320390319/0800, variable symbol 9116001251, (message for the recipient: XXXX), and to do so within 15 days of the delivery of this summons. Kindly pay attention to crediting the said account with the prescribed amount within the given time limit.

The illegal act was committed by an unspecified driver, who did not respect the traffic sign "speed limit – 50km/h", and as such violated section §125c, paragraph 1, letter c), item 4 of the road traffic law. This violation appears to satisfy the definition of an offense under section **§18, paragraph 4** of the road traffic law. The offense was documented by an automated speed measurement system without the presence of a human operator.

Based on the findings of the town authority of Ricany, legal division, department of fines, you are the operator of the vehicle with license plate ####### and, according to the provisions of section **§ 10, paragraph 3** of the road traffic law, you are obliged to ensure that, while the vehicle is in use on the road, all driver's duties and road traffic rules are followed as prescribed by this law. This particular offense constitutes a breach of the driver's duties and, concurrently, of the road traffic rules. The offense shows indicia of a violation under the road traffic law; there was no traffic accident.

Because the above-mentioned offense may, in accordance with the legal provisions, be handled by issuing a fine on the spot and, as previously mentioned, other conditions were also fulfilled for the special procedure by the administrative authority for the application of the strict liability of the vehicle operator under the provisions of section **§ 125h, paragraph 1** of the road traffic law, the prescribed amount of **900 Kč** has a legal basis according to the provisions of section **§ 125h, paragraph 2** of the road traffic law.

Notice:

1. If the prescribed amount is paid by the due date, i.e. if it is credited to the stated account within 15 days of the delivery of this summons, the town authority of Říčany, legal division, department of fines, will defer the case in accordance with the provisions of section **§ 125h, paragraph 5** of the road traffic law. Otherwise, it will continue investigating the offense.
2. If the prescribed amount is paid after the due date, the town authority of Říčany, legal division, department of fines, will, in accordance with the provisions of section **§ 125h, paragraph 7** of the road traffic law, immediately return it to the vehicle operator and will continue investigating the offense.
3. Concurrently, in accordance with the provisions of section **§ 125h, paragraph 6** of the road traffic law, we instruct you that if you do not pay the prescribed amount, you may report, in writing, the details of the identity of the driver who was driving the vehicle at the time of the offense to the town authority of Říčany, legal division, department of fines, and you may do so within 15 days of the delivery of this summons. You may use the attached form to report these details. Providing the identity details of the driver is considered, according to section § 125h, paragraph 6, as a provision of an explanation.
4. If you neither pay the prescribed amount nor make use of your right to report the details of the identity of the vehicle's driver nor provide any other explanation within the given time limit, the town authority of Říčany, legal division, department of fines, will continue investigating the offense.

If you consider it necessary to provide an oral explanation on record, you may visit our offices during office hours (Monday and Wednesday 07:30-12:00 and 12:30-18:00; Tuesday and Thursday: 07:30-12:00) at Olivova 1800, Říčany.

Upon payment of the prescribed amount, no record is made. No demerit points will be imposed on the vehicle operator within the framework of the demerit point system for drivers under the provisions of sections § 123a to § 123f of the road traffic law. This summons is not an administrative adjudication.

Appeal against this summons is not admissible.

Contact officials' signatures.

Attachments:

- Photograph from the location of the speed measurement
- Form for reporting the identity details of the vehicle's driver at the time of the offense
- Postal order for payment

D Appendix: Theoretical Framework

This sections describes a formal model framework that studies the decision if and when to pay a speeding ticket. The predictions discussed in Section 4.1 derive from this model. Note that the framework is similar to the model studied in, e.g., Altmann *et al.* (2017). It follows the logic of job-search models (e.g., McCall 1970) and can be easily expanded to a broad set of economically relevant choices of costly task completion under a deadline (e.g., submitting work before a due date or buying a product before a price increase; Altmann *et al.*, 2017).

We consider an agent who receives a speeding ticket in period $t = 0$. Paying the stipulated fine f involves transaction and opportunity costs c_t. These costs are i.i.d. according to a given distribution $F(c)$, which is continuous and increasing in its support $[\underline{c}, \infty]$.[4] In every period t, after the realization of the costs, the agent faces a binary choice: to pay or not to pay the fine f.[5] As long as the fine remains unpaid, the agent re-considers the problem in the next period, $t+1$.[6] Postponing the payment beyond the deadline T implies additional costs K (a late fee and, potentially, demerit points). $C(t)$, the costs of paying the speeding ticket in period t, are then given by

$$C(t) = \begin{cases} c_t + f & \text{if } t \leq T \\ c_t + f + K & \text{if } t > T. \end{cases}$$

The agent pays the ticket in period t if the present costs are lower than the expected costs of postponing the choice. Formally, this condition is given by

$$-c_t - f \geq \delta V_{t+1}, \tag{D1}$$

where V_{t+1} is the option value of 'waiting' for the next period and δ is the discount factor. Note that our empirical application uses discrete periods in terms of days. Hence, the (day-to-day) discount factor should be reasonably close to unity.

From (D1) follows that the agent pays if and only if the costs c_t are sufficiently low:

$$c_t \leq \hat{c}_t := -(f + \delta V_{t+1}) \tag{D2}$$

and the probability that the agent pays the fine in a pre-deadline period t – conditional on not having done so before – is given by

$$h_t := F(\hat{c}_t). \tag{D3}$$

With the cutoff rule from (D2), the option value V_t for a pre-deadline period $t < T$ is

$$V_t = \int_0^{\hat{c}_t} (-c - f) dF(c) \; + \; (1 - h_t)\delta V_{t+1}. \tag{D4}$$

The first term of V_t captures the expected costs $C(t)$ conditional on cutoff $\hat{c}_t$; the second term measures the expected option value from further postponing to $t+1$ (which happens with prob-

[4]By assuming independency we neglect liquidity constraints (which would imply inter-temporally correlated draws). Section 5 discusses evidence suggesting that liquidity constraints are not an issue in our context.

[5]Anticipating the empirical fact that partial payments are defacto unobserved we neglect incomplete payments.

[6]We abstract from memory limitations ('forgetting' about the speeding ticket; see Altmann *et al.* 2017).

ability $1-h_t$). As discussed below, $V_{t+1} < V_t < 0$. The RHS of (D2) is thus positive as long as $\delta \approx 1$.[7]

If the agent has reached period $t = T$ without having paid before, the cutoff becomes

$$\hat{c}_T := -\left(f + \delta V_{T+1}\right) \quad \text{with} \quad V_{T+1} = \int_0^{\hat{c}_{T+1}} (-c - f - K) dF(c) + \left(1 - F(\hat{c}_{T+1})\right) \delta V_{T+2}. \tag{D5}$$

The increase in $C(t)$ at the deadline T provides an incentive to pay before the deadline. Once the deadline gets closer, the option value of further postponing the payment shrinks: there are fewer periods left that could yield a low cost draw before the payment obligation increases from f to $f + K$. From this follows $V_{t+1} < V_t$ (recall that $V_t < 0$).[8]

Based on the definition of h_t from (D3), the cumulative payment rate (or the chance that an agent has paid the fine) by period t is

$$s_t := 1 - \Pi_{\tau=0}^{t}(1 - h_\tau), \tag{D6}$$

where $\Pi_{\tau=0}^{t}(1-h_\tau) = (1-h_0)(1-h_1)\dots(1-h_t)$ measures the probability of not having paid until t. The pre-deadline compliance rate – the share of tickets paid before the deadline – is given by s_T.

D.1 Comparative static: late penalty.

How does s_T, the rate of timely payments, change with a *ceteris paribus* increase in the late penalty K? Differentiating $\hat{c}_T$ w.r.t. K yields

$$\frac{\partial \hat{c}_T}{\partial K} = -\delta \left(\underbrace{-F(\hat{c}_{T+1})}_{A} + \underbrace{\left(1 - F(\hat{c}_{T+1})\right) \delta \frac{\partial V_{T+2}}{\partial K}}_{B} + \underbrace{\left(-\hat{c}_{T+1} - f - K - \delta V_{T+2}\right) \frac{\partial F(\hat{c}_{T+1})}{\partial \hat{c}_{T+1}} \frac{\partial \hat{c}_{T+1}}{\partial K}}_{C} \right). \tag{D7}$$

From the Envelope Theorem and the discussion above it follows that terms A and B are negative and term C is zero (it follows from (D5) that $\hat{c}_{T+1} = -(f + K + \delta V_{T+2})$). As the sum $A + B < 0$ is multiplied with $-\delta$ we get $\partial \hat{c}_T / \partial K > 0$. This result is intuitive: an increase in K causes an increase in the payment rate at the deadline.

Does the same hold for pre-deadline periods $t < T$? In these periods, there is no direct increase in the payment obligation for $t+1$. The counterpart of expression A from (D7) is missing and we get

$$\frac{\partial \hat{c}_t}{\partial K} = -\delta \left(\left(1 - F(\hat{c}_{t+1})\right) \delta \frac{\partial V_{t+2}}{\partial K} \right) \quad \text{for } t < T \tag{D8}$$

[7] To assess this condition, recall first that δ is the day-to-day discount factor (see above). Second, let us consider the case of $\delta = 1$. We can then re-arrange $-\left(f + V_t\right)$ to obtain $-f + f + \int_0^{\hat{c}_t} c\, dF(c) - \left(1 - h_t\right)\left(V_{t+1} + f\right)$. This must be positive since $V_{t+1} < -f$.

[8] Our analysis will focus on the pre-deadline period. To close the model, however, we might further assume that the late penalty K will increase over time. This would be the case, for instance, if the (perceived) enforcement pressure increases over time. Suppose that a (risk neutral) individual expects that, even after missing the deadline, she will get away with just paying the 'regular' fine f with probability $1-p$. With probability p, she would have to pay f plus an additional penalty, κ. The expected late pay penalty would then equal $K = p\kappa$. If p is time variant, a plausible assumption would be $p(t)\kappa$ with $p(t+1) > p(t)$ for some $t + 1 > T$. This would assure that option values decline over time, even after the deadline has passed.

(where we have already omitted term C). The option value V_{t+2} is declining in K: with a marginal increase in the late penalty, postponing becomes less attractive as the future costs of the speeding ticket, conditional on missing the deadline, increase. Hence, $\partial \hat{c}_t / \partial K > 0$. From this it follows that $\partial h_t / \partial K > 0$ for $t \leq T$, which ultimately means that s_T is increasing in K. The rate of pre-deadline payments is therefore increasing in K.

D.2 Misperceptions.

Next, we consider agents with (mis)perceptions of the deadline, $\tilde{T}(\theta_T) = \theta_T T$, and the late penalty, $\tilde{K}(\theta_K) = \theta_K K$. The θ parameters, with $0 < \theta < \infty$, capture whether T and/or K are over- or underestimated (Taubinsky and Rees-Jones, 2018). It is straightforward to extend the cutoff rule from (D2) to the case of (mis)perceptions. If agents optimize based on $\tilde{K}(\theta_K)$ and $\tilde{T}(\theta_T)$, one can substitute these values for the actual K and T, respectively. The survey evidence from Section 6 indicates that the treatments from our RCT alter these perceptions. Let us next derive the behavioral implications.

D.3 Treatment effect on (mis)perceptions: late penalty.

How does an increase in $\tilde{K}(\theta_K)$ (via an increase in θ_K) influence pre-deadline compliance? The analysis from above implies that an increase in $\tilde{K}$ will have the same effect as an increase in K: timely compliance should increase. If the P- and the $D\&P$-treatments push θ_K upwards, we therefore predict an increase in timely compliance (relative to the control treatment). The opposite prediction emerges for agents that *overestimate* K (i.e., $\theta_K > 1$). For this case, the treatments would lower $\tilde{K}$ and, in turn, timely compliance should decline.

D.4 Treatment effect on (mis)perceptions: deadline length.

To assess variation in the perceived deadline $\tilde{T}(\theta_T)$, we must discuss several basic properties from our model framework. Note, first, that for any given pre-deadline period t, the option value V_t is increasing in T. A longer deadline offers more opportunities to draw a low cost c_{t+s} in future periods $t + s \leq T$. A higher option value, in turn, lowers the incentive to pay in period t. From (D2) it then follows that $\hat{c}_t$ decreases. Hence, $h_t = F(\hat{c}_t)$, the probability to pay in a given period $t < T$ (conditional on not having done so before), drops if the deadline T is extended. Under two arbitrary deadlines $T'' > T'$ we therefore have

$$h_t \mid^{\tilde{T}=T'} > h_t \mid^{\tilde{T}=T''} \quad \text{for any } t \leq T' \tag{D9}$$

(where $h_t \mid^{\tilde{T}}$ indicates the hazard rate under a given deadline perception). From this we can immediately derive predictions regarding the impact of a *treatment induced decline in deadline misperceptions*. Consider an agent who initially overestimates the deadline and perceives $\tilde{T} = T'' > T$. Whenever the D- and the $D\&P$-treatments lower perceptions towards T' (with $T \leq T' < T''$), it follows from (D9) that the pre-deadline payment rate s_T must increase. In each period $t \leq T$, the agent considers a lower option value and is therefore more likely to pay (conditional on not having done so before). Reducing an over-estimation of the deadline (i.e., $\theta_T \downarrow$ starting from $\theta_T > 1$) therefore increases the rate of timely compliance (i.e., payments before the actual deadline T).[9]

Let us turn to a *treatment induced increase in the perceived deadline* (starting from an underestimation; i.e., $\theta_T \uparrow$ departing from $\theta_T < 1$). To evaluate this case, a further model property becomes important. Consider two agents, one of whom perceives a 'short' deadline T', and one who perceives a longer deadline $T'' = T' + s$ with $s > 0$. From the cutoff rule (D5) it follows that the first agent's conditional probability h_t of paying in a given pre-deadline period $t = T' - \tau$ (that is $\tau \geq 0$ periods before the perceived deadline T') is exactly the same as the second agent's probability $h_{t'}$ in period $t' = T'' - \tau = T' + s - \tau = t + s$. Formally, this is

$$h_t \mid^{T'} = F(\hat{c}_t) \mid^{T'} = h_{t'} \mid^{T''} = F(\hat{c}_{t'}) \mid^{T''} \quad \text{with } t' = t + s \text{ and } T'' = T' + s.$$

The intuition behind this property is straightforward. Conditional on not having paid before, the probability of paying τ periods before the perceived deadline is independent of the time that has passed. What matters is τ, the 'distance' to the perceived deadline, but not time t in itself. From this follows that

$$\Pi_{t=0}^{T'}(1 - h_t \mid^{T'}) = \Pi_{t=s}^{T''}(1 - h_t \mid^{T''}). \tag{D10}$$

Under a short deadline T', the probability of not having paid the fine between periods $0 \leq t \leq T'$ is exactly the same as the probability of an agent with a perceived deadline T'' not having paid between periods $s \leq t \leq T'' = T' + s$.

Making use of these properties, we can now evaluate the treatment effect on an agent who initially underestimates the deadline, $T' = T - s$, and then updates her perceptions to $T'' = T' + s = T$. Under the perception T', the pre-deadline compliance rate can be decomposed as:

$$s_T \mid^{T'} = 1 - \underbrace{\Pi_{t=0}^{T'}(1 - h_t \mid^{T'})}_{A1} \underbrace{\Pi_{t=T'+1}^{T}(1 - h_t)}_{B1} \tag{D11}$$

(compare definition D6). With a perceived deadline T'', the corresponding pre-deadline compliance rate can be presented as

$$s_T \mid^{T''} = 1 - \underbrace{\Pi_{t=0}^{s-1}(1 - h_t \mid^{T''})}_{B2} \underbrace{\Pi_{t=s}^{T''}(1 - h_t \mid^{T''})}_{A2} \quad \text{with } T'' = T \tag{D12}$$

From (D10) it follows that A1 = A2. If B1 > B2, we would thus get $s_T \mid^{T'} < s_T \mid^{T''}$. Vice versa, if B1 < B2, we would obtain $s_T \mid^{T'} > s_T \mid^{T''}$. Let us next discuss the expressions B1 and B2.

The term B2 measures the probability of not paying the fine during periods $0 \leq t < s$ for an agent who optimizes subject to the correct deadline $T'' = T$. The term B1 measures the corresponding probability during the first s periods *after* a perceived deadline T' (with $T' = T - s$), i.e., in periods $T' < t \leq T' + s = T$. It turns out that the comparison between B1 and B2 is ambiguous.

[9] Note that the cases of $T' \leq T < T''$ (i.e., when the treatment induces the perceived deadline to drop below the true deadline) and $T' < T'' \leq T$ is less clear. Section 6 suggests, however, that both scenarios are of limited empirical relevance.

To see this, recall first that periods $(T', T]$ are – from the misperceiving agent's perspective – the first s periods after the perceived deadline T'. Note further that the relevant cutoff in a post-(perceived-)deadline period τ is $\hat{c}_\tau := -(f + K + \delta V_{\tau+1})$ where $V_{\tau+1}$ is the post-deadline option value. If K (or $\tilde{K}$) is large relative to the difference between $V_{\tau+1}$ and V_{t+1}, it follows from (D2) that we might get $c_\tau < c_t$ and, in turn, $h_t \mid^{T''} > h_\tau$ for $\tau = T' + 1 + s$ and $t = 0 + s$ (with $0 \leq s < T - T'$). Stated more intuitively: if the disincentive to pay associated with the late penalty dominates any differences in the pre- and post-deadline option values, we should see lower conditional payment probabilities during periods $(T', T]$ (after the perceived deadline) as compared to the very first periods $[0, s)$ (under a correct deadline perception). If this were the case, condition B1 > B2 could hold. In principle, however, we could get the opposite and B1 < B2 would hold. Without imposing further assumptions, we therefore have an ambiguous prediction:[10] A treatment-induced correction of a deadline underestimation (i.e., $\theta_T \uparrow$ towards $\theta_T = 1$) could trigger either an increase or a decrease in the pre-deadline compliance rate.[11]

[10] To arrive at an unambiguous comparative static, one would have to impose further structure (as, e.g., in fn. 8) to specify post-deadline option values.

[11] This ambiguous result (which assumed $T'' = T$) applies to any upward shift in deadline-perceptions with $T' < T'' \leq T$. The case of $T' < T < T''$ (an 'overshooting' in perceptions) is even more complex. However, survey evidence from Section 6 suggest that this latter case is empirically irrelevant.

E Appendix: Cost-Benefit Analysis

In this appendix, we derive the formula for the treatment's effect on revenue (equation 2), taking into account the increase in the ultimate payments as well as the loss of the late fees K due to a treatment-induced shift in the post-deadline payments of $f + K$ (see Section 5.2). To do so, we introduce the following formal structure. Let s_0^τ denote the cumulative payment rate during the first τ days after receiving a ticket in the absence of the treatment (control group benchmark). Let s_3^τ indicate the corresponding rate observed for the $D\&P$ treatment. The pre-deadline payment rates are then denoted by $s_\cdot^{15}$. Following the discussion in Section 5.2, from above, we use payments within 100 days ($s_\cdot^{100}$) as proxies for the ultimate payment rates. Neglecting the timing of payments (i.e. zero interests and no discounting), the treatment effect on revenue collected from fines and late fees is then given by

$$\Delta R = [s_3^{15} f + (s_3^{100} - s_3^{15})(f + K)] - [s_0^{15} f + (s_0^{100} - s_0^{15})(f + K)]. \tag{E1}$$

That is, share s_3^{15} of speeding offenders pays the basic fine by the deadline and an additional share $(s_0^{100} - s_0^{15})$ pays the basic fine plus the late fee $(f + K)$. After some manipulation, the difference between post- and pre-treatment revenues from equation E1 becomes

$$\Delta R = (s_3^{100} - s_0^{100}) f + [(s_3^{100} - s_0^{100}) - (s_3^{15} - s_0^{15})] K \tag{E2}$$

which can be expressed as

$$\Delta R = \beta_3^{100} f + (\beta_3^{100} - \beta_3^{15}) K. \tag{E3}$$

Intuitively, an increase in the rate of payments within 100 days yields revenue gains from collecting the basic fine f. In addition, the expression accounts for the share of those tickets that are already paid within 15 days and thus avoid the late fee K.