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Ride Your Luck!A Field Experiment on Lottery-based Incentives for Compliance*

Marco Fabbri†, Paolo Nicola Barbieri‡, Maria Bigoni§

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Abstract

We designed a natural-field experiment in the context of local public transportation to test whether rewards in the form of lottery prizes coupled with traditional sanctions efficiently reduce free-riding. We organized a lottery in a medium-size Italian city the participation in which is linked to purchasing an on-board bus ticket. The lottery was then implemented in half of otherwise identical buses operating in the municipality. Our theoretical model shows that the introduction of the lottery generated an increase in the number of tickets sold and that it is possible to design a self-financing lottery. To estimate the effect of the lottery's introduction on the amount of tickets sold, we matched and compared treated and control buses operating on the same day on the exact same route. The results show that buses participating in the lottery sold significantly more tickets than the control buses. The increase in revenue from the tickets sold was more than the lottery prize amount.

JEL-Classification: D04; H42

Keywords: Enforcement; Free-riding; Public Good; Risk Attitudes; Sanctions.

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1 Introduction

Societies and organizations are based on norms that must be enforced to prevent opportunistic behaviors. Enforcement can occur through the use of "sticks", like fines, damages, and imprisonment, or through the use of "carrots", such as bonuses and rewards. Enforcement systems often rely on sticks, and the literature has traditionally focused on optimal deterrence and efficient punishment (Becker, 1968, Polinsky and Shavell, 2000). One argument in favor of sticks is their comparative efficiency compared to carrots (Dari-Mattiacci and De Geest, 2010). Indeed, although both enforcement tools are costly to use, the (costless) threat of punishment can be repeated a number of times without resorting to punishment when parties comply. This is not possible with carrots, as every time a party complies the cost of the reward has to be borne.

Despite the presumed efficiency of sticks, modern enforcement systems are characterized by an increasing use of carrots to achieve compliance (Ayres, 2010). Scholars point out this tendency in fields such as criminal law (Corman and Mocan, 2005), intellectual property (Gordon, 1992), environmental protection (Chang, 1997, Zhang and Flick, 2001), tax evasion (Falkinger and Walther, 1991) and public health (Rothschild, 1999).

Several reasons have been suggested to explain the increasing use of rewards and bonuses over punishments. First, the complexity of modern societies makes it increasingly difficult for lawmakers to understand the effort required by an individual to comply, and the intentions and motivations behind non-compliance choices (De Geest et al., 2013, Houser et al., 2008). For instance, the cost of having a family member joining the army is highly heterogeneous across households and difficult to estimate for a central state. Similarly, it would make little sense for a central government to enforce a generalized "duty to innovate", since lawmakers may not know who has the capabilities to efficiently invest in research and development. Therefore, when compliance costs are highly heterogeneous among agents and difficult to estimate, using sticks may artificially increase inequality and generate unjust punishment. Moreover, studies in psychology and behavioral economics show that in many situations a mix of rewards and punishments is the most efficient solution to achieve compliance (Andreoni et al., 2003, Fehr and Schmidt, 2007, Sefton et al., 2007, Sutter et al., 2010). Even in situations where carrots are a less efficient policy choice, politicians and lawmakers often opt for rewards and bonuses because these enforcement tools are positively perceived by voters (Galle, 2012). Given the increasing use of carrots istead of or in addition to traditional sticks, it seems of paramount importance to design efficient reward systems and to empirically verify their effectiveness.

In this paper, we report the results of a natural-field experiment in the context of public transportation. We test whether adding to traditional enforcement based on sanctions a reward for compliance in the form of a lottery prize reduces free-riding. As is the case for most Italian and European municipalities, in the city where the experiment took place the local public transportation system is available for all to use such that anyone can use the service, but they are expected to pay the fare. The system is monitored occasionally, and free riders caught red-handed are subject to penalty. The system works very imperfectly: free riding is widespread, which implies that the fee revenues are low and a large part of the cost of the public transportation is financed by taxpayers. In our experiment, we complement the deterrence approach based on sanctions by rewarding individuals' compliance, namely the purchasing of a valid bus ticket, with a lottery ticket.

Lotteries are widely used by private companies to reinforce customers' brand loyalty and increase revenue (Thaler and Ziemba, 1988). Governments and other organizations commonly use lotteries to finance public goods (Clotfelter and Cook, 1991). Moreover, scholars emphasize lottery effectiveness in promoting charitable giving (Landry et al., 2006, Lange et al., 2007, Morgan, 2000, Morgan and Sefton, 2000). In recent years, policies based on lottery rewards to fight indirect tax evasion have been adopted by an increasing number of countries (Fabbri, 2015, Naritomi, 2013). Similarly, we see that lottery-linked deposit accounts (also known as "prized-linked savings"), where some of the interest on bank accounts comprises the prize money in periodic lotteries distributed among account holders, are rapidly increasing in number. Lottery-linked savings accounts have proved to be highly effective in increasing the amount of private savings (Filiz-Ozbay et al., 2015).

However, despite the widespread use of and remarkable results achieved by lotteries in funding public goods and charitable giving, the implementation of lottery reward policies as an instrument to achieve compliance in other contexts of the public sphere have so far been rare. To the best of our knowledge, no study to date has empirically investigated the possibility of implementing a lottery policy to reduce free riding in a publicly provided good subject to congestion. Our experiment took place in a medium-size Italian municipality. In collaboration with the public company that manages local public transportation, we designed three lotteries in which participation is linked to the on-board purchase of bus tickets. The three lotteries offer the same prize but have different durations of 7, 10, and 14 days. We implemented the lotteries only for a subset of otherwise identical buses operating in the municipality served by the bus company. As explained in detail in the next section, we made sure that the buses participating in the lotteries ("treated") not distinguishable from the other buses ("control")on the outside. To estimate the effects of the lottery's introduction on the amount of tickets sold, we retrieved detailed information regarding the route to which each bus was allocated on each day. We then matched and compared the amount of tickets sold on the control and treated buses that ran the same routes on the same day.[1]

[1]As a robustness check, we additionally estimate the results using an alternative approach. Specifically, we took advantage of the randomization process that allocates busses to a specific route and timetable on each given day. Indeed, interviews with the company managers clarified that even for employees of the company it is impossible to foresee to which bus route and time schedule a bus will be allocated on a given day. Consequently, each one of the 158 buses has in principle the same likelihood to travel a specific route and follow a specific

Our theoretical model predicts that the introduction of a lottery decreases free riding and increases the number of tickets sold by inducing compliance among the more risk-loving agents. In addition to this, we use a numerical example to show that in principle it is possible to design a self-financed lottery that increases the fare revenues to completely cover the cost of the lottery prize.

The empirical results show that during the experimental period the number of tickets sold on board the buses participating in the lottery was significantly higher than on the control sample. The increase mostly occurred on bus routes operating in the urban area of the municipality, where occasional bus users are more common compared to extra-urban routes. While the initial 7-day and the following 10-day lotteries generated a similar and sharp increase in the number of tickets sold, the effect of the 14-day lottery was more limited. The total increase in ticket revenue as a result of the three lotteries more than covered the cost of the prizes paid out.

The remainder of the paper proceeds as follows. In the next section, we describe the experimental design. Section 3 reports the predictions of our theoretical model. In section 4, we present the results, and in section 5 we summarize the findings and present the conclusion.

2 Experimental Design

The experiment was implemented in the city of Rimini, Italy (population 146,000) in cooperation with Start Romagna SPA, the publicly owned company providing local bus transportation, and Agenzia Mobilità, the local agency in charge of coordinating public transportation services in Rimini province. The bus company has a total 158 buses operating in the urban area of Rimini, all of them identical except for an unique identifying serial number. Passengers can buy a ticket before or upon boarding a bus. Attempting to limit opportunistic behaviors, ticket inspectors randomly monitor travelers and sanction free riders. However, despite this enforcement activity, a consistent proportion of passengers[2] continues to free ride when using public bus transportation[3].

A standard hourly ticket can be purchased off-board for a price ranging from €1.00 (a book of 10 tickets) to €1.20 (a single ticket). Alternatively, a ticket can be purchased on board for

schedule in any given day. Therefore, under the assumption that the daily allocation of each bus to a specific route happens at random, the comparison of tickets sold by control and treated busses isolates the effects of the lottery. The results obtained using this approach (available upon request) are qualitatively the same as those presented in the paper. We opted to present the results obtained with our matching pairs approach that relaxes the assumption of perfect randomization in bus routes allocation.

[2]Estimation of free-riding rate based on the comparison between the number of users of a bus and revenue from tickets sold on that bus suggests that in 2013 the rate of free riding was between 30% and 50%.

[3]An alternative strategy to prevent free riding adopted in some countries consists in only allowing on board passengers with a regular ticket or passengers who purchase a ticket directly from the driver. This solution was attempted for a period in Rimini and other Italian cities. However, it was quickly abandoned due to its associated costs: the queue of passengers wanting to purchase tickets on board created continuous delays, and on the narrow medieval streets characterize most Italian urban areas affected traffic in the entire city.

a price of €2.00 using an automatic machine installed on each bus. The fine for free riders amounts to €65 if paid within 5 days, €80 if paid between 6 and 60 days after the sanction, and €240 if paid after more than 60 days. Our experiment focuses on who board a bus without a previously purchased ticket and who face the choice of either buying an on-board ticket using the automatic machine or free riding. Focusing on tickets purchased on board would be a problem if, when traveling on a bus participating in the lottery, passengers were substituting tickets purchased off board with on board tickets. We consider the possibility of a substitution effect between on-board and off-board tickets very unlikely for at least three reasons. First, for a price equivalent to the surcharge for purchasing tickets on board, the Italian government offers a wide array of gambling products, all of which are characterized by a higher expected payoff and direct cash compensation.[4] The existence of these gambling opportunities is well known, and these products are also available in the same locations where off-board tickets can be purchased. Second, compared to our bus lottery, these low-cost gambling products have significantly lower costs for checking actual winnings and collecting the prize.[5] Finally, while the prize of the bus lottery is subject to time discounting, because of the time delay between ticket purchase and lottery extraction, the outcome of the low-cost gambling is revealed right after purchase.

We advised Start Romagna during the organization of a lottery in which participation was linked to the purchase of on-board tickets.[6] From the sample of identical buses operating in Rimini, we randomly selected a subsample of 50 participate in the lottery. Inside each of these 50 buses, we affixed posters informing customers that because they bought on-board tickets on that bus they were eligible to participate in a lottery. In order to rule out the possibility of passengers self-selecting on treated buses, we designed and placed the posters in such a way as to make it impossible for the passengers to see them before getting on-board. Thus, the treated samples were indistinguishable from the control buses.[7]

Six tickets with a lottery value of ,Ç¨500 each were distributed among the tickets sold on board the treated buses during the period of November 15,ÄìDecember 15 2014. Three

[4]The Italian regulation of gambling activities forbids giving a monetary prize as compensation for lotteries organized by SPA companies such as Start Romagna. Therefore, we opted for a voucher of the equivalent amount that could be used in a well-known chain food store.

[5]Our bus lottery requires storing the used tickets until the end of the lottery period; checking the results of the lottery online, on the news, or posters located at the bus stops; and going in person to the bus company office to collect the prize. Conversely, the low-cost gambling products can be scratched right away after purchase, and eventual winnings up to €1,000 can be collected in cash directly from the shop owner.

[6]In order to rule out possible demand effects, we wished the population to perceive the lottery as a "marketing strategy" implemented by the bus company to reward compliant customers rather than as an experiment run for scientific purposes. Therefore, during the lottery promotional campaign and in the content of the informative posters and flyers we carefully avoided mentioning the scientific nature of the research.

[7]In addition to the impossibility of distinguishing treated and control buses from the outside, an additional reason why the self-selection of passengers on treated buses is unlikely is the relatively low frequency of vehicles running on the same route in the city. For most of the routes, the time interval between two buses ranges between 15 and 30 minutes, making quite unrealistic the hypothesis that a passenger waiting at a bus stop would only travel if the bus belongs to the treated group.

lotteries, each one distributing two identical prizes, were organized. The three lotteries had different durations. Two winning tickets were sold during the period November 15,Äì21, two were sold during the period November 22,ÄìDecember 1, and two were sold during the period December 2,Äì15. To identify the lottery winners, we exploited the fact that a serial number uniquely identifies each ticket purchased on board. In the days following the end of each of the three lottery periods, two serial numbers were drawn from the list of all the on-board tickets sold in the treated sample. The person possessing the ticket having the corresponding serial number printed on it was entitled to claim the prize.

To estimate the effects of the lottery's introduction on the number of on-board tickets sold, we retrieved detailed information about the specific route to which each bus was assigned any given day from the archive of the bus company. This made it possible to match and compare the number of tickets sold by treated and control buses that were assigned the same route on a specific day.

3 Theoretical Predictions

Suppose that the economy consists of a continuum of N bus riders with constant absolute risk aversion (CARA) utility given by $u(Y,i) = -e^{-iY}/i$, $i \neq 0$, where Y denotes consumption and i is a parameter denoting risk preferences.[8] We assume that bus riders differ only in their degree of risk aversion, i, which is distributed in the interval $(\underline{i}, \bar{i})$ according to a cumulative density function $G(i)$, where riders with $i > 0$ are risk-averse and riders with $i < 0$ are risk-loving.

Every bus rider i faces the binary decision of whether to pay the travel fare t or to free ride. A consumer who does not pay the travel fare faces the risk of being sanctioned, in which case he will have to pay an exogenous fine $F \in (t, Y)$. We assume that the probability of being sanctioned π is exogenous and independent from the number of paying consumers and/or free riders.

A bus rider i pays the travel fare t if

$$u(Y-t,i) \geq \pi u(Y-F,i) + (1-\pi)u(Y,i) \tag{1}$$

or

$$1 \geq \frac{u(Y,i) - u(Y-t,i)}{\pi[u(Y,i) - u(Y-F,i)]} \tag{2}$$

[8] The assumption is consistent with the literature; see, for example, Lange et al. (2007). We further assume that $U(Y,i) = Y$ if $i = 0$.

Under the stated assumptions regarding the utility function, we can write inequality (2) as

$$1 \geq \frac{-e^{-iY} + e^{-i(Y-t)}}{\pi[-e^{-iY} + e^{-i(Y-F)}]} = \frac{e^{it} - 1}{\pi\left(e^{iF} - 1\right)} \tag{3}$$

Proposition 3.1. *For any given probability π, fare t, and fine F, there will be a marginal rider $\hat{i}$ who is indifferent between paying the fare and free riding, and all the riders with $i > \hat{i}$ will pay the fare, while all those with $i < \hat{i}$ will free ride.*

Proof. Differentiating the right hand side (RHS) of (3), for i we get

$$\frac{(t-F)e^{i(F+t)} + Fe^{Fi} - te^{it}}{\pi\left(e^{Fi} - 1\right)^2} \tag{4}$$

which is negative if

$$Fe^{iF}(1 - e^{it}) - te^{it}(1 - e^{iF}) < 0.$$

This implies that

$$\begin{cases} \frac{Fe^{iF}}{1-e^{iF}} < \frac{te^{it}}{1-e^{it}} & \text{if } i < 0 \\ \frac{Fe^{iF}}{e^{iF}-1} > \frac{te^{it}}{e^{it}-1} & \text{if } i > 0 \end{cases}$$

which is always true $\forall F > t$. In addition, $\lim_{i \to -\infty} \frac{e^{it}-1}{\pi(e^{iF}-1)} = \frac{1}{\pi} > 1$ and $\lim_{i \to \infty} \frac{e^{it}-1}{\pi(e^{iF}-1)} = 0$. ■

Adding a carrot to the stick. Suppose that in order to reduce free riding the local transportation authority introduces a lottery. Agents purchasing a ticket participate in the lottery and receive with probability q a reward equal to R. Under the lottery rules, the probability of agent i winning prize R is inversely proportional to the total number N_p of agents who pay the fare: $q = \frac{1}{N_p}$.

Proposition 3.2. *If, absent the lottery, the proportion of free riders is strictly higher than 0, and strictly lower than 1, for any given probability π, fare t, fine F, and reward $R > 0$, the introduction of the lottery cannot increase, and possibly decreases, the proportion of free riders.*

Proof. A bus rider i pays the travel fare t if

$$qu(Y - t + R, i) + (1 - q)u(Y - t, i) \geq \pi(u(Y - F, i)) + (1 - \pi)u(Y, i) \tag{5}$$

or

$$1 \geq \frac{u(Y, i) - u(Y - t, i)}{\pi[u(Y, i) - u(Y - F, i)]} - \frac{q(u(Y - t + R, i) - u(Y - t, i))}{\pi[u(Y, i) - u(Y - F, i)]} \tag{6}$$

With a CARA utility function, Equation (5) yields:

$$1 \geq \frac{e^{it}-1}{\pi\left(e^{iF}-1\right)} - q \times \frac{\left(e^{iR}-1\right)e^{i(t-R)}}{\pi\left(e^{iF}-1\right)} \tag{7}$$

Since the second element of the RHS of Inequality (7) is always positive, the introduction of the lottery cannot increase the level of i that equals the two sides of (7), thus possibly inducing more agents to pay the fare.[9] However, the positive impact of the lottery on compliance is attenuated by the fact that the probability of winning the prize decreases in the number of compliers, which implies that the second element of the RHS of Inequality (7) can be non-monotonic in i, depending also on $G(i)$.

A numerical example will show that, under more specific assumptions, it is possible to introduce a "self-financed" lottery that increases fare revenues so as to completely cover the cost of the prize.

Example. Consider a population of riders of size N, with two types of agents, who differ in their risk attitudes. A proportion $f = G(\underline{i})$ of the agents are moderately risk-loving with preferences characterized by a parameter $\underline{i} < 0$, while the others are risk-averse ($\bar{i} > 0$).

Let the probability of detection be $\pi = \frac{1}{N}$, and let the sanction be equal to $F = t \times f \times N$. Under these conditions, it is straightforward to see that a risk-neutral agent would not pay the fare, as

$$Y - t < \pi(Y - F) + (1 - \pi)Y$$

Let us assume, instead, that $\bar{i}$ is such that condition (3) is satisfied, that is,

$$1 \geq \frac{e^{\underline{i}t}-1}{\pi\left(e^{\underline{i}F}-1\right)} = \frac{N(e^{\bar{i}t}-1)}{e^{\bar{i}tfN}-1}$$

This implies that, absent any lottery, a fraction f of the agents free rides, while the remaining $N(1-f)$ pay the travel fare.

Let us now consider the introduction of a lottery with a prize $R = F$, where the probability of getting the prize for an agent who pays the fare is equal to 1 over the total number of compliant riders in the population. The introduction of the lottery simply strengthens the incentive to pay the fare; therefore all the risk-averse agents will continue to comply under the new regime. The risk-loving agents instead will comply if condition (7) is satisfied when all agents pay the fare, that is, for $q = \frac{1}{N}$. This implies that:

$$1 \geq \frac{e^{\underline{i}t}-1}{\pi\left(e^{\underline{i}F}-1\right)} - e^{\underline{i}(t-F)} = N\frac{e^{\underline{i}t}-1}{\left(e^{\underline{i}tfN}-1\right)} - e^{\underline{i}t(1-fN)} = N\frac{e^{\underline{i}t}-1}{\left(e^{\underline{i}tfN}-1\right)} - \frac{e^{\underline{i}t}}{e^{\underline{i}tfN}}$$

[9] Whether the fraction of compliers acutally increases depends on the distribution of preferences $G(i)$.

Because

$$\lim_{\underline{i}\to-\infty} N\frac{e^{\underline{i}t}-1}{(e^{\underline{i}tfN}-1)}-\frac{e^{\underline{i}t}}{e^{\underline{i}tfN}}=-\infty$$

there must be a value i^* such that $1 \geq \frac{e^{it}-1}{\left(e^{itfN}-1\right)} - \frac{e^{it}}{e^{itfN}}$ for all $i < i^*$. Therefore, if $\underline{i} < i^*$, all agents will pay the fare after the introduction of the lottery, and the total amount of money collected through the fares will increase by $f \times N \times t$, which by assumption is exactly enough to cover the cost of the prize R.

As a numerical example with parameters that are roughly consistent with those in our field experiment, suppose that the number of travelers is $N = 1000$, the travel fare is $t = 2$, and the sanction is $F = 80$. Let $\underline{i} \leq 0.1$, $\bar{i} \geq 0.1$, and $f = \frac{1}{25}$.

Without any lottery, only the risk-averse agents pay the fare, while the risk-loving free ride. Figure 1 illustrates the LHS and RHS of inequality (3), with the selected parametrization.

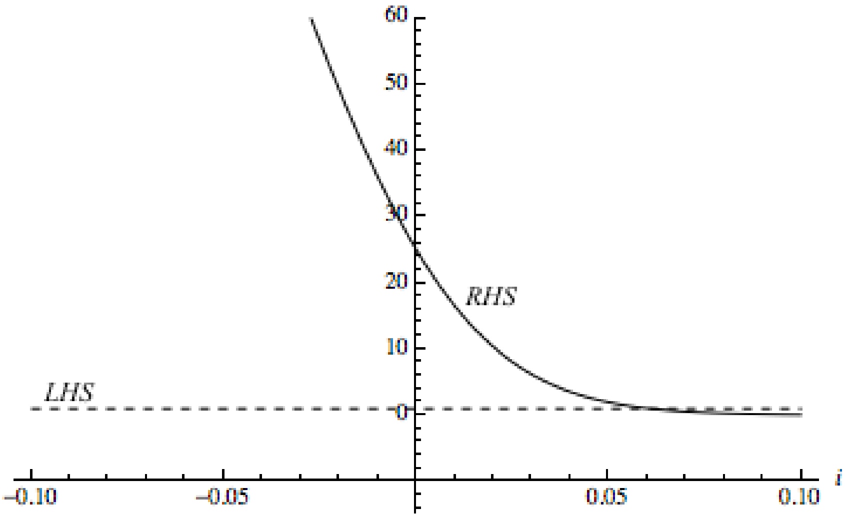

Figure 1: Condition for compliance without the lottery (inequality 3)

When a lottery is introduced, all agents prefer to pay the fare, the risk-averse ones because they are afraid of the sanction and the risk-loving ones because they are attracted by the prize. Figure 2 illustrates the LHS and RHS of inequality (7), with the selected parametrization.

The number of riders who pay the fine increases by $f \times N = 40$ as a consequence of the introduction of the lottery; therefore the revenues increase by an amount that is sufficient to cover the cost of the prize, equal to 80.[10]

[10]In the field experiment, the prize is in fact roughly ten times larger than the fine, but the share of free riders is also about ten times larger than in this example. This implies that if the reward is large enough to convince all free riders to comply, the lottery will indeed generate an increase in the revenues which covers the cost of the prize.

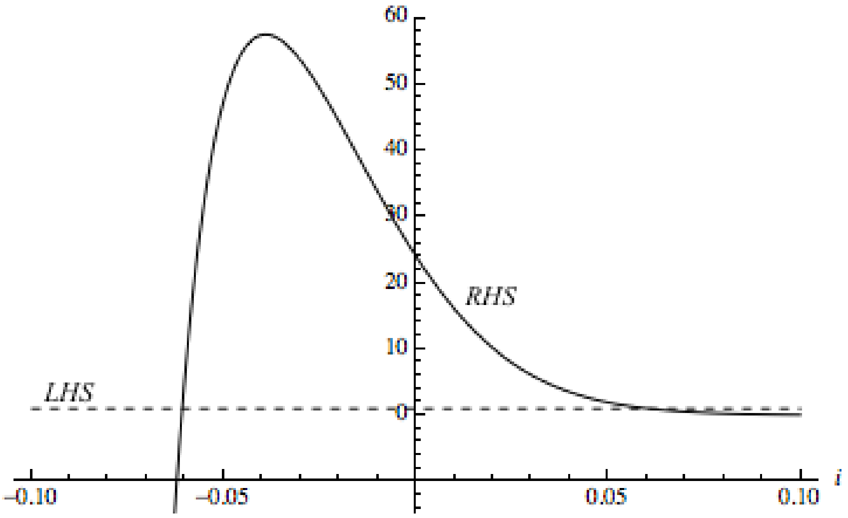

Figure 2: Condition for compliance with the lottery (inequality 7)

4 Results

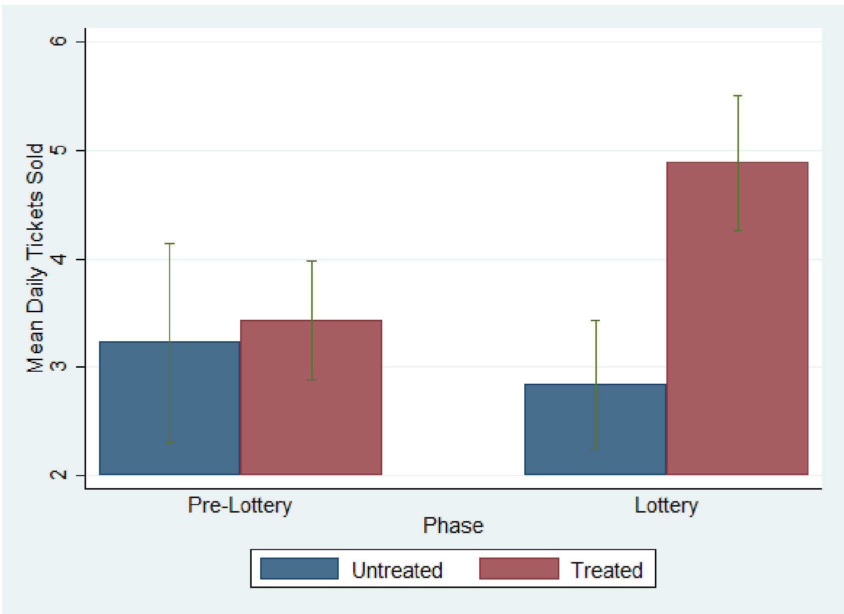

Figure 3: Treated and control buses operating on the same day on the same bus route, average daily sales per bus route by treatment during the lottery period and the months before.

We retrieve information regarding the routes assigned in each day to the buses in our sample. We then match treated and control buses that were operating on the same route the same day. A comparison of the tickets sold on the buses where the lottery is in place against control buses isolates the causal effects of the lottery's introduction on the likelihood to purchase a travel ticket.

Figure 3 shows descriptive statistics of the average number of on-board tickets sold on a specific bus route during the lottery period as well as in the previous and following months. In the month preceding the lottery, control and treated buses sold on average the same number of tickets. During the lottery period, treated buses sold on average approximately twice as many tickets per bus per day compared to control buses. In the month following the lottery, the difference between tickets sold on treated and control buses, while still positive, nevertheless decreased and was not statistically different from zero.

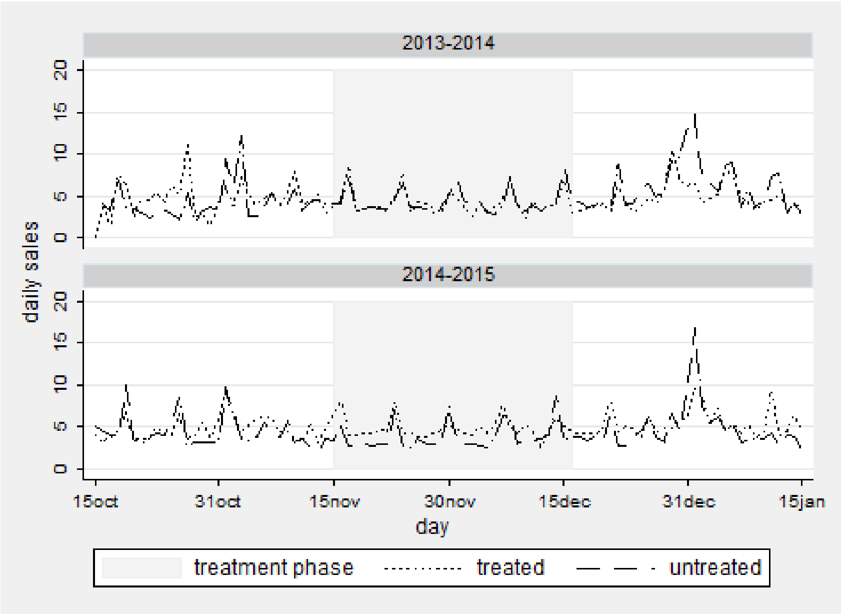

Figure 4: Average daily on-board tickets sold per bus, 10/15/2013-1/15/2014 and 10/15/2014-1/15/2015.

To estimate the effects of the lottery's introduction on the number of tickets sold, we again matched control and treated buses operating on the same bus route on the same day. We then implemented a Tobit model to take into account that our dependent variable *daily_sales* reporting the tickets sold each day on a specific bus route is left-censored at zero.

Results are reported in table 1. In model (1) and (2), we regress *daily_sales* on the dummy $Treated$ taking the value of 1 for buses that implement the lottery, the variable *phase* labelled "pre", "treatment" and "post" respectively during the month before the lottery introduction, the lottery period and the month following the lottery introduction, and the interaction of these variables. Compared to model (1), in model (2) we restrict the attention only to those bus routes operating in the urban area of the municipality of Rimini. In both models, we also control for weather conditions (amount of rain fell and average wind speed), holidays, and day of the week.

The results confirm the impression conveyed in Figure 3. The coefficient of the interaction term between the dummy $Treated$ and the lottery phase in model (1) suggests that the lottery's introduction determines a statistically significant increase at the conventional level of roughly 2.3 tickets sold per bus route per day. The increase in the number of tickets sold rose to 3.6 per bus route per day (p-value $< 1\%$) if we only include in the analysis bus routes in the urban area of the municipality. This result is intuitive if we consider the lottery design. Indeed, by focusing on passengers who board a bus without having acquired an off-board travel ticket solution, the lottery is likely to have the greatest impact on occasional bus users. However, on extra-urban bus route, a large proportion of passengers are regular commuters who are likely to acquire long-term travel solutions such as seasonal passes or ticket books.

In models (3) and (4), we disaggregate the period in which the lottery treatment was in place, considering the effect of each of the three lotteries separately. Recall that while the prizes offered were identical, the three lotteries lasted 7, 10, and 14 days. We created the three lottery-duration dummies $d7lott$, $d10lott$, and $d14lott$ taking a value of 1 for the 7, 10, and 14 days lotteries respectively. We then replicated models (1) and (2) but substituted the variable *phase* with the three lottery-duration dummies and interacted them with the variable $Treated$.

The coefficient of the interaction term $Treated\#d10lott$ is positive and statistically significant in both model specifications (weakly significant in model 3), suggesting that the 10-day lottery resulted in an increase of roughly 2.5/4 tickets sold per line per day in the whole municipality and in the urban area respectively. With respect to the 7-day lottery, the large and positive coefficient of model (4) that excludes extra-urban bus routes, albeit weakly statistically significant, is comparable in magnitude with the coefficient of the 10-day lottery. Conversely, when in model (3) we consider bus routes operating in the entire municipality, the coefficient of the interaction term $Treated\#d7lott$ becomes statistically not different from zero, suggesting a limited impact of the first lottery, especially as related to the extra-urban routes. The coefficient of the interaction term $Treated\#d14lott$, albeit positive, is small and not statistically different from zero in both model specifications, suggesting a limited impact of the 14-day lottery on the number of tickets sold.

A quick calculation makes it possible to verify that the increase in revenue generated by the lottery's introduction is able to cover the cost of the lottery prizes awarded. The results suggest that the lottery's introduction determined an average daily increase of approximately 2.3 tickets sold on each of the 34 bus routes serving the municipality. Thus, the bus lottery generated a revenue increase of roughly €2,420. This amount more than covered the expenditure for prizes, as only two lottery prizes of €500 each have been claimed by winners.[11]

Finally, during the interview we conducted with the bus company managers they highlighted

[11]Under Italian regulation, lottery prizes not claimed could be used by the company to enrich the jackpot of subsequent lottery rounds. In the case of our experiment, uncollected prizes were donated to a local non-governmental organization supporting people in need.

Table 1: Daily Tickets Sold, Matching Pairs by Day and Bus Route

	(1)	(2)	(3)	(4)
Treated	1.064	-0.159	1.960***	1.060*
	(0.78)	(1.00)	(0.51)	(0.64)
lottery	0.544	0.103		
	(0.76)	(0.96)		
post	-0.541	-0.825		
	(0.74)	(0.93)		
Treated#lottery	2.368**	3.604***		
	(1.05)	(1.35)		
Treated#post	1.540	2.066		
	(1.02)	(1.30)		
d7lott			0.301	-1.087
			(1.11)	(1.44)
d10lott			0.669	0.133
			(0.98)	(1.25)
d14lott			1.291	1.695
			(0.84)	(1.05)
Treated#d7lott			1.088	3.751*
			(1.55)	(2.01)
Treated#d10lott			2.473*	4.284**
			(1.34)	(1.73)
Treated#d14lott			0.929	0.399
			(1.17)	(1.48)
_cons	10.585***	11.638***	10.588***	11.635***
	(0.18)	(0.22)	(0.18)	(0.22)
Bus-line fix effect	Y	Y	Y	Y
N	3852	2432	3852	2432
pseudo R^2	0.119	0.082	0.119	0.082

* p<0.10, ** p<0.05, *** p<0.01

Notes: Tobit regression, bus matching on bus-line and day. Dependent variable tickets sold daily. Model (1) and (3) include all the matched observations, model (2) and (4) considers only bus-line operating within the urban area of the municipality.

a series of additional benefits deriving from a reduction in the number of free riders in addition to the increase in revenue. First, when discovering a free rider, employees checking for passengers' compliance have to follow a procedure requiring a large amount of time compared to the few seconds it takes to monitor a compliant passenger. Therefore, given the resources for enforcement, the probability of monitoring and sanctioning a non-compliant passenger endogenously increases when a smaller number of free riders is present in the system. Second, while each endorsed sanction implies administrative costs for the bus company, a sizeable fraction of the total monetary amount deriving from sanctions is not actually cashed in by the bus company.[12] This is the case, for instance, when the sanctioned individual is a destitute person or the resident of a foreign country.

5 Conclusion

In this paper, we tested the possibility of using lotteries to combat free riding in the context of local public transportation. We set up a field experiment in collaboration with a publicly owned transportation company in a medium-size Italian municipality. We organized a lottery in which participation was connected to purchasing an on-board bus ticket. We created two samples of treated and control buses by implementing the lottery only in the former. In treated buses, posters and flyers informed passengers of the possibility of participating in the lottery. The lottery was repeated three times, keeping the prize constant while varying the lottery length (7, 10, and 14 days).

Our theoretical model predicted that the introduction of the lottery would generate an increase in the number of tickets sold and that it is possible to design a self-financing lottery such that the increase in revenue more than cover the cost of the lottery prizes. The results confirm the model's hypothesis. To estimate the effect of the lottery's introduction on tickets sold, we retrieved detailed information on the specific route taken by each bus on each day. A matching-pairs analysis was used to compare the number of on-board tickets sold by treated and control buses being assigned to precisely the same route on the same day. During the experimental period, passengers on treated buses purchased more than double the number of tickets. The increase in the number of tickets sold occurred for the 7-day and 10-day lotteries, while for the 14-day one the effect was close to zero.

In recent years, scholars have extensively investigated enforcement methods that are alternative or complamentary to punishment and sanctions. In particular, the use of lotteries to steer agents' behavior has received increasing attention. However, most of the contributions have focused on the provision of public goods and on charitable fundraising. Furthermore, the contributions so far have mostly been either theoretical or focused on experimental laboratory evidence.

[12]For 2013, the percentage of fines imposed but not cashed in amounted to roughly 35% of the total.

This paper adds to the literature by focusing on a publicly provided good subject to congestion, by modelling the theoretical properties of a reward system based on lotteries and by empirically testing its effectiveness in the field. The results suggest a zero-cost policy tool to increase compliance that can be implemented by public organizations to substitute or complement traditional enforcement tools. Future research will have to establish whether and to what extent the results achieved in the month in which the lottery was in place can be maintained in the long run.

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