Shaping Tax Norms Through Lotteries

Marco Fabbri

Department of Economics, University of Bologna
Hamburg Institute of Law and Economics, Hamburg University
Rotterdam Institute of Law and Economics, Erasmus University Rotterdam

Abstract
The aim of this work is to explain the success registered by a zero-cost policy against sales tax evasion based on a lottery mechanism which has been recently implemented in a growing number of countries. It is suggested how the specific sales tax evasion situation in which this policy has been applied could be traced back to a general public goods framework. After a discussion of the empirical evidences showing the policy success, we propose a theoretical model incorporating Tversky and Kahneman’s (1992) Cumulative Prospect Theory insights. Furthermore, a test for verifying the applicability of the lottery ticket policy in specific contexts is developed. Such a test could represent a useful ex-ante indicator of the expected success of the lottery ticket policy for policymakers interested in increasing the private provision of public goods.

Keywords: Public Goods, Tax Evasion, Law and Economics, Lottery, Natural Experiment, Prospect Theory

JEL: H26, H41, K34
1. Introduction

Developing effective policies that promote tax compliance is a challenging task for authorities and policymakers. Traditionally contributions in Economics and Law & Economics focus on monitoring and sanctioning as instruments to achieve compliance (Allingham and Sandmo, 1972; Yitzhaki, 1974; Andreoni et al., 1998). However enforcing the payment of indirect tax through deterrence methods could be especially costly for the government. In fact, indirect tax payments are based on collection of private and corporate financial records of transactions. Hence, because of the information asymmetry between private agents and central government, a revenue-maximizer taxpayer would be tempted to underreport the due tax amounts unless a costly system of monitoring and sanctioning is in place.

Efficiency reasoning would impose setting deterrence level such that the marginal cost of monitoring and sanctioning equals the marginal benefit. Hence, given the practical impossibility of rising sanctions level over reasonable thresholds\(^1\), we could expect that high monitoring costs are associated with a high level of tax evasion. Moreover, even in the case coercive actions would be an efficient solution, political constraints could prevent the implementation of effective deterrent measures. An incumbent regulator interested in maximizing his chances to be reelected could be captured by interest groups benefitting from tax evasion and avoid implementing successful contrasting policies (Stigler, 1971). Finally, tax evasion in some segment of the population could be perceived as a morally justified behavior and pro-tax evasion social norms could develop (for a survey on the ethics of tax evasion McGee, 1998). In situations like the ones described above, any coercive intervention of an external authority would be perceived from the targeted population as a violation of the established norm and would produce countervailing effects (Carbonara et al., 2012). Indeed empirical evidences suggest that, irrespectively of the legal and socio-economic context and the effort put by central governments in fighting indirect tax evasion, the phenomenon

\(^1\)Theoretically Becker (1968) suggests that increasing the sanction level would decrease tax evasion. In fact, for a given probability of detection, the expected profits deriving from evasion are a decreasing function of sanction level. However there are practical arguments that impose a sanction ceiling like, for example, the necessity to preserve the marginal deterrence effect of sanctions and the credibility of the threat made by sanctioning authority.
is still a widespread problem. See Cowell (1990) for a list of the empirical studies on tax evasion and the black economy in nineteen main countries. For a recent review of the literature see also Slemrod (2007).

Despite the traditional methods based on deterrence has not been capable to solve the tax evasion problem, nonetheless traditionally the tax compliance literature has been skeptical about the possibility of implementing alternative policies (for a detailed discussion of this point see Feld et al., 2006). Nonetheless in recent years it is possible to find some contributions investigating reward mechanisms aiming at enhancing tax compliance. A seminal work that analyzes theoretically the consequences of the introduction of a reward mechanism for monitored individuals is due to Falkinger and Walther (1991). The authors show that a mixed of sanctions and rewards would outperform the only sanction system without increasing expenditures for the government. Experimental Economics literature also investigated the performance of rewards compared to the one of a sanctions in achieving compliance. Alm et al. (1992) in a laboratory experiments show that conditioning participation to a lottery to tax compliance behavior *ceteris paribus* increases the rate of compliance more than just rewarding all compliant individuals. Torgler (2003) performed a field experiment among Costa Rica tax payers in order to test the comparative effects of reward, moral suasion and fiscal exchange on tax compliance. He finds that monetary reward is the most effective mechanism to increase compliance. Other disciplines outsides the traditional tax policy literature seem to confirm the positive effects of rewards on motivating desired behaviors. Both social Psychology (Nuttin and Greenwald, 1968; Molm, 1994) and Neuroscience (Gray, 1981; Larsen and Ketelaar, 1991) emphasize the role and effectiveness of rewards in achieving individuals compliance with a given outcome. In particular it seems that punishments and rewards have asymmetrical effects on humans behavior (Sims, 1980), hence making it possible reinforces compliance through a combination of the two methods.

In this paper we discuss a complementary tool to the traditional deterrence approach to tax evasion recently adopted by some Asian and Latin-American countries, the Lottery Ticket Reward Policy (onward LTRP). The idea of LTRP is to provide direct incentives to individual customers to request the emission of the sales receipt associated with a business transaction. In many countries a sales receipt is the proof of the existence of a monetary transaction and it contains information relative to the amount of due tax payment. Once emitted the receipt, for business owners it becomes difficult,
if not impossible, to hide information regarding business volume and taxable income. Hence a key strategy adopted by business owners in evading sales taxes is to avoid printing the receipt of a business transaction. In fact, as we discuss more in details in section 3, absent any policy intervention, customers have virtually no benefits asking for the business transaction receipt, while they could face material and moral cost.

Implementing LTRP, a central government institutes a lottery and links the participation to this lottery to the possession of sales receipts of business transactions. Specifically, a serial number is printed on any sales receipt and the individual owning the receipt with the number corresponding to the lottery extraction is entitled to claim the prize. If the monetary prize of the lottery is smaller than the increase in tax revenue due to the implementation of the LTRP, the government increases its final tax revenue at zero costs. As of today, LTRP has been implemented by countries like Taiwan (already in the 1950s), Philippines, Malaysia and recently Brazil (since 2008) in order to mitigate the sales tax evasion phenomenon. Also China starting 1998 adopted LTRP. As discussed in the next section, the peculiar way Chinese government implemented the policy created a (quasi-) natural experiment and allowed for an estimation of the policy causal effects. However, the successful results reported by these empirical findings seem still to lack a clear theoretical explanation.

The objective of this paper is first of all to explain the positive impact empirically registered of LTRP. We show that relaxing some of the neoclassical assumptions in individual decision making and considering behavioral regularities violating economic rationality paradigm it is possible to explain the policy success. A theoretical model based on Tversky and Kahneman’s Cumulative Prospect Theory (1992) is proposed. Furthermore, given this model specification and calibration of parameters, we introduce a test for verifying the applicability of LTRP in the specific environment and population of interest. Such a test could represent a useful ex-ante indicator of the expected success of LTRP for policymakers interested in increasing the private provision of public goods.

The paper structure is as follow: in the next section it is briefly discussed the peculiar implementation of LTRP in China. Section 3 clarifies the parallelism between requesting a sales tax receipt and a public goods framework. In section 4 we present the model and in section 5 a discussion over possible limitations as well as additional long-run benefits deriving from the policy implementation is provided. Finally, section 6 summarizes conclusions and
2. The Lottery Ticket Reward Policy against Sales Tax Evasion: Evidences from China

An interesting application of LTRP has been implemented in China since 1998. In order to reduce the negative effects of widespread sales tax evasion, the Chinese government started printing a lottery number on receipts registering business transactions. Each lottery pays out a prize after some periods of time. Once issued the receipt, it becomes impossible for the seller to evade business taxes referred to that transaction. Thus the buyer has a direct incentive to ask for the receipt and indirectly oblige the seller to reveal information to the tax agency.

The peculiarity of the Chinese experience consists in the implementation strategy of this policy the government adopted. In fact, the Chinese State Commission for Restructuring the Economic System\(^2\), a Chinese governmental agency, during the period 1998 - 2003 decided to introduce the lottery policy ticket only in some experimental districts in order to test its effects. At first only some service industries, such as food service businesses, issued lottery tickets; however starting from 2002, the spectrum of industries involved has enlarged to include other service industries as well. Also, even within the initial experimental period, the timing for the implementation of the policy was not uniform. Instead the trial area has been progressively expanded involving a growing number of districts. Thanks to the peculiar implementation of the lottery policy the Chinese government carried on, the Chinese experience constitutes a (quasi-) natural experiment.

To the best of our knowledge there is only one study conducted by Wan (2010) investigating the effects of this policy in China. Wan estimated that LTRP causally increased by 17% revenues from sales tax collection in the experimental districts and that the ratio between lottery prizes paid by the government and increased tax revenue ranges between 1:30 and 1:40. In fact, such a success induced the Chinese government to extend progressively the region of application from the initial trial area to the whole state. In an early

unpublished version of his work presented at the International Conference on Econometrics and the World Economy 2009, Wan (2009) tries to explain the success of the lottery policy in increasing tax collection through the saving of transaction costs of cheating\(^3\) associated with a high level equilibrium of tax evasion. Consumers in a standard setting would choose to buy from a tax-evading firm since in a competitive market it can offer lower prices than the honest firm. However, the author suggests it is possible to introduce a lottery having an expected value smaller than the gain deriving from increased tax revenue but greater than the difference between taxes paid by honest firms and the sum of taxes of evading firms plus the transaction costs of cheating. Such an expected gains associated with lottery participation represents a sort of subsidy sufficient to provoke consumers’ shift toward honest firms, driving off the market the evading firms. Hence Wan concludes that there is social gain associated with the introduction of the lottery policy which could be achieved only if transaction costs of cheating are higher than individual costs of asking for the receipt to the seller.

Despite the empirical results presented by Wan are convincing and appear to be robust, the theoretical model proposed does not seem to have the power to explain the challenging success reported. First, from a micro-perspective Wan’s introduction of transaction costs of cheating excludes virtually every level of business - mostly small enterprises and independent workers - for which accountability standards are reduced or so simplified that transaction costs of cheating are negligible. The example of China, where LTRP achieved striking positive results involving only small service businesses, seems to clash with the assumption of high transaction costs of cheating above defined. Moreover on a macro-perspective, assuming that LTRP could be successfully implemented only in the presence of substantial transaction cost of cheating limits its applicability to a handful of cases. In particular, it would exclude developing countries or countries where institutions and the rule of the law are weak and unlawful behaviors are widespread and socially accepted. In those countries where evading tax is considered the rule, evading firms bear no or little transaction costs. On the other hand those countries would be the most in need of innovative policies having immediate beneficial effects without

\(^3\)In the literature on tax evasion a standard assumption is that, for a firm evading taxes, besides the expected costs associated with being discovered and punished, there are additional costs such as hiring CPAs or lawyers and bribing tax officials and law administrators. See for example Allingham and Sandmo (1972).
the need of increase public expenditures. Wan himself recognizes that, in some of the provinces involved in the lottery experiment, tax evasion was the predominant behavior adopted by almost the entire business population: thus it does not seem reasonable to assume that firms were sustaining high transaction costs to hide this widespread behavior.

Stressing on this point, while Wan correctly assumes that asking for a sales receipt implies some costs for consumers (we will return to this point in the next section), at the same time there is evidence that social interactions influence consumers’ behavior with respect to the quantification of these costs. In a laboratory experiment, Falk and Fischbacher (2002) show that the level of criminal behavior adopted by individuals is positively correlated with the level of criminal activity perceived in the social group they belong. Falk et al. (2010) also show that individual’s contribution to public goods is causally related to the level of contribution of her group members. Furthermore Anderlini and Terlizzese (2009) show that adding a social interaction component to the characterization of individual behavior in trust decisions (e.g. the higher an agent’s perception of average trust in the population the more she trusts) could account for the rising of a multiplicity of different equilibria that capture different trust rates in different societies. All the aforementioned studies report evidences that agents’ perception of the other population members’ behavior affects individual choices. In situations where evading taxes is widespread and socially acceptable, ceteris paribus the cost of asking for a receipt born by individual consumers would be higher than in a place with a lower level of tax evasion. Hence paradoxically from Wan’s assumptions, the introduction of LTRP would have a smaller impact the higher the level of unlawful behavior in the population. This result fails to explain the success registered in China, where high tax evasion levels as well as widespread social norms fostering this behavior are in place.

Given the above arguments, it seems the reasons explaining LTRP success have to be investigated starting from different micro-foundations. A model that accounts for individual taste for gambling and overestimation of the utility deriving from a probabilistic lottery prize will be discussed in section 4. The aim of this different approach is first of all to give a comprehensive explanation and a theoretical foundation to an interesting empirical phenomenon. On the other hand this paper tries to enlarge the range of application of LTRP to a wider pool of situations. With respect to the tax evasion situation I argue that, even absent transaction costs of cheating as in countries where the rule of law is weak and social norms pro-tax evasion
present, a correct implementation of the policy mechanism could result in a net tax revenue increase. Moreover, abstracting from the tax evasion context, it is argued that LTRP could be an useful tool for increasing private contribution in any general public goods framework.

Before proceeding, a word of caution regarding the estimation of the results of LTRP in China has to be spent. Concerns could emerge regarding the central state commitment problem, namely the long-term effects deriving from strategic behavior of the Chinese Government. In fact in a one-shot interaction, the optimal behavior for a state holding exclusive enforcing power would be to commit at time zero to pay a prize at time one, collect the increased tax revenue between zero and one and then, at time one, do not paying out any prize. However, such a behavior maximizes revenue in one period but, needless to say, would prevent any possibility to collect revenues in repeated interactions.

Some scattered data collected in China and reported by Wan (2010) during the experimental period show that at the time of the lottery draft the Chinese government paid out only a relatively small fraction of the announced prizes. For example in Beijing during 2002, while the Beijing Local Tax Bureau\(^4\) announced thirteen million Yuan total prize amount to be distributed in multiple extractions, ex post payments are on average less than 17% of the total prizes announced. Given the lack of comprehensive data on this issue and the relatively short period Wan’s contribution analyzes, it should be tested by future investigations if the commitment problem arose out of this behavior and the success of the policy decreased overtime.

### 3. Framing Sales Tax Evasion as a Public Goods Situation

In this section I clarify how buyers that after a business transaction do not receive a sales tax receipt from the seller face a condition symmetrical to a public goods situation. Despite there are evidences that, contrary to the theoretical prediction of zero contribution, the voluntary contribution mechanism in general provides a positive quantity of public goods, nonetheless total contribution in equilibrium remains below the social efficient level (for a survey on experimental economics results on public goods see Ledyard,\(^8\)

\(^4\)See Beijing Local Tax Bureau announcement on July 17th 2002.
The reason is that individuals only partially internalize the benefit deriving from individual contribution, hence complete free-riding results as the dominant strategy.

Now consider a buyer that, after a business transaction, has to claim the sales tax receipt from a deceitful seller and imagine her as a potential contributor to a specific public good, namely state sales tax revenue. In many countries, the sales tax receipt is the document registering the information relative to business transactions and it determines the associated amount of sales taxes that have to be paid. Once emitted a sales tax receipt, it becomes almost impossible for the seller to evade sales taxes. While the law obliges sellers to print out the receipt at any business transaction, however a common source of tax evasion for business owners consists in avoiding the emission of the receipt. Hence it becomes for them possible to underreport the level of earnings and business transactions made. The rational buyer evaluates private cost and benefit linked to the decision of asking for the sales tax receipt to the seller. Consider the total amount of sales taxes involved in the transaction. Assume the time spent by the buyer for asking and waiting the printout of the receipt is negligible. The private benefit deriving to the buyer from asking the sales tax receipt would be equal to the sales taxes involved in the transaction divided by the total population of the institutional entity to which sales taxes are paid (e.g. state level, federal level, etc.). Hence, given that this population is usually large, private incentives to ask for a receipt are almost zero.

On the other hand, even ruling out the opportunity cost of time in asking and waiting for a receipt, a customer not enforcing a sales tax receipt emission may derive some benefits. First of all, it is possible to enjoy a price discount on the purchased goods. In fact a business owner that does not emit a receipt increases his profit by the amount of taxes involved in the transaction subtracted the expected cost of sanction. Any positive fraction of this increased profit could be transferred to the customer through a price discount. Hence customers and business owners could collude evading taxes due to the collectivity and privately sharing the benefits. Moreover, even in situations where bargain solutions are not available, scholars report evi-

---

\(^5\)There is a multitude of transactions where individual bargaining over a price discount in exchange of an unlawful action is not feasible. For example situations in which the payment happens to be made in front of an audience. Moreover for transactions of small entity the opportunity cost of avoiding to bargain would be higher than the eventual gain
dences of the existence of positive moral, ethical and social costs for buyers associated to requesting sellers to comply with fiscal norms. McGee (1998) collects two decades of scholars’ contributions investigating ethical aspects of evading taxes. The book provides extensive discussions of cultural, philosophical and religious perspectives on tax-evasion underlying the arguments that could lead to the formation of pro-tax evasion norms of behavior. As a consequence of this social norms, in certain cultures individuals wanting to broke these informal norms have to bear social costs. Chang and Lai (2004) proposed a model incorporating social norms into a collaborative tax evasion agreement between a seller and his customer. They found that this collusive practice tends to intensify the extension of the tax evasion problem and could give rise to a multiplicity of equilibria. Moreover the authors point out how the snowballing effect stemming from social norms of tax evasion has decisive influences either on the authority’s tax enforcement efficacy and to consumers’ conformity to the tax code. Also Kirchler (2007) in his extensive contribution analyzes the behavioral aspects of tax compliance and evasion, focusing on the psychological reasons leading customers to collude and accept tax evasion.

The contributions above suggest that, in some culture or societies, positive costs are associated to the failure of complying with established norms favouring sales tax evasion. Hence it is possible to see the similarity with a public goods situation from the perspective of the consumer. While she bears personal costs in expressly requesting the emission of a sales receipt, however, absent any external reward, she internalizes no benefit from this enforcing operation. Hence, while it would be optimal from a social point of view having consumers enforcing sales receipt emission, nonetheless in the above mentioned social contexts free-riding remains the individual dominant strategy. In the next section I provide a model describing this situation and the changes implied by the introduction of LTRP.

4. The Model

Consider a Public Goods situation where it’s no possible or not feasible to increase the level of private contribution by increasing sanctions and it from a discount. Finally, in some cultures like for example the Japanese one, bargaining over a price is unusual or even considered unpolite (Berton, 1998).
is not efficient to incentivize contributions through costly subsidies. Define parameters as:

\( N \): number of players.
\( t : 1, \ldots, T \): number of contribution periods.
\( y_i \): initial endowment player i.
\( x_i \): expected payoff player i.
\( a_{i,t} \): per period contribution player i.
\( a^* \): per period required level of contribution to get a lottery ticket (exogenously settled).
\( m \): marginal per capita return to the public good.

Under a voluntary contribution mechanism to the public good with no lottery the expected individual payoff for each period is:

\[
x_i = y_i - a_i + m \sum_{j=1}^{N} a_j
\] (1)

In order to replicate a classical public goods game situation set the parameters in such a way that it holds:

- \( m > \frac{1}{N} \)
- \( m < 1 \)

Participants to the public goods game maximize individual payoffs with respect to the chosen contribution level:

\[
\frac{\partial x_i}{\partial a_i} : -1 + m < 0
\] (2)

Hence it is a dominant strategy for individuals to completely free-ride while it would be Pareto-efficient everyone contributes the full endowment to the public good. Theoretical predictions indicate that the contribution rate will converge toward a suboptimal equilibrium level of contribution \( \hat{A} \) (equal or close to 0 if it is assumed that a small fraction \( \tau \) of players always adopts strictly altruistic behavior):
\[ \hat{A} = \sum_{i=1}^{N} a_i = \tau N a^* \]

Now assume a Central Authority interested in increasing the amount of public good collected introduces a lottery linked to the public good. The prize \( \delta_{t=z} \), \( z = 0, T, 2T, ... \), will be cyclically announced at time \( t \) and assigned after period \( T \). Each lottery ticket has probability of being drawn of \( 1/(N*T) \). Each subject has the possibility of acquiring a lottery ticket in each period providing a contribution to the public good \( a_i \geq a^* \). Therefore the individual probability probability \( p_i \) of winning the lottery prize depends on the individual player choices of contribution:

\[ p_i = (NT)^{-1} \sum_{t=1}^{T} c_{i,t} \]

where \( c_{i,t} = 1 \) if \( (a_{i,t} \geq a^*) \) and 0 otherwise.

The individual per period payoff when the lottery policy is implemented becomes:

\[ x_i^R = y_i - a_i + m \sum_{j=1}^{N} a_j + (1/T)p_i \delta_z \]

where \( \delta_z \) is equal or smaller to the estimated quantity \( \hat{\delta}_0 \) announced at the initial period for \( t=0 \) and paid after \( T \) periods; while for \( t>0 \) \( \delta_z \) is equal or smaller the total public good contributions collected in the previous \( T \) periods subtracted the sum of per period voluntary contributions level \( \hat{A} \) that is collected when no lottery policy is in place (\( \hat{A} \) is assumed to be constant).

Moreover to complete the feasibility constraint the Central Authority takes into account that the lottery prize will not be paid out with probability \( (1-p^*) \), where \( p^* \) is the fraction of the total number of tickets emitted for each lottery that has been acquired by contributors. Hence:

\[ \hat{\delta}_{z=0} = \left[ \sum_{t=1}^{T} \sum_{i=1}^{N} a_{i,t} - T \hat{A} \right] p^* \]
\[
\delta_{z>0} = [\delta_{z-T} - T\hat{A}]p^*
\]  
\[p^* = (NT)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} c_{i,t} \]  
(7)  
(8)

Without loss of generality, assume that in each period agents face a single binary decision either to positive contribute to the public good or free-ride, hence \(a_i = 0\) or \(a_i = a^* = 1\). As discussed in the previous section, in the specific context of sales tax evasion \(a_i\) could be interpreted as the opportunity cost of a lost price discount combined with the moral costs associated with a receipt request. Moreover for simplicity consider the case where \(t=T=1\) and \(z=0\). Per period \(p_i\) becomes:

\[
\frac{1}{N}
\]  
when \(a_i=1\) and 0 otherwise.

Now consider the individual choice over the binary alternative to either contribute or free-ride. Individuals per period payoff given no contribution becomes:

\[
x_i = y_i + m \sum_{j\neq i,j=1}^{N} c_{i,t}
\]  
(10)

Instead the payoff associated with a contribution to the public good that implies the possibility to win the lottery prize is:

\[
x_i^R = y_i - 1 + m \sum_{j=1}^{N} +U(\hat{\delta},p)
\]  
(11)

To further simplify the analysis and without loss of generality, assume that \(N\) is large enough such that the individual contribution is negligible with respect to the quantity of public good provided:

\[
\sum_{i=1}^{N} \approx \sum_{j\neq i,j=1}^{N}
\]  
(12)
The disequation reduces then to compare the value of the prospect $\hat{\delta}$ with that of the required contribution $a_i$. Hence individual contribute to the public good iff:

$$U(\hat{\delta}, p) \geq 1$$  \hspace{1cm} (13)

Now introduce heterogeneity in population types. Assume that a fraction $(1-\psi)$, $\psi \in [0,1]$, of the population behaves as an expected Von Neumann-Morgenstern (VNM onward) utility maximizer (Von Neumann and Morgenstern, 1944). Hence individuals evaluate the probabilistic prospect $\hat{\delta}$ through maximization of expected utility. Given the probability to win the lottery prize specified in (9), individuals contribute iff:

$$U(\hat{\delta}, p) = \frac{U(\hat{\delta})}{N} \geq 1$$  \hspace{1cm} (14)

where $\frac{\partial U}{\partial \hat{\delta}} > 0$ and $\frac{\partial^2 U}{\partial \hat{\delta}^2} \leq 0$.

**Proposition 1.** For any VNM expected utility maximizer agent having a utility functional form that does not imply risk seeking behavior the individual optimal strategy of contribution is $a_i = 0$, irrespectively of the implementation of LTRP.

**Proof.** Consider the feasibility constraint in setting the prize $\hat{\delta}$ in (6) and the condition for contribution in (14). Consider the extreme case of a risk-neutral agent interested in maximizing wealth. Consider the best-case scenario in which all the members of the population contribute to the public good. The condition for individual contribution becomes:

$$\frac{1}{N} \left[ \hat{\delta} = \sum_{a=1}^{N} a_i \in [0, N] \right] - \hat{A} < 1$$  \hspace{1cm} (15)

Given that by assumption utility is marginally constant or decreasing in wealth and risk-seeking preferences are ruled out, the case considered represents the most attractive possibility for a VNM expected utility maximizer agent to accept the gamble opportunity. Hence, given that any other possible combination of risk-preferences and utility functional form results in a decreased value of the left side of equation (15), it is possible to conclude that for VNM-type agents free-riding remains the dominant strategy, independently from the implementation of LTRP. \qed
Now assume that the remaining fraction $\psi$ of the population evaluates the prospect $\hat{\delta}$ through Cumulative Prospect Theory (CPT). CPT is a model describing decisions under risk proposed in their pathbreaking articles by Tversky and Kahneman (1992). The theory was introduced in order to capture some behavioral regularities in individual decision-making, like risk-seeking, loss aversion and overweight (underweight) of unlikely (average) events, that could not be explained by Expected Utility Theory. In particular CPT modifies Expected Utility Theory by replacing final wealth with payoffs relative to the status quo, replacing the utility function with a value function that depends on relative payoffs, and replacing cumulative probabilities with weighted cumulative probabilities.

The interesting aspect of CPT for the purpose of this article is the attention paid to behavioral regularities/anomalies like nonlinear preferences and risk-seeking behavior in betting and lotteries\(^6\). It is in fact well known that Expected Utility Theory cannot explain why individuals at the same time buy insurances and like gambling (Camerer et al., 2003). Specifically, CPT implies that individuals weight non linearly the probability of getting the lottery prize and evaluate the lottery outcome by mean of a value function. In the discussion that follows, I adopt the same value and weighting functional forms proposed by Tversky and Kahneman (1992)\(^7\).

**Proposition 2.** When LTRP is established, it is possible to find a set of conditions under which, for a CPT-type agent, contributing to the public good becomes the individual dominant strategy.

**Proof.** Consider CPT value and weighting functions. Substituting and plugging the terms defined above in CPT model it is possible to derive individual

---

\(^6\)As well summarized by Camerer and Loewenstein (2004): "Expected Utility hypothesis is like Newtonian mechanics [...] Linear Probability weighting in Expected Utility works reasonably well except when outcome probabilities are very low or high. But low-probability events are important in the economy, in the form of gambles with positive skewness (lottery tickets, and also risky business ventures in biotech and pharmaceuticals), and catastrophic events that require large insurance industries. [...] People are typically averse to risky spreading of possible money gains."

\(^7\)A correct characterization of the most appropriate functional form for the value function is outside the scope of the present work. While I decided to adopt Tversky and Kahneman’s original formulation, it must be underlined that finding the most appropriate utility functional form remains an open issue. Nevertheless notice that the results obtained assuming an exponential utility function hold for any continue and concave functional form.
conditions for contribution:

\[ U(\hat{\delta}, p) = \frac{(\frac{1}{N})^\sigma}{((\frac{1}{N})^\sigma + (1 - (\frac{1}{N})^\sigma))^{\frac{1}{\sigma}}} \hat{\delta}^{\rho} \geq 1 \] (16)

where \( \sigma \in [0, 1] \) and \( \rho \in [0, 1] \) describe respectively the curvature of the weighting function and the degree of risk aversion.

Since the fraction \((1-\psi)\) of the population constitutes of VNM-type agents will not contribute to the public good for any feasible amount of \(\hat{\delta}\), the feasibility constraint for the Central Authority setting the prize becomes:

\[ \psi \hat{\delta} \leq \sum_{i=1}^{N} a_i - \hat{A} \] (17)

because with probability \((1-\psi)\) the lottery prize remains to the Central Authority. Substituting \(\hat{A}\) according to (3), rearranging (16), and solving for \(\hat{\delta}\) restricting the attention to the case of equality the result is:

\[ \hat{\delta} = N - \frac{\tau N}{\psi} \] (18)

Plugging (18) in (16) results in a non-linear equation depending from the population size and from a set of parameters \(\tau, \psi, \rho\) and \(\sigma\). Hence it is possible to derive the condition under which it becomes a dominant strategy for individuals to contribute to the public good:

\[ U(\delta) = \frac{(\frac{1}{N})^\sigma}{((\frac{1}{N})^\sigma + (1 - (\frac{1}{N})^\sigma))^{\frac{1}{\sigma}}} (N - \frac{\tau N}{\psi})^{\rho} - 1 \geq 0 \] (19)

Providing a calibration of the aforementioned parameters, it is possible to find a graphical solution of (19). A sensitivity analysis (see for example figures 1 - 3 below) shows that it exists a set of conditions where contributing to the public good becomes for agents an individual dominant strategy.

In particular it seems that, given a set of values of the parameters, the authority organizing the lottery could verify if the size of the population of interest is at least equal to the level \(N = N^*\). In fact, above this threshold level it is possible to set a prize \(\hat{\delta}\) such that the entire fraction of the population \(\psi\) finds contributing to the public good the dominant strategy.
Figure 1: Example of a population where 25% of agents is assumed to be altruistic contributors, i.e. always contribute the socially efficient amount of the public good irrespectively of what the other members are doing. The percentage of agents evaluating the probabilistic LTRP prize through CPT is 30%. The exponent of the value function $\rho$ and the weighting function parameter $\sigma$ are reported as in Tversky and Kahneman (1992). It is possible to see as in this situation the minimum number of agents in the population required for LTRP to be successful is $N \approx 350$.

The fact that $N$ is the variable of interest for the central authority should not appear matter of concern. While the dimension of the population involved in the provision of the public good and so in LTRP is usually an exogenously given parameter, nevertheless it could be possible that the same authority (e.g. a central government) has the possibility to organize and implement the policy at different levels (e.g. city, county, province or regional level). The model presented could suggest policymakers the hierarchical lower level where such a policy would work. On the other hand, in situations in which the size of the population of interest is fixed and exogenously given, the model would provide a cheap and practical ex-ante test of the likelihood of success for a policymaker interested in applying LTRP in specific contexts.

5. Possible Counter-arguments and Positive Side-Effects

The empirical evidences discussed in previous sections and the theoretical results of the model presented in section 4 suggest that LTRP could be an
Figure 2: An increase in the fraction of altruistic contributors $\tau$ with respect to the example reported in Figure 1 implies, all things equal, a larger minimum population size for LTRP implementation.

Figure 3: Increasing risk-aversion, i.e. dropping the value of the exponent of the value function $\rho$, all things equal requires an increase in the minimum population size necessary for LTRP application. In this example we could see how, given high level of risk-aversion, LTRP could not be applied successfully for any population size.
effective tool for policymakers in order to achieve social efficient outcomes. As an example consider a population where, as a consequence of her institutional setup, norms and traditions is entitled to a low level of social capital. This could imply the rise of high transaction costs within the society that prevent a full economic development. Examples could be developing countries or societies where there is a combination of weak central authority power and lack of the rule of law on one hand and an established set of inefficient social norms on the other. In these situations, central governments would face difficulties in achieving welfare improvement by means of traditional policies.

In fact, as Basu (2000) argues, ”Law is Economics”: the provisions of the law per se have no influence on people’s behavior. If not played by all agents, law ends up to be just ink on paper. In fact law efficacy is founded entirely on people’s belief that - at least some of - the other agents’ behavior will coordinate toward the focal point prescribed by the law. It is hopeless for lawmakers targeting a societal outcome through the implementation of inexpressive laws (McAdams, 2000; Carbonara et al., 2011). In the case of public goods situations like the ones mentioned above, it is inefficient for any private individual to adopt cooperative behavior. In fact, given the high probability that other individuals would free-ride on the public goods provision and the low probability of being sanctioned, the dominant strategy for individual players consists in free-riding. Indeed it has been repeatedly shown by experimental economists that, unless a credible sanctioning mechanism is instituted, contribution to the public good converges overtime toward a suboptimal quantity provided. Hence, under the social and institutional conditions described above, non-orthodox policies have to be considered in order to improve social welfare.

One possible counter-argument toward the implementation of LTRP described is that it requires a central authority to commit at time 0 paying a defined prize. This lottery prize has to be ex-ante announced, however effective increases deriving from the policy implementation are registered only afterwards. So the amount of the prize initially offered could be seen as an investment made in condition of uncertainty that cannot guarantee future returns. While the policy proposal is founded on a theoretical argument supported by experimental and empirical evidences, nevertheless the design and practical implementation of LTRP could be complex and subject to failures. Moreover, while in a laboratory environment it is possible to run pilot experiments and learn from mistakes, for societies or organizations could be
prohibitively costly to attach a positive probability that LTRP fails due to incorrect implementation. Finally, the mechanism rests on the assumption that agents’ taste for gambling does not decrease overtime. The sustainability of the LTRP in the long-run depends on this factor. It should be tested if individual contributions, boosted by the excitement for the new gambling opportunity in the early lottery periods, will eventually decline overtime.

On the top of the concerns discussed above, in the next sub-section I consider an additional possible cause of inefficiency for LTRP, namely the crowding-out of voluntary contribution.

5.1. Do Monetary Incentives Crowd Out Altruistic Behavior? Another Possible Argument of Caution

One recent branch of investigation followed by Experimental Economics and Law and Economics scholars is the controversial relation between legal regulation and the presence of "mild laws". While the former enforcement mechanism exogenously imposes sanctions decided by an external authority, mild laws instead are based on social norms and other mechanisms of self-regulation. How it has been pointed out (Ellickson, 1998; Zasu, 2007; Kube and Traxler, 2011), when feasible mild laws regulation should be promoted, since it makes possible to achieve social efficient outcomes at a lower cost for the society with respect to a formal system of enforcement. Moreover, as Van der Weele (2012) notices, the presence of a formal legal apparatus indirectly signals to the uninformed reciprocal cooperative citizen that a better informed central authority estimated necessary to decrease the general level of defection. This could have a crowding-out effect of trust on reciprocal cooperators, resulting in a decrease of the actual level of compliance (Galbiati et al., 2010).

On the other hand there is a growing body of literature both in Psychology and Economics focusing on the direct and indirect detrimental effects of monetary incentives. In fact, it seems that monetary incentives directly crowd out individuals’ willingness to behave pro-socially and indirectly affect the well-functioning of a norm-enforcing mechanism\textsuperscript{8}. Investigating this issue, Fuster and Meier (2010) set up an experimental treatment in order to verify the presence of such a negative indirect effects of monetary incentives.

\textsuperscript{8}Quoting Ariely (2008) "Money, as it turns out, is the most expensive way to motivate people. Social norms are not only cheaper, but often more effective as well".

20
The authors conduct a classical public goods game experiment with punishment option, adding in some treatments monetary incentives in the form of lottery tickets as an exchange to contribution to the public good. The stake of the prize of the lottery is set in such a way that it remains optimal for the rational player to free-ride completely. It results that in the treatments with monetary incentives players are less likely to punish the free-riders with respect to treatments without monetary incentives. Moreover in the presence of private monetary incentives, the increase in contribution level of free-riders to punishment in subsequent periods is less pronounced with respect to the situation in which no incentives are provided. The combination of these negative factors leads the contribution level to the public good unchanged in the situation with or without the private incentives scheme. The possible explanations for this counter-intuitive results summarized by the authors include: destruction of intrinsic motivation by extrinsic incentives; reduction of trust in a principal-agent relationship together with a shift of an individual’s frame from a social to a monetary frame; and the possibility that individuals’ motivation to contribute is reduced when other people could quantify individuals’ provision of public good.

The results reported by Fuster and Meier have significant implications for LTRP. If it is true, in the short-run, the overall level of society’s welfare might not be affected by the alternative between punishment enforcement and rewards, nevertheless in the long-run the choice leads toward different cost-benefit paths. Indeed the (costless) threat of sanction by itself could sustain cooperation while the provision of rewards must be repeated over-time (Dari-Mattiacci and De Geest, 2010). As a consequence, it seems that LTRP could be effective and self-sustaining only if applied in the presence of some accessory conditions. In particular, the possible crowding-out effect of monetary incentives on norm enforcement might not represent a problem when inefficient behaviors are socially established. In fact, in situations where a set of inefficient social norms is established, no social punishment or peer pressure enhancing voluntary contribution to public goods have to be expected. Hence a system of reward incentives could achieve higher contribution levels without creating indirect effects. Moreover in situations where the cost of enforcement is higher than the benefit deriving from an increased level of contribution, it could be more effective trying to increase the level of individual contribution through the provision of rewards.

However, beside the concerns emerging from possible side-effects, it is worth mentioning some possible positive externalities connected to LTRP
implementation. In the next paragraphs a brief discussion of two desirable functions that LTRP implies is provided: screening (in the short-run) and equilibria shift in a *no pain no gain situation* (in the long-run).

5.2. Screening

In this subsection I discuss the possibility that the introduction of LTRP in some contexts could indirectly increase the efficiency of the monitoring system. Imagine LTRP is adopted in order to increase sales tax payments in retail shops. Assume that tax evasion, in the form of absence of release by sellers of the business receipt, is a widespread behavior and also that collusive consumers accept it. The implementation of LTRP links the right to gain a lottery ticket for the buyer to the acquisition of the receipt registering a business transaction. If this policy is adopted, a fraction of buyers has private incentives to require the transaction receipts from the shops that are used to evade tax. Since the central authority has access at no cost to the historical records of taxable income reported by shop owners, it is easy to identify those shops that present an abnormal peak in reported income during the period of implementation of LTRP. This allows the monitoring agency to separate them from shops reporting instead a continuous taxable income level. This signal could be used as an indicator in order to efficiently convey resources and monitoring expenses, attaching a higher probability of monitoring to those shops that reported a discontinuous trend. Shop owners used to evade taxes, anticipating the increased probability of being monitored, would review their behavior and increase contribution levels.

On the other hand, it could be argued that the shop owners compliant before LTRP introduction are simply the more risk-averse agents. Hence a monitoring system that conveys resources on the non-compliant agents would lower the actual probability of being monitored for the compliant ones. Therefore, the reduction in the probability of being monitored might induce formerly compliant shop owners to stop printing sales receipts when not explicitly requested by customers. This might offset any positive effect of the monitoring resources reallocation. However empirical and experimental findings show that deterrence models predict a level of tax evasion much higher than the one observed. For an overview see Alm (1999) and Torgler (2002). Elffers (2000) argues that tax evasion as interpreted by economic theory is just the last of a longer series of step that has to be walked before an individual become a tax evader. Frey (1999) shows that there are taxpayers not even searching for the way of evading taxes. Tyran and Feld (2002)
show that certain individuals always comply, independently of the level of audits and penalties. This studies suggest that honest shop owners often comply with the tax authority for reasons different from a rational cost-benefit analysis. Hence, it seems plausible to assume that most of the shop owners that are compliant before LTRP introduction will not modify their behavior thereafter.

As discussed before, it is possible LTRP turns out to be not sustainable after the first prize payment. In fact, the policy would be suspended if the increase in tax revenue eventually is not sufficient to pay back the prize promised. Hence in this case the central agency that committed to paying the prize has to incur a temporary loss. However benefits of a higher contribution level deriving from a more efficient screening and sanctioning systems will produce revenue increases also in subsequent periods, when the policy is no more in place. Therefore, even if LTRP could create a loss for the government in the initial period of introduction, in the long-run it would translate in a net increase of tax revenue.

5.3. Equilibria Shift in a No Pain No Gain Situation

Following Parisi (2000), it is possible to interpret the apparently irrational presence of Pareto-inefficient norms within a society as a point of local optimum in a set of non-convex preferences. This inefficient equilibrium would require an initial effort and loss of utility to be modified. Facing this no pain no gain situation, bounded rational individuals with no perfect information regarding all the possible states of the world might not evolve toward a Pareto efficient equilibrium, unless an external shock incentivizes them to move away from the local optimum.

The introduction of LTRP and the consequent presence of an augmented fraction of agents that undertake a social efficient behavior could work as an incentive in this sense. This individuals adopting a pro-social behavior because of the lottery incentives might create a snowball-effect that triggers a virtuous mechanism of contribution also in the rest of the population (Aviram, 2004). Even if, after the first prize is assigned, the government cannot financially sustain repetitions of the lottery, nonetheless players might have already reached a Pareto-efficient equilibrium. Therefore in the new situation, even absent external incentives, agents would continue to adopt the socially efficient behavior. In practice, while initial investments and incentives mechanisms might last only a limited time, the positive externalities created by LTRP would continue to spread also in the future.
6. Conclusion

Evidences from the (quasi-) natural experiment happened in China show that the implementation of LTRP increases the level of private contribution to a special kind of public good, namely sales tax revenue. In this paper, after providing a clarification regarding the parallelism between sales tax evasion and public goods situations, I propose a theoretical model explaining the results of the Chinese experience. Given the theoretical framework proposed and a calibration exercise, it is suggested the possibility to test the likelihood of LTRP successful implementation in particular contexts. Furthermore, a discussion on the conditions necessary for the policy application has been provided. In particular I discussed the roles of risk-preferences, norms of voluntary contribution and population size with respect to the well functioning of this incentives scheme.

Major concerns emerge on one hand from the calibration of a proper lottery prize and, on the other hand, from the possibility of crowding-out effects due to the introduction of monetary incentives. Regarding the first issue, a well specified reward must be able to induce agents contributing to the public good, despite it is not an efficient strategy for an expected utility maximizer. A theoretical model based on Cumulative Prospect Theory has been proposed. This model, combined with a calibration of population risk preferences, constitute a starting point for testing the applicability of LTRP in specific socio-economic environments.

With respect to the possibility of crowding-out voluntary contributions, experimental economics provides evidences of a possible crowding-out effect of either direct pro-social behavior and indirect norm enforcement as a consequence of the introduction of monetary incentives. The combination of this two factors might offset the benefit deriving from LTRP introduction. Hence, in order to limit crowding-out effects, I suggest to restrict the range of possible application of LTRP to situations characterized by inefficient social norms and low levels of voluntary contribution.

Finally, it has been pointed out how in some peculiar settings LTRP could have additional long-run efficiency enhancing properties, even if implemented only for a limited number of periods.
References


Ariely, D., 2008. The cost of social norms: Why we are happy to do things but not when we are paid to do them. Predictably Irrational: The Hidden Forces That Shape Our Decisions, 67–88.


