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WASTE POLICY IN THE TIME OF GOMORRAH: A TALE OF ILLEGAL DISPOSAL, MAFIA AND SOCIAL WELL BEING

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Keywords : waste policy, organized crime, enforcement

Waste policy in the time of Gomorrah: A tale of illegal disposal, Mafia and social well being.*

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Abstract

The paper extends the existing literature on optimal waste policy in two ways: it endogenize enforcement effort and it allows for the presence of a criminal organization receiving a (socially costly) rent in exchange of illegal disposal. We assume that a criminal organization extorts rents from agents willing to perform illegal disposal. In such a case, the State enforcement effort can hit directly only the criminal organization; agents are therefore subject to *indirect* enforcement *via* the Mafia extortion. In a setting where the State acts as a Stackelberg leader with respect to the Mafia, our first conclusion is that actual enforcement under the Mafia can be higher or lower than in its absence, depending on enforcement cost and effectiveness differentials as well as the rent social costs. Our analysis also leads us to conclude that social welfare can be higher under organized crime when the State enforcement costs in the absence of the Mafia are sufficiently high and the rent social costs are sufficiently low. Finally we provide a numerical example and identify possible economic efficiency explanations rationalizing the willingness of local authorities to tolerate the presence of a criminal organization in illegal waste disposal.

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1 Introduction

Organized crime plays a crucial role in distorting waste management in many parts of Italy as well as worldwide[1]. It is therefore surprising that no attention is devoted by the waste policy literature to this specific issue. The aim of this paper is to move a first step to fill this gap by explicitly modelling the presence of Mafia in the waste cycle[2].

We develop a simple model where an economic agent (a firm or a consumer) chooses the level of economic activity as well as the way of disposing of the consequent waste. More specifically, the agent can choose among legal and illegal disposal. Legal disposal implies convex private costs and the payment of a price to a waste disposing firm. The latter acts on a perfectly competitive market and pays a tax on the amount of legally disposed waste[3]. Illegal disposal can be performed directly by the firm or by a criminal organization, whose aim is to maximize net rents. Finally, we assume that enforcement is costly: the State cannot directly enforce taxes on illegal disposal, and to punish a dishonest agent the State must expend costly monitoring resources.

We start by deriving first best conditions and comparing them with those arising from a two stage incomplete enforcement game. In the first stage the State (an environmental authority) sets the waste tax rate and the enforcement effort to maximize social welfare, while in the second stage the firm chooses legal and illegal disposal and the resulting level of economic activity to maximize its expected net benefits. Not surprisingly, we conclude that, under costly enforcement, first best, though feasible, is not socially desirable. As a result, illegal disposal is higher than in the social optimum.

The second part of the paper introduces organized crime. Coherently with real life observation[4], we assume that in the presence of organized crime, enforcement by the State is devoted to the criminal organization, while no enforcement on individuals is possible: the criminal organization is capable of disposing of wastes and provides individuals with a seemingly lawful documentation. As it is reasonable, enforcement cost under the Mafia is assumed to be equal or higher than the corresponding cost when no criminal organization operates. The costs born by organized crime are supposed to be fixed costs, related to lobbying and becoming part of the political and economic establishment. Finally, we assume that the rent accruing to the Mafia is socially costly[5].

The first stage of the enforcement game is modelled as a Stackelberg game

[1] See Legambiente ([8] and [9]).

[2] Though our model applies in general, our setting is specifically suitable to consider the case of special waste management. Indeed, evidence deems the latter as a sector where organized crime is especially present ([9]). Further, special waste need specific and costly treatment practises, due to the related risks for the environment and human health.

[3] Such a setting is coherent with the institutional framework for special waste in Italy, where firms earn profits from the treatment of special waste and pay a tax on the amount of landfilled waste, under the assumption that firms themselves do not recycle products. As the treatment firms are perfectly competitive, the results are not expected to change in qualitative terms if disposal is directly made by agents producing waste.

[4] See [2],[8].

[5] See [6].

between the State (leader) and the Mafia (follower). More specifically, the State sets the tax rate on legal disposal and the enforcement effort, then the Mafia sets the extortion rate that must be paid by waste producing agents in order to dispose of waste illegally. In the presence of organized crime, therefore, the State exert enforcement effort only indirectly, by influencing the Mafia extortion rate. The latter is shown to increase with the former, but on a less than one to one basis.

Our first conclusion is that actual enforcement under the Mafia can be higher or lower than in its absence. The outcome depends on three counteracting effects: the higher enforcement costs and the lower enforcement effectiveness under organized crime lead to a higher effort without the Mafia, but social costs related to the illegal rent imply a higher effort under organized crime. The net effect is not straightfoward.

The analysis also leads us to conclude that social welfare can be higher under organized crime. This happens when the State enforcement costs in the absence of the Mafia are sufficiently high and the rent social costs are sufficiently low.

Finally we provide a numerical example where symmetric enforcement costs are assumed, and show that our model can identify possible economic efficiency explanations of the presence of organized crime in the waste disposal and treatment industry. This happens when organized crime brings about an increase in economic activity, which generates a more than proportional increase in illegal disposal. In order for this to be possible, however, the benefits stemming from the boost in economic activity *plus* enforcement cost savings have to more than offset damages from increased illegal disposal and the social costs of the illegal rent.

The starting point of our work is the paper by Sullivan [11], where different policy options to address waste disposal are compared in the presence of illegal waste disposal: a laissez-faire policy, a subsidy on legal disposal and a penalty coupled with monitoring effort. Fullerton and Kinnaman [5] extend Sulllivan paper to account for the joint use of several policy instruments. The paper addresses, in a general equilibrium setting, the optimal waste policy under the assumption that illicit burning or dumping cannot be taxed directly. The authors conclude that the optimal fee structure is a deposit-refund system: a tax on all output plus a rebate on proper disposal through either recycling or garbage collection. Though our paper adopts a partial equilibrium modeling strategy, we add to the received literature by explicitly endogenizing enforcement and by allowing for the presence of a criminal organization in managing illegal disposal. Under this respect we also connect to the literature on the economics of organized crime (see, for instance, Fiorentini and Peltzman [4]). A relevant contribution is, in particular, Grossmann [7], who develops the organized crime as a competitor of the State in the provision of public services. This modeling strategy implies an upper limit to the "price" that the State itself might charge to taxpayers. A similar trade off is likely to arise in waste disposal choices. Another crucial contribution under this respect is Garoupa [6]. The author extends the optimal law enforcement literature to organized crime and models the criminal organization as a vertical structure where the principal

extracts some rents from the agents through extortion, concluding that, at least as long as extortion is a costless transfer from individuals to the criminal organization, the existence of extortion might even be social welfare improving. We borrow the modeling strategy by Garoupa, and apply it to the specific problem of waste disposal.

The paper is organized as follows: the next Section presents the model and Section 3 introduces incomplete enforcement. Section 4 derives results in the presence of organized crime whereas Section 5 performs the relevant comparisons and provides an illustrative example. Finally, Section 6 concludes.

2 The model

Consider a representative agent (a firm or a consumer) which performs an economic activity and produces waste that can be legally or illegally disposed of. The legal disposal is termed as g, whereas b is the amount of illegal disposal. Benefits from the economic activity (gross of enforcement related costs) are:

$$U(g,b) = \alpha(g+b) - \frac{(g+b)^2}{2} - \mu\frac{g^2}{2} \tag{1}$$

where α is a positive parameter and $\mu\frac{g^2}{2}$ are private costs due to legal disposal[6].

Waste is disposed of by a waste treatment firm operating on a perfectly competitive market. The firm's profits are:

$$\Pi(g) = (p - \varepsilon - t)g$$

where p is the price received for legal waste disposal, ε is the unit disposal cost and t is the unit tax on legal disposal, i.e. the tax the waste management firm has to pay to the regulator. Under perfect competition, the zero profits condition implies:

$$p = \varepsilon + t$$

The damage function from waste disposal is supposed to be:

$$D(g,b) = \delta g + \gamma b$$

Specifically, we assume that $\gamma > \delta$, implying that (for a given quantity of waste) illegal disposal produces higher damages. Both δ and γ are defined in very broad terms, accounting for any kind of damage related to waste disposal. They include, therefore, damages related to forgone recycling opportunities.

Maximization of social welfare,which is affected by waste disposal net social costs, implies the solution to the following problem:

$$\max_{g,b} W = U(g,b) - \varepsilon g - (\delta g + \gamma b)\,. \tag{2}$$

[6] Private costs from illegal disposal are normalized to 0.

First best levels for legal and illegal disposal are:

$$g_f = \frac{1}{\mu}(\gamma - \delta - \varepsilon) \tag{3}$$

$$b_f = \frac{1}{\mu}(\delta - \gamma + \varepsilon) + (\alpha - \gamma) \tag{4}$$

3 Incomplete enforcement

This Section examines the two stage game resulting from the presence of illegal disposal under incomplete enforcement. The State sets a tax rate t on legal disposal, while it cannot observe the amount of illegal disposal, unless it expends resources in doing so. The State enforcement efforts are summed up in the level of the expected fine per unit of illegal disposal, termed as F. The expected fine paid by the economic agent is therefore bF[7]. Unit enforcement costs are constant and equal to θ.

The incomplete enforcement game is solved backwards: in the second stage, the waste producing agent takes the tax and the expected fine as given and chooses the amount of legal and illegal disposal. In the first stage, the environmental authority chooses the waste tax and the expected fine which maximize social welfare.

3.1 Second stage: waste producing agent

Under incomplete enforcement, the agent maximizes its utility $U(g,b) - pg - Fb$, where U is defined as (1) and $p = \varepsilon + t$.

For internal solutions, it follows that[8]:

$$g(t,F) = \frac{1}{\mu}(F - t - \varepsilon) \tag{5}$$

$$b(t,F) = \alpha + \frac{1}{\mu}(t + \varepsilon) - \frac{1+\mu}{\mu}F \tag{6}$$

As expected, illegal (legal) disposal increases (decreases) with t and decreases (increases) with F. Also, increasing private and treatment costs leads to a decrease in g and to an increase in b. Notice also that first best is feasible[9].

[7] To keep the model tractable we assume that the firm is audited in an unexpected way and cannot change b after realizing. Further, the expected unit fine is assumed not to vary with b. For a discussion of the implications of such hypothesis see, for example, Malik [10].

[8] We focus on internal solutions. On one hand, the case where only legal disposal takes place seems unrealistic. On the other hand, we disregard the extreme case where the agent dispose of all waste illegally.

[9] By setting $F = \gamma$ and $t = \delta$, (5) and (6) would replicate (3) and (4).

3.2 First stage: the State.

In the first stage, the government chooses t and F in order to maximize social welfare:

$$\max_{t,F} U(g(t,F)+b(t,F)) - \varepsilon g(t,F) - (\delta g(t,F) + \gamma b(t,F)) - \theta F \tag{7}$$

subject to the firm's first order conditions (5) and (6). Necessary and sufficient conditions for the optimum imply:

$$F_n = \gamma - \theta \tag{8}$$

$$t_n = \delta - \theta \tag{9}$$

$$p_n = \delta - \theta + \varepsilon$$

The corresponding levels of legal and illegal disposal are:

$$g_n = \frac{1}{\mu}(\gamma - \delta - \varepsilon) \tag{10}$$

$$b_n = \frac{1}{\mu}(\delta - \gamma + \varepsilon) + (\theta + \alpha - \gamma) \tag{11}$$

where the subscript n labels all variables under incomplete enforcement. Notice that the fine, the tax and the price are lower than under first best. As a consequence, we get the following result.

Proposition 1 *Under costly enforcement, first best, though feasible, is not optimal.*

Although it is quite intuitive, our result seems to differ from what is obtained in Fullerton and Kinnaman [5], where first best can be achieved even in the presence of illegal burning. Indeed, we adopt a different modelling strategy where only a tax on legal disposal is available and recycling is only implicitly accounted for. On the other hand, in [5] the tax on the level of economic activity (consumption, in their terminology) acts as a costless substitute for enforcement effort.

We label social welfare corresponding to the incomplete enforcement solution as W_n.

4 Organized crime

In this Section organized crime is assumed to participate in the waste disposal management. The strategic relationship between the government and the Mafia is modelled as a Stackelberg game, where the State acts as a leader with respect

to the criminal organization[10]. As noted in the Introduction, we consider that, in the presence of organized crime, the State enforcement is devoted to the criminal organization, whereas no enforcement on waste producing agents is possible. This assumption may be explained by considering that the criminal organization can dispose of wastes and provide individuals with a seemingly lawful documentation. We also assume that costs born by organized crime are mainly fixed costs, related to its lobbying activity and the need of becoming part of the political and economic establishment. Finally, as it is reasonable, enforcement costs are never lower in the presence of organized crime.

Under the assumption that the State acts as a Stackelberg leader, the model involves a three stage game: the firm chooses legal or illegal disposal in the last stage, the Mafia chooses the "price" of illegal disposal in the second stage and, in the first stage, the State sets the monitoring effort as well as the tax on legal disposal. In what follows, we solve the game backwards.

4.1 Third stage: waste producing firms

The firm maximization problem is quite similar to the case without organized crime. However, when Mafia enters the game, illegal disposal requires the payment of an extortion rate x to the criminal organization. In such a case, the firm solves the following problem:

$$\max_{g,b} U(g,b) - pg - xb$$

First order conditions with respect to g and b imply:

$$g(t,x) = \frac{1}{\mu}(x - t - \varepsilon) \tag{12}$$

$$b(t,x) = \alpha + \frac{1}{\mu}(t + \varepsilon) - \frac{1+\mu}{\mu}x \tag{13}$$

4.2 Second stage

In the second stage, the criminal organization chooses the extortion rate which maximizes the net rent, given by[11]:

$$\max_{x} (x - \phi)\, b(t,x) - K \tag{14}$$

[10] The leader-follower setting has been deemed as the most suitable to describe the specific waste policy setting, where criminal organizations react to the regulatory framework set by the State. As a consequence, they can be accounted for as followers (see [9]). Further, modelling the strategic relationship as a Nash-Cournot game or letting organized crime act as a leader, would make enforcement by the State on the criminal organization useless, as will be explained below.

[11] Notice that private illegal disposal costs are normalized to 0 *independently* of who is performing illegal disposal.

subject to (13), where ϕ is the expected fine due to the enforcement effort performed by the State in the presence of the Mafia, while K are fixed costs. As entry is not an issue, we normalize such fixed costs to 0.

First order necessary and sufficient conditions imply that the Mafia sets the extortion rate according to the following function[12]:

$$x(t,\phi) = \frac{1}{2}\left(\frac{t+\varepsilon+\alpha\mu}{\mu+1}+\phi\right) \tag{15}$$

Notice that a unit increase in ϕ implies an increase of x by $\frac{1}{2}$. This implies that the enforcement effort is less efficient in the presence of organized crime than in its absence. Further, notice that an increase in t implies an increase in x. This confirms the intuitive idea that the government is somewhat constrained by the existence of organized crime in setting the tax on legal disposal: when the latter rises, the "price" for illegal disposal rises as well, increasing *ceteris paribus* the unit Mafia rent.

4.3 First stage

The government solves the following problem, constrained by conditions (12), (13) and (15):

$$\begin{aligned}&\max_{t,\phi}\alpha(g(t,x(t,\phi))+b(t,x(t,\phi)))-\frac{(g(t,x(t,\phi))+b(t,x(t,\phi)))^2}{2}+\\&-\mu\frac{g(t,x(t,\phi))^2}{2}-\varepsilon g(t,x(t,\phi))-\delta g(t,x(t,\phi))-\gamma b(t,x(t,\phi))+\\&-\tau\phi-\eta\left(x(t,\phi)-\phi\right)b(t,x(t,\phi))\end{aligned} \tag{16}$$

where τ identifies unit enforcement costs, so that $\tau\phi$ are total enforcement costs (i.e. unit cost times the unit fine ϕ), while the last term in (16) identifies the social costs related to the organized crime rent, that is, unit social cost $\eta > 0$ times rent. As noted above, we assume $\tau \geq \theta$.

The government maximization problem leads to the following values for the tax rate, enforcement, legal and illegal disposal:

$$t_o = \delta - \tau \tag{17}$$

$$\phi_o = \frac{2}{(2\eta+1)}\gamma + \frac{(2\eta-1)(\delta+\alpha\mu+\varepsilon)}{(2\eta+1)(\mu+1)} - \frac{(4\mu+2\eta+1)\tau}{(2\eta+1)(\mu+1)} \tag{18}$$

$$x_o = \frac{\gamma}{2\eta+1} - \frac{(2\mu+2\eta+1)\tau}{(2\eta+1)(\mu+1)} + \frac{2\eta(\delta+\varepsilon+\alpha\mu)}{(2\eta+1)(\mu+1)} \tag{19}$$

$$g_o = \frac{(\gamma-\delta-\varepsilon)}{\mu(2\eta+1)} + \tau\frac{(2\eta-1)}{(2\eta+1)(\mu+1)} + \frac{2\eta(\alpha-\delta-\varepsilon)}{(2\eta+1)(\mu+1)} \tag{20}$$

[12] Condition (15) implies that, if the extortion rate is set before the expected fine (or if the two variables are set simultaneously), there is no way for the State to influence x directly by its choice of ϕ. As a consequence, the State would set $\phi = 0$ both if we modelled the State-Mafia relationship as a Nash/Cournot or as a Stackelberg setting with Mafia as the leader.

$$b_o = \frac{\alpha + 2\tau - \gamma}{2\eta + 1} - \frac{\gamma - \delta - \varepsilon}{\mu\,(2\eta + 1)} \tag{21}$$

The subscript o identifies all variables under organized crime. We label the corresponding social welfare as W_o.

5 Comparisons

The comparison between enforcement effort in the absence of organized crime and "actual enforcement" under the Mafia (measured by x_o) shows that:

$$F_n - x_o = \frac{1}{(\mu+1)\,(2\eta+1)}\,(2\eta+1)\,(\tau-\theta) + \frac{\mu\,(2\tau-\theta)}{(\mu+1)\,(2\eta+1)} - \frac{2\eta\,(\delta-\gamma+\varepsilon+\mu\,(\theta+\alpha-\gamma))}{(\mu+1)\,(2\eta+1)} \tag{22}$$

Eq.(22) can be decomposed in three effects:

1. a higher enforcement cost under the Mafia, captured by the first term (*cost effect*),
2. the lower effectiveness of the State enforcement effort when it is exerted on the Mafia, captured by the second term (*effectiveness effect*);
3. the impact of social costs from the Mafia rent (*Mafia rent effect*).

To investigate the last term, notice that $(x - \phi)$ decreases with ϕ, as one unit increase in ϕ increases x by less than 1, and b decreases with x and therefore with ϕ. As a consequence, an increase in ϕ implies a lower unit rent, a lower illegal disposal and, therefore, a lower rent accruing to the Mafia. The third term in (22) implies threfore an incentive to the regulator to increase ϕ in order to reduce the socially costly rent. Such incentive disappears if $\eta = 0$.

The difference between tax rates on legal disposal depends only on the enforcement cost differential, i.e.

$$t_n - t_o = \tau - \theta$$

A higher enforcement cost under the Mafia implies therefore a lower corresponding tax on legal disposal. This is clearly related to the constraint imposed by the criminal organization on the tax rate: increasing the tax rate would imply a higher enforcement to reduce unit rent. Enforcement is, however more costly the higher is τ, making such constraint stricter.

Turning to legal and illegal disposal, comparison implies:

$$g_n - g_o \begin{cases} > 0 \text{ if } \gamma > \gamma_g \\ < 0 \text{ otherwise} \end{cases}$$

where $\gamma_g = \frac{1}{2\eta(\mu+1)}\,(2\eta\,(\delta + \varepsilon + \alpha\mu + \tau\mu) - \tau\mu)$, and

$$b_n - b_o \begin{cases} > 0 \text{ if } \gamma < \gamma_b \\ < 0 \text{ otherwise} \end{cases}$$

where $\gamma_b = \frac{1}{2\eta(\mu+1)}\left(2\eta\left(\delta+\varepsilon+\theta\mu+\alpha\mu\right)-\mu\left(2\tau-\theta\right)\right)$.

It is easily shown that $\gamma_g \geq \gamma_b$, with equality if $\theta = \tau$. Therefore,

- if $\gamma < \gamma_b$ then $g_n < g_o$ and $b_n > b_o$
- if $\gamma_b < \gamma < \gamma_g$ then $g_n < g_o$ and $b_n < b_o$
- if $\gamma > \gamma_g$ then $g_n > g_o$ and $b_n < b_o$

We can therefore conclude that the the comparisons of legal and illegal disposal under the two "regimes" (with and without the Mafia) depends on parameter values in a complex way. The same holds with respect to the overall level of economic activity, which is strongly linked to the comparison between F_n and x_o according to the following proposition.

Proposition 2 *Enforcement effort is higher in the absence of organized crime if γ is sufficiently high, i.e.*

$\gamma > \gamma_o = \frac{1}{2\eta(\mu+1)}\left(\left(\theta-\tau\right)\left(1+2\eta\right)+\mu\left(\theta-2\tau\right)+2\eta\left(\delta+\varepsilon+\theta\mu+\alpha\mu\right)\right)$. When this is the case, the level of economic activity is larger when the Mafia is present.

Proof. Solving (22) with respect to γ we get that $F_n - x_o > 0$ when

$$\gamma > \frac{1}{2\eta\left(\mu+1\right)}\left(\left(\theta-\tau\right)\left(1+2\eta\right)+\mu\left(\theta-2\tau\right)+2\eta\left(\delta+\varepsilon+\theta\mu+\alpha\mu\right)\right) = \gamma_o$$

The overall level of economic activity can be shown to depend on the same threshold value; more specifically:

$$g_n + b_n - \left(g_o + b_o\right) \begin{cases} > 0 \text{ if } \gamma < \gamma_o \\ < 0 \text{ otherwise} \end{cases}$$

■

In other words, when the State chooses a stricter effort under the Mafia, the corresponding level of economic activity is lower and vice versa. While the first two effects in (22) do not depend on γ, the third one is, in absolute term, decreasing in γ, making (22) increasing in the same parameter. This is a consequence of the fact that the organized crime rent is decreasing in γ. Indeed, notice that, to have a positive b_o, it must be:

$$\frac{\partial\left[\left(x_o-\phi_o\right)b_o\right]}{\partial\gamma} = -2\frac{\mu\left(\alpha+2\tau-\gamma\right)-\left(\gamma-\delta-\varepsilon\right)}{\mu\left(2\eta+1\right)^2} < 0$$

Therefore, the higher is environmental damage from illegal disposal (γ), the lower is *ceteris paribus* the Mafia rent, and the lower is the amount of effort that has to be devoted to reduce such rent by the State. As ϕ_o and x_o decrease correspondingly, the difference $F_n - x_o$ increases. If γ is low, then the absolute value of the Mafia rent effect is dominated by the sum of the cost and the effectiveness effects. The opposite holds, instead, when γ is relatively high. Notice that a higher η implies a higher γ_c, making $F_n - x_o > 0$ less likely.

Finally, comparison of social welfare implies the following proposition, which is a crucial result of our paper.

Proposition 3 *Social welfare can be higher in the presence of organized crime. This can indeed be the case when enforcement costs in the absence of the Mafia are sufficiently high, i.e.* $\theta > \frac{1}{\mu(2\eta+1)}\left(2\tau\mu - 2\varepsilon\eta - 2\alpha\mu\eta + 2\mu\delta\eta\right)$ *and when the marginal social costs of the rent accruing to the criminal organization are sufficiently low, i.e.* $\eta < \frac{\left(\mu\theta^2 - 4\mu\theta\tau + 4\mu\tau^2\right)}{(2(\theta-\tau)(\theta-\delta+\tau-\delta-2\varepsilon-2\alpha\mu))}$.

Proof. The function $W_n - W_o$ can be shown to have a stationary point in $\gamma_b = \frac{1}{2\eta(\mu+1)}\left(\mu\left(\theta - 2\tau\right) + 2\eta\left(\delta + \varepsilon + \theta\mu + \alpha\mu\right)\right)$.This is indeed a minimum, as $\frac{\partial(W_n - W_o)}{\partial\gamma} = \frac{2}{2\mu(\mu+1)(2\eta+1)}\left(2\eta\mu^2 + 4\eta\mu + 2\eta\right) > 0$. Further,

$$W_n - W_o|_{\gamma=\gamma_b} = -\frac{1}{4\eta\left(\mu+1\right)}\left(\left(2\left(\tau-\theta\right)\left(\theta-\delta+\tau-\delta-2\varepsilon-2\alpha\mu\right)\right)\eta + \left(\mu\theta^2 - 4\mu\theta\tau + 4\mu\tau^2\right)\right) \tag{23}$$

In order for such minimum to be possible, γ_b must be in the relevant range (i.e. $\gamma_b \geq \delta$); this is the case when $\theta > \frac{1}{\mu(2\eta+1)}\left(2\tau\mu - 2\varepsilon\eta - 2\alpha\mu\eta + 2\mu\delta\eta\right)$. On the other hand, in order for $W_n - W_o|_{\gamma=\gamma_b} < 0$ we must have that the term in parenthesis in (23) is positive. This requires

$$\eta < \frac{\left(\mu\theta^2 - 4\mu\theta\tau + 4\mu\tau^2\right)}{\left(2\left(\theta-\tau\right)\left(\theta-\delta+\tau-\delta-2\varepsilon-2\alpha\mu\right)\right)}$$

■

Notice that, as $\gamma_b - \gamma_o = -\frac{1}{2}\left(\theta-\tau\right)\frac{2\eta+1}{\eta(\mu+1)} \geq 0$, then a higher welfare under the Mafia only takes place when the corresponding enforcement is lower and the overall level of economic activity is higher. Also, as $\gamma_g \geq \gamma_b$, legal disposal under the Mafia evaluated in $\gamma = \gamma_b$ is higher than the corresponding level without the Mafia.

These considerations provide an intuitive explanation of the circumstances under which the presence of the Mafia can be welfare improving. When γ is close to γ_b, the Mafia brings about an increase in economic activity driven by an increase in legal disposal, while illegal disposal remains almost unchanged. The combined effect of lower enforcement and higher economic activity more than counteract the increased damages from legal disposal, leading to a higher welfare with respect to the incomplete enforcement case. As a matter of fact, however, evidence about illegal disposal is mixed, even though it is often true that illegal disposal tend to be higher in Regions where the Mafia is traditionally stronger. In order to have a clearer picture of the Mafia effects on social welfare we present an illustrative example that fit the assumptions of the model for a set of parameter values. Specifically, we assume symmetric enforcement costs. In such a way, results depends on the existence of the Mafia *per se* and not on differences between parameter values in the two settings[13].

The symmetry assumption implies $\gamma_g = \gamma_b = \gamma_c$. The common value of γ is termed as γ_o. Comparisons are represented in Figure 1 for three values of η (red: $\eta = \frac{1}{5}$; blue: $\eta = \frac{3}{4}$; green: $\eta = 4$).

[13] Parameter values are as follows: $\varepsilon = 0$, $\mu = 1$, $\delta = 1$, $\alpha = 2$, $\theta = .5$. Such parameter values guarantee strictly positive values for all variables and the Mafia rent.

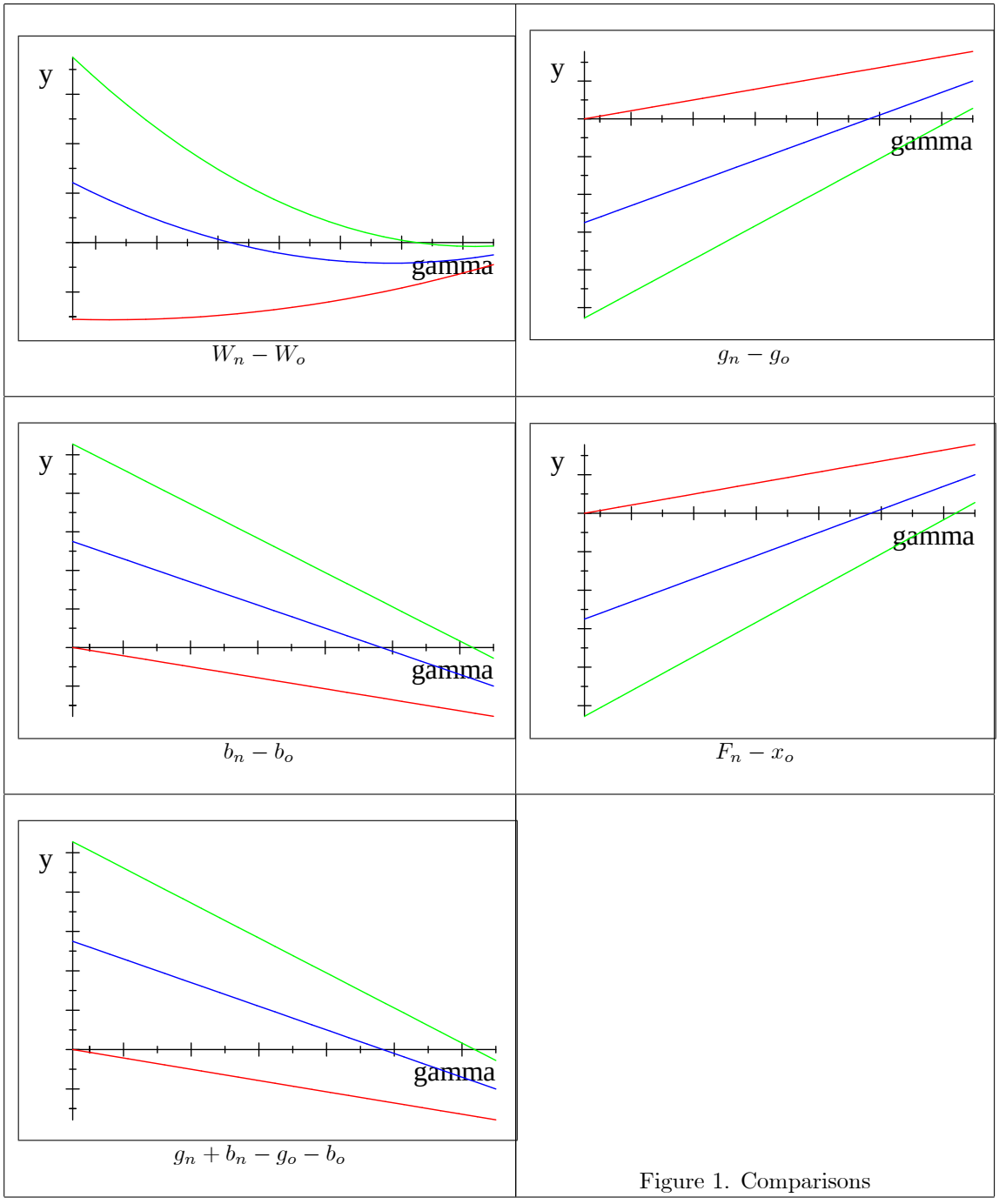

Figure 1. Comparisons

Figure 1 shows the comparisons between the incomplete enforcement and the Mafia cases. As enforcement costs are assumed to be symmetric, the relationship between F_n and x_o (middle right in Figure 1) depends on the relative strenght of the effectiveness effect and the Mafia rent effect. From proposition 2 we can conclude that the lower is γ and the higher is η, the more likely it is $x_o > F_n$[14]. Obviously, the sign of the comparison with respect to illegal disposal is reversed. Notice also that when b is higher under the Mafia the same holds with respect to the level of economic activity and vice versa. As a consequence, in our example the absolute value of changes in legal disposal is always lower than the corresponding absolute value of changes in illegal disposal. As a result, the latter determines changes in the overall level of economic activity.

Finally, when η is relatively low welfare is always higher under organized crime (top left graph in figure 1, red line). Indeed, in such a case the advantage in terms of higher economic activity and lower enforcement costs more than counteract the damages related to a larger illegal disposal and the social costs of the Mafia rents. When η increases, social welfare is less likely to be higher under the Mafia.

It is worth to note that red lines in Figure 1 identify an interesting case that rationalizes the willingness of local authorities to tolerate the Mafia in illegal waste disposal. When social costs of the Mafia rent are perceived as sufficiently low, social welfare may be higher, even though the Mafia implies higher illegal disposal. Lower enforcement costs and higher levels of economic activity can then justify the presence of the criminal organization in the waste cycle.

6 Concluding Remarks

Organized crime is widespread in any branch of economic activity, and waste management is not an exception. The increasing evidence of illegal waste trade from the EU and the spreading of waste related crimes all over Italy come as a confirmation[15]. Yet, waste policy literature seems to have neglected this specific issue. Our paper is a first step to fill this gap. Our main conclusions suggest that the existence of the Mafia imposes restrictions on the "freedom" of the government in setting taxes on legal disposal and reduce enforcement effectiveness. Nonetheless, we might have the case that welfare is improved by the presence of a criminal organization, supported by low enforcement costs and a boost in economic activity. The latter surprising result is coherent with those obtained in previous contributions, although following different routes (Buchanan [1] suggests a "competition enhancing" role for the Mafia, while Garoupa focuses on the "complementarity" between State and Mafia enforcement effort [6]).

Our surprising conclusion is not good news. On the opposite, it suggests possible reasons behind the "acceptance" of criminal organization in the waste disposal sector by local governments and/or the State. By uncovering some of

[14] Low values of γ and/or high values of η imply a higher ϕ_o and, therefore, a higher x_o.
[15] See [9] and [3].

the driving forces behind illegal disposal under the Mafia, we intend to contribute to the debate on how waste policy should be designed to reduce the presence of criminal organizations in the waste cycle.

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