

Acocella, Nicola; Di Bartolomeo, Giovanni

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Natural resources and environment preservation: Strategic substitutability vs. complementarity in global and local public good provision *

Nicola Acocella** and Giovanni Di Bartolomeo***

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Abstract. Environment is a public good whose preservation requires some type of intervention. Use of natural resources for economic activities should be regulated by the local communities; however, this can have in turn external effects on other communities. Environment then takes the double nature of local and global public good, requiring intervention of different levels of governments, whose interplay may raise further conflicts. The aim of this paper is twofold. First, we survey the literature on conflicts arising from the alternative uses of land and natural resources and discuss the effects and policy implications of the interplay between different governments. Second, we focus on the role of strategic interactions in the environmental governance and the implied policy trade-offs and present a formal policy game with potential conflicts between central and local authorities. The model aims to describe the circumstances according to which the lack of coordination between local and central authorities leads to under- or over- provision of natural resources and environment preservation.

JEL: H20, O10, Q01

Keywords: Environment, Development, Public goods, Conflict.

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** Department MEMOTEF, Sapienza University of Rome (nicola.acocella@uniroma1.it).

*** Department of Economics and Law, Sapienza University of Rome (giovanni.dibartolomeo@uniroma1.it); Board of Experts, Ministry of Economy and Finance, Italy; School of European Economy, Luiss, Rome.

1. Introduction

The conflicts that usually arise for allocating scarce goods between different possible uses are particularly deep in the case of natural resources. These can be used in various ways, as localization of economic activities and dwellings or for preservation of biodiversity, pure air, water and soil for protecting human health as a condition for survival. The provision of goods such as environment requires some type of public intervention to support efficiency. Conflicts arising for their provision, in fact, can hardly be solved by the market because of their public good nature.

Apart from the well-known limitations, public solutions are not trivial also because of the multiplicity of public authorities involved in their provision at different levels, which derives from the tension stemming from the different relative relevance of environmental protection for the global and local community. Local governments can be *prima facie* in charge of environment protection, but other governments can also be interested in it when there are external effects over other communities, adding to, or substituting, a reduction of the environment allocated to a public good role by the local government. In such a context, a global public good can be defined as a good that creates externalities among different jurisdictions, even at different levels of governance, e.g., local vs. national.¹

To make a concrete example, let us refer to land. A given portion of it may increase enjoyment of people, if properly equipped with infrastructures, instead of staying wild. Public expenditure can also compensate for reduction of the area used for construction activities, in case a larger portion of it is used for private dwellings, by creating isles of green, recreational activities in a green environment and similar protected areas. These substitutes of the environment subtracted to wilderness can be either imposed by the central government regulation or financed through its financial contribution.

The aim of this paper is twofold. First, we survey the literature on conflicts arising from the alternative uses of land and natural resources and discuss the effects and policy implications of the interplay between different governments. Second, we focus on the role of strategic interactions in the environmental governance and the implied policy trade-offs and present a formal policy game with potential conflicts between central and local authorities. The model

¹ See, e.g., Caillaud *et al.* (1996), Finus and Rübhelke (2013), Batina and Galinato (2016), Cornes (2016), and Bonilla *et al.* (2017).

aims to describe the circumstances according to which the lack of coordination between local and central authorities leads to an under- or an over- provision of natural resources and environment preservation.

The rest of the paper is organized as follows. In the next section, we give an overview of conflicts stemming from the alternative uses of land and natural resources, focusing on the issue of the environmental governance and the interactions between public authorities operating at the same or at different level. In section 3, we present a simple general framework that provides an example of the formalization of the conflict between local and central authorities. Section 4 concludes.

2. Natural resources and environmental governance

2.1 Conflicts in the use of land and natural resources

Land use has many aspects that have been investigated, such as its destination, the determinants of choices about this destination, the implications in the small and in the large (including those having to do with people located at a distance), and policy instruments to correct market failures. As for the type of use, the main object of study has been that for dwellings and, even more, city development, its determinants (e.g., Fullerton and Monti, 2013), the issues of sustainability it raises, and the ways to cope with it.²

The discussion on the importance and nature of the conflicts arising from the different uses of land started with the concept of growth sustainability. Pearce and Atkinson (1993) and Turner (1993) introduced two types of sustainability, a *weak* and a *strong* one. The former is based on the idea that the well-being of future generations can be ensured by substituting man-produced capital to the original natural endowment. The latter derives from the belief that the entire natural endowment inherited from the past should be left to future generations.³

Conflicts do not arise only between generations, but also, and more frequently, within each of them. There are too many conflicts opposing different people, often represented each by public authorities or by public authorities and non-governmental organizations. We only cite a

² Some recent papers on the point are, e.g., Wu *et al.* (2016) and Broitman *et al.* (2018).

³ The debate on choosing between weak and strong sustainability is discussed by, among others, Turner (1993); De Groot *et al.* (2003); Ekins *et al.* (2003); Turner and Daily (2008).

few of them: a well-known case is that opposing local communities and authorities to state authorities in the construction of rails for the *Train à grande vitesse* (TGV) (High-speed train), or incinerators or the cases of regional vs local governments for construction of too many dwellings, numerous at least in some countries, leading to a conflict between local housing and short-term economic needs, on the one hand, and protection of the landscape (and the reduction of environmental risks), on the other. In Italy, the illegal constructions were 19.8% in 2017. The number of illegally constructed buildings has almost doubled in a decade or so (it was 11.9% in 2005).⁴ In Campania, the Italian region most exposed to the problem, the rate is 50.6%. Only in the island of Ischia, there are 600 squatter homes with standing demolition orders and an amnesty has been requested for more than 25,000. In Torre Annunziata (on the Gulf of Naples), the properties to be demolished are more than 3,000. However, demolitions are difficult to implement. A clear conflict emerges between the local authorities (often less prone to environmental protection) and the central ones (which even struggle to enforce national or regional laws)

Reed and Wilkinson (2012) point out that land use management has alternative goals. Specifically, it may aim at protecting environment or at allocating land for business and industry. The former roughly corresponds to limitation of the amount of land for an economic use and, possibly, to public expenditure devoted to its protection. The latter responds to the need of economic growth and development, following choices that are often ‘cheap’ in terms of environment protection and sustainability and myopic in terms of long-run welfare. However, Reed and Wilkinson do not formalize the problem of allocation.

The alternatives that people face to assess the desirability of different management outcomes and the trade-offs between them are the object of many analyses. Conflicts over the use of environment between search for private profit and public interest for a better enjoyment of environment are analyzed by Pacione (2013). Bonilla *et al.* (2017) investigate the synergies and tradeoffs between abatement of different pollutants having a different impact on global environment. Cornes (2016) explores a new approach to the analysis of public good provision and open access resource models and considers the applicability of this kind of approach for modeling current environmental problems. Other relevant studies are Heal *et al.* (2001), Nalle *et al.* (2004), De Groot (2005), and Farber *et al.* (2006).

⁴ See Istat (2018).

Along the lines of the policy consequences deriving from the analysis of specific cases, proper policy interventions can reduce the negative effects and/or foster a positive impact of land use. Such policies can be implemented not only on a restricted scale, but also at an international level, if they take account of the relevant externalities. Interest has been paid to the type of externalities for other – close or distant – areas and, then, to the other levels of governments in charge of them, in terms of, e.g., damages from pollution or benefits from respect of wilderness. Negative external effects are not limited to pollution, as they refer more generally to habitat fragmentation, which causes separation of population, reduces bio-diversity and produces bio-system decay. These effects, together with the determinants of habitat fragmentation, have been studied for a long time by natural sciences. By contrast, they have been the object of economic analysis as negative externalities only in recent years (a review of the studies on habitat fragmentation is offered by Albers *et al.*, 2018).

Certain types of land use can cause positive – rather than negative – externalities. This is the case of protected wild areas, which can enhance the quality of air and water and preserve biodiversity. In any way, conflicts and market failures always arise from the existence of external effects. Then the use of natural resources for economic activities (and thus environment preservation) should be regulated by the local communities. However, local regulation (or the decision not to regulate) may have in turn external effects on other communities, advocating for further centralized interventions. In other words, environment then takes the double nature of local and global public good, requiring intervention of different (levels of) governments, whose interplay may raise further or attenuate existing conflicts, leading to an under- or over- provision of natural resources and environment preservation.

The nature of the conflicts deriving from the existence of transboundary external effects and the way they can be solved are the object of the next sub-section, which introduces the issue of the level of governance.

2.2 The different levels of governance

Environmental governance in the presence of the externalities created by land use is an important topic. Depending on the geographical extent of their external effects, the subjects of this governance can be governments either of the same level or of a different level. Environment protection is in fact a true global public good, involving the intervention of different authorities.

Sustainability can be supported by the intervention of both the local and the central

government. Conflicts can, however, derive from their different interests and perspectives. Given the possibility of a conflict (or even a convergence of interests which needs a kind of coordination), the appropriate setting for dealing with these prospects is a strategic one.⁵ The cooperative or non-cooperative stance of the governments involved can depend on knowledge of the outcomes in terms of environment deriving from each, even if other considerations, e.g., political ones, can be relevant. To exemplify, the different orientations of the parties governing each region, or the central authority can be relevant. More generally, because of time consistency and other implementation problems, policy coordination may be unfeasible in many situations.

A solution intermediate between the cooperative and non-cooperative one is offered by the concept of polycentric governance, which was introduced initially by Polanyi (1951) and later developed by Elinor Ostrom in many papers dealing with commons, beginning in 1990 (see Ostrom, 1990 and, more recently, McGinnis and Ostrom, 2011). Polycentricity is a situation where multiple centers of governance operate, each with some degree of autonomy within commonly set rules. This situation can apply to different (levels of) governments within a country or at an international level. In both cases there is a kind of arrangement with some degree of autonomy of each level of government and possibly some kind of cooperation, if the set of rules each level should obey to is agreed on cooperatively. This is really a not very common case for different (levels of) governments within a country, being instead diffuse for international agreements. We can say that polycentricity is a mix of cooperative and non-cooperative (or competitive) governance. With reference to environmental issues, an advantage of polycentricity is that it can help manage cross-scale issues offering satisfactory solutions when there are complex interrelationships (Heikkila and Weible, 2018; Villamayor-Tomas, 2018).

Non-cooperative agreements are in general sub-optimal with respect to cooperative, harmonized or centralized policies. This notwithstanding, they can be justified when a government wants to maintain some degree of autonomy, especially if there are wide divergences

⁵ For cases of non-cooperative games between governments see, e.g., Golombek and Hoel (2004); Ulph and Ulph (2007), whereas cooperation is assumed, inter alia, by Barrett S. (2007) and Endres and Rundshagen (2013). Dannenberg (2012) deals with coalition formation. For the relative organizational issues see, e.g., Barrett (2007), Acocella and Di Bartolomeo (2011), and Acocella *et al.* (2013). Cooperative and non-cooperative attitudes and the regulation dilemma arising from them are discussed by Potoski and Prakas (2004), who say that conflicts can be avoided in favor of win-win cooperation through voluntary programs and compliance incentives if each side believes the other is cooperating.

of preferences between the various centers, or when the choices of a government have spillovers across multiple targets. Cooperative solutions ensuring superior outcomes usually derive from explicit agreements or some more limited form of policy coordination obtained through incentives and subsidies (Endres and Rundshagen, 2013).

In many cases, cooperative solutions are studied through a game-theoretical approach with no mention of the practical process leading to them. In fact, many approaches neglect consideration of a stage that is usually preliminary to the agreement, i.e., the bargaining process. During this preliminary process, there are offers and counteroffers, which constitute an important step towards the final solution.

The above argument raises the issue of the bargaining process that precedes any reached or attempted agreement. In many cases, the exact contents of a cooperative agreement depend on the ability of the parties involved in negotiations and are biased by the path taken or imposed on negotiations. In fact, an important aspect of the decisions about the environment is the uncertainty tied to its likely evolution, the effects of policy actions as well as to the possible formation of coalitions between some agents that can displace a wider coalition (Gomes, 2005; Wangler *et al.*, 2013; Caparrós, 2016). Then, an important role in negotiations is taken by uncertainty and information. The ability to exploit these can influence the outcome of negotiations. The impact of including consideration of uncertainty and risk in the formation of the agreement is investigated by, among others, Bramoullé and Treich (2009) and Boucher and Bramoullé (2010).

The participation of citizens and their representative private organizations for advocacy of intervention by the government, prescription of standards, preparation and/or assessment of the agreements, rule implementation and the direct involvement of citizens in the administration of projects on environment are also important chapters for its governance. They can also take the form of negotiated agreements or partnerships between citizens' associations and firms (in particular, NGOs and transnational corporations) or the government(s) involved.

All the parties involved (the citizens, the private corporations, the governments) can draw benefits from participation of citizens to environmental agreements. Sinclair and Diduck (2017) find that the practice of participation of residents of local communities, members of environmental organizations and other groups interested in environment is mixed. Together with cases where it has been effective in helping to devise better agreements – which is the result that other researchers obtain (see, e.g., Murdock *et al.*, 2005) – they also found cases where citizen

participation has been decisively wanting.

Sinclair and Diduck (2017) also highlight some important design features that should be given more attention to for fairer and more robust processes of participation. Carr (2015) also insists on the strategies and mechanisms that can manage consensus-building for solving conflicts, while overcoming asymmetrical power of participants, thus enhancing the benefits deriving from the agreements, especially to people that are in an inferior position. In addition, citizens' participation can facilitate the implementation of agreements.

Finally, considering conflicts and policy interactions, equity considerations are important both at the individual and institutional levels. The former is relevant when regulations or other kinds of policies are introduced. The latter characterize international or regional agreements among different countries or institutions operating at different levels of governance. At an individual level, a large literature elucidates important trade-offs between efficiency and equity.⁶ Considering transboundary environmental agreements, these should pay attention not only to limiting the negative effects of land use, but also to imposing an equitable distribution of the burden needed for that. In fact, many participants to transboundary agreements show some degree of inequality-aversion and favor an equitable sharing of the cost required for environment abatement, as they derive disutility from unequal payoffs.

3. Global vs. local public good provision and environment: A formal model

3.1 Model overview and scenarios

As an application of the discussion above, this section proposes a simple policy game to formalize the logic of conflicts arising from alternative uses of resources when different levels of governance interact. We aim to be as general as possible to underline the policy tradeoffs arising from different levels of public decisions to stress under what circumstances a lack of coordination might lead to under- or over- provision of natural resources and environment

⁶ For instance, considering an efficient market-based regulation based on uniform pollution pricing and the principle of equalizing marginal abatement costs of production, several economists have focused on the issue of how the revenues from regulation can be used to alter incidence outcomes. See Poterba (1989), Bovenberg *et al.* (2005), Bento *et al.* (2009), Rausch *et al.* (2010), and Fullerton and Monti (2013).

preservation.⁷ Our model does not therefore refer to a specific application, even if it was originally built to analyze the tradeoffs between local and central government in the management of potentially urban and industrial areas and the construction of marine and land natural parks.⁸

The typical problem we have in mind is that of a local authority (for example, a regional government) that has to define its *regulatory plan* and decide how to allocate the territory between areas dedicated to productive activities and areas where the natural environment is preserved (natural parks). Environment is a common good for all citizens of the community, but increasing productive activities generates employment that has a positive impact on some of them. Therefore, within the territory everyone would like to preserve the environment, but at the expense of the work options of some people, for whom they have a higher weight.

The local tradeoff between the environment and productive activity however does not exhaust the topic. If environmental and biodiversity protection has effects that extend beyond local boundaries, each local government is likely to weigh less the environment and more productive activities, while the opposite is likely to be with the central government. This would lead to under provision of environmental preservation without the intervention of the central government. In almost all countries, natural parks are centrally financed or incentivized. In such a case, in fact, due to the growth pressure, the local government incentives can be rather different from an overall goal of preserving a certain portion of the environment. However, the national policy that subsidizes natural parks interacts with local policies about the organization of the territories. Our model aims to describe the logic of the conflicts deriving from such interactions.⁹

As a theoretical benchmark, we model an economy where two goods are present: a private good (consumption good) and a public good (environment services). The private good is produced by a competitive sector using labor and natural resources. Services deriving from the public good depend on central government expenditure for environmental policy and the level of natural resources used in its production, set by local government's regulation. As total natural resources are given, the private and the public good are rival in the use of natural resources. This

⁷ In line with our aim, we keep the formalization as simple as possible (e.g., we assume separable utilities and Cobb-Douglas production functions). Clearly, different assumptions may deliver additional results.

⁸ The interest on this issue is linked to the origins of this work, conceived within a European FP7 project on Solutions for Environmental Contrasts in Coastal Areas (SECOA). See Musella *et al.* (2016).

⁹ Practical examples of the types we are interested in are described, among others, in Bobbio and Zeppetella (1999), Martinez-Alier (2002), Forno (2006), Centemeri (2017).

may generate a conflict in their use between the private and public good.

We consider first different fiscal regimes to investigate whether the local and the central government policies for production of the public good are complements or substitutes, under different assumptions about the level of taxation, whenever the public good is financed by taxes collected in the local community or not. Complementarity or substitutability also depend on the cooperative or non-cooperative attitudes of the different levels of government.

The formal model is described as follows. Section 3.2 presents the analytical framework and solve the optimization problem of private agents, deriving the competitive equilibrium. Section 3.3 computes the optimal policy of the local and central government and presents the results derived under different assumptions about: 1) whether a cooperative or non-cooperative attitude holds; 2) how public expenditure for environment is financed.

3.2 The competitive equilibrium

3.2.1 Preferences and constraints

The production functions for the private good, y , and the public good, b , are

$$y = l^\alpha n_y^{1-\alpha} \quad (1)$$

$$b = g^\beta n_b^{1-\beta} \quad (2)$$

where l is labor and n_y are natural resources used in the private good production; g is the central government expenditure for environmental policy and n_b is the amount of natural resources used for producing the public good; α and β are the coefficients of the Cobb-Douglas production functions (1) and (2).

As the total amount of natural resources is fixed to \bar{n} , it follows that

$$n_y = \bar{n} - n_b \quad (3)$$

Equation (3) implies the existence of a direct conflict in the allocation of natural resources between the two production activities, y and b . Moreover, as the natural resources are allocated by the local authority, equation (3) defines the supply for n_y .

The utility function of the representative consumer of the local community is increasing in the consumption good, c , leisure $(1-l)$, and environment. We assume a separable utility of

the following kind:

$$u(c, l, b) = \frac{c^{1-\sigma} - 1}{1-\sigma} + \eta \frac{(1-l)^\zeta - 1}{\zeta} + \rho \ln(b) \quad (4)$$

where $\sigma \in (0, 1]$, $\zeta > 0$, $\rho > 0$, and $\eta > 0$ are the parameters of the utility function.

The household's budget constraint is:¹⁰

$$c = wl + p_y n_y - \tau \quad (5)$$

where w is the real wage rate; p_y is the real price for natural resources use; τ is the amount of taxes charged to the local consumers by the central government. We assume that $\tau = \bar{\tau} + \chi g$, i.e., taxes are composed by two parts: 1) an exogenous given amount, $\bar{\tau}$, independent of the environmental policy; 2) an endogenous part, χg , which is proportional to the local expenditure of central government for environmental services; if $\chi = 1$, the whole expenditure for environment policies is locally financed, whereas if $\chi = 0$, it is financed by the central government.

3.2.2 First-order conditions

In the competitive market, maximization of private producers' profit implies the following demand for labor and land:

$$w = \alpha \left(\frac{1 - n_b}{l} \right)^{1-\alpha} \quad (6)$$

$$p_y = (1 - \alpha) \left(\frac{l}{1 - n_b} \right)^\alpha \quad (7)$$

Labor supply is obtained by solving the representative household's problem:

$$w = \eta (1-l)^{\zeta-1} c^\sigma \quad (8)$$

where the real wage is equal to the marginal rate of substitution between leisure and consumption.

Given the public policy vector (n_b, τ, g) and (2), by combining (6), (7), (8), we can

¹⁰ The price of the consumption good is normalized to one. As we assume competitive markets, profits are zero.

obtain the solution of the model conditional on public policy to which we refer as the competitive equilibrium. Formally, competitive equilibrium is implicitly defined as:

$$l = f(n_b, \tau) \quad (9)$$

$$c = f(n_b, \tau)^\alpha (\bar{n} - n_b)^{1-\alpha} - \tau \quad (10)$$

$$b = g^\beta n_b^{1-\beta} \quad (11)$$

where $f(\cdot)$ is a function that solves the problem (6)-(8).

The model is then closed by choosing the public policy vector, which consists in the tax policy and environmental expenditure and the amount of natural resources devoted to environment protection (τ, g, n_b) . As τ maps into g , we can focus on the vector (g, n_b) . We will investigate different scenarios about how policies are financed, i.e. different assumptions about the value of $\chi \in [0,1]$. However, before doing that we discuss the model calibration as analytical solutions for the policy game are not available due to the non-linearity present in the model.

3.2.3 Calibration

In our baseline calibration, regarding the production side of the economy, we assume that $\alpha = \beta = 1/2$. This permits to derive an analytical solution for (9), which is

$$l = \frac{1}{1+2\eta} + \frac{2\eta^2\tau^2}{(1+2\eta)^2(\bar{n}-n_b)} - \frac{2\eta\tau\sqrt{1+2\eta+\eta^2\tau^2(\bar{n}-n_b)^{-1}}}{(1+2\eta)^2(\bar{n}-n_b)} \quad (12)$$

Indeed, equation (9) is non-linear and has two solutions. We select the one that is economically relevant in our model,¹¹ i.e., we assume that if tax increases (non-labor income falls), leisure and consumption fall. Moreover, to avoid trivial cases, we also assume that the minimum amount of natural resources used by the private sector is 0.1 and the maximum is 0.9.

Regarding household's preferences, we assume $\zeta = 0$ and $\sigma = 1$. Normalizing \bar{n} to one and assuming that the tax level is 20% of income and $n_b = 0.1$, we calibrate η to obtain an equilibrium level of labor equal to 0.3. The weight of the environmental good in the household's

¹¹ In our model leisure is a normal good whose demand is reduced when income is reduced as an effect of higher lump-sum taxes.

preferences is obtained by seizing to one its maximum amount (b^*) and choosing ρ to obtain an optimal level of b for the households equal to 0.1.¹²

Alternative calibrations do not qualitatively affect our results.

3.3 The policy game

3.3.1 Policymakers' preferences and interactions

The policies of the two governments are endogenous and simultaneously set. The local authority decides the amount of natural resources to be used for the production of the public good and the central government chooses the amount of environment expenditures. We consider different scenarios to investigate whether the local and the central government policies for production of the public good are complements or substitutes, under different assumptions about the level of taxation charged to local consumers.

We assume that the local authorities maximize:

$$W_L = u(c, l, b) - \frac{\theta}{2}(b - b^*)^2 \quad (13)$$

where b^* is the level of environment demanded by environmental associations, acknowledged by the representative consumer and the local authority with a weight of $\frac{\theta}{2}$ as a factor of correction to household preferences. The second term of this function captures the conflict between the representative consumer (with his possible short-sightedness) and environmental associations, whose requests are mediated with those of the consumer, to a different extent. The preferences of these associations would be totally neglected if $\theta = 0$, whereas they would be recognized) if $\theta > 0$.

The problem of the central government is similar, but this policymaker maximizes:

$$W_C = u(c, l, b) - \frac{\theta}{2}(1 + \gamma)(b - b^*)^2 \quad (14)$$

where $\theta(1 + \gamma)$ is the weight put by the central government on the public good locally produced.

¹² As $n_b = 0.1$, this implies that in our baseline calibration $g = 0.1$.

In order to capture the global¹³ public good nature of the environmental quality we assume that $\gamma > 0$, in addition to the contribution that the public good would give to the welfare of the central government simply through the welfare of the local community producing it.¹⁴ If $\gamma = 0$, there is no difference between the central and local authorities. Then the public good has a local nature since it does not create externalities outside the local region.¹⁵ In other words, the net effects of the public good in the rest of the country are captured through (14).

Formally, the local authorities choose n_b to maximize (13) subject to the competitive equilibrium constraint (9)-(11), taking as given the central government policy (t, g) . Simultaneously, once a fiscal regime is chosen (exogenously fixing χ), the central government decides g to maximize (14) subject to the competitive equilibrium constraint (9)-(11), taking environmental regulation (n_b) as given.

The non-cooperative Nash equilibrium is obtained by simultaneously solving the two above policy problems. Moreover, Nash outcomes can be compared to those arising from the Pareto optimal cooperative solution, obtained from maximization of the Nash product, i.e.,

$$\max_{g, n_b} \Pi_{NASH} = W_L^{1/2} W_C^{1/2} \quad (15)$$

The model is solved by numerical simulations. The policies of both governments and the outcomes of the Nash equilibrium in terms of environmental protection (b) are compared to those derived from the (efficient) cooperative solution.

3.3.2 Local government behavior and central government's policy regimes

Now we consider the local authorities' problem. They choose the natural resource allocation, n_b , as a function of the central authority policy (indicated by a pair of τ and g). constrained by the competitive equilibrium (9)-(11).

¹³ In the context of our model, the adjective global simply means as 'encompassing more than one jurisdiction,' e.g., a local and a central government, as we are doing in this paper.

¹⁴ In an alternative, but equivalent, way one could assume that the central government maximizes the sum of private preferences of all local community members i giving (possibly different) weights to each community.

¹⁵ By contrast, $\gamma < 0$ would make the unlikely case of negative externalities to other communities from the local public good.

Formally, the local authority solves

$$\begin{aligned} \max_{n_b} W_L = & \ln\left(f(n_b)^\alpha(1-n_b)^{1-\alpha} - t\right) + \eta \ln(1-f(n_b)) + \\ & + \rho \ln(g^\beta n_b^{1-\beta}) - \theta\left(g^\beta n_b^{1-\beta} - b^*\right)^2 \end{aligned} \quad (16)$$

taking g and τ as given.

The corresponding first-order condition is

$$\begin{aligned} 0 = & \frac{\alpha f'(n_b)^{\alpha-1}(1-n_b)^{1-\alpha}}{f(n_b)^\alpha(1-n_b)^{1-\alpha} - \tau} - \frac{(1-\alpha)f(n_b)^\alpha(1-n_b)^{-\alpha}}{f(n_b)^\alpha(1-n_b)^{1-\alpha} - \tau} + \\ & - \eta \frac{f'(n_b)}{1-f(n_b)} + (1-\beta) \frac{g^\beta n_b^{\beta-1}}{b} \left[\frac{\rho}{b} - \theta(g^\beta n_b^{1-\beta} - b^*) \right] \end{aligned} \quad (17)$$

Equation (17) is the best response of the local authority to central government action (reaction function). By using (17) and the competitive equilibrium (9)-(11), we can simulate the local authorities' optimal policy conditional on the central government's choice under different fiscal regimes. We consider two polar cases.

1. We assume that τ is fixed as g changes. This implies that when the central government raises its environmental expenditures, it does not charge local households for that (i.e., $\chi=0$). Under this assumption the local and the central government policy for environment protection are complements.
2. We assume that τ is raised as g rises ($\chi=1$). Now the two policies become substitute: the local environment regulation becomes laxer as g (and τ) rise.

The complementary or substitute nature of the central and local government policies for environment protection is illustrated in Figure 1.

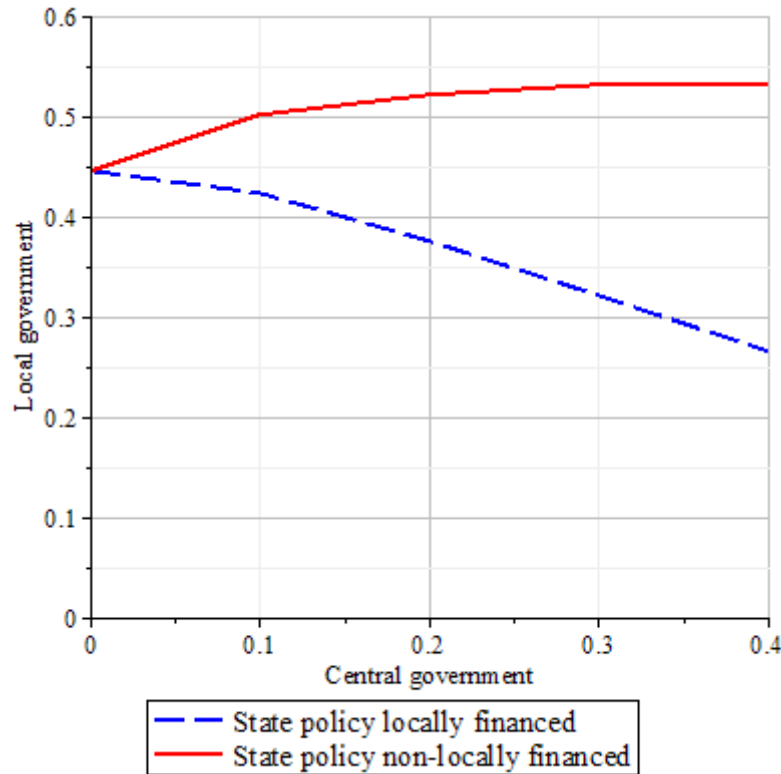


Figure 1 – Central and local government policies

The figure shows that the attitude of environment stakeholders is in favor of local policy or against it according to the central government’s policy regime. In our simple setup, the former is the case when either the central government raises its expenditure but does not charge local households (thus making for a stricter environment regulation by local government), or it lowers its expenditure while relieving local households for its burden. It is worth noticing that as a larger public expenditure is considered (independently of how it is financed), the conflict between local public authorities and private stakeholders increases. By contrast, the conflict between environmental associations and the public sector falls. In fact, the level of b always rises when g rises (as it is trivial to see from Figure 1).

3.3.3 Policy game (Nash) equilibrium

The equilibrium outcomes of our policy game are described in Figure 2, where we report the non-cooperative and cooperative Nash equilibrium for two possible central government’s policy regimes to explore both cases of policy complementarity and substitution. Figure 2 describes both central and local optimal policies for different weights placed by the central government on environment protection. We assume that $\theta = 4$ and simulate the Nash and cooperative

equilibrium for different values of γ , implying that $(1 + \gamma)\theta$ varies from 4 to 20.¹⁶ In the origin $\gamma = 0$ and environmental services are just a local public good.

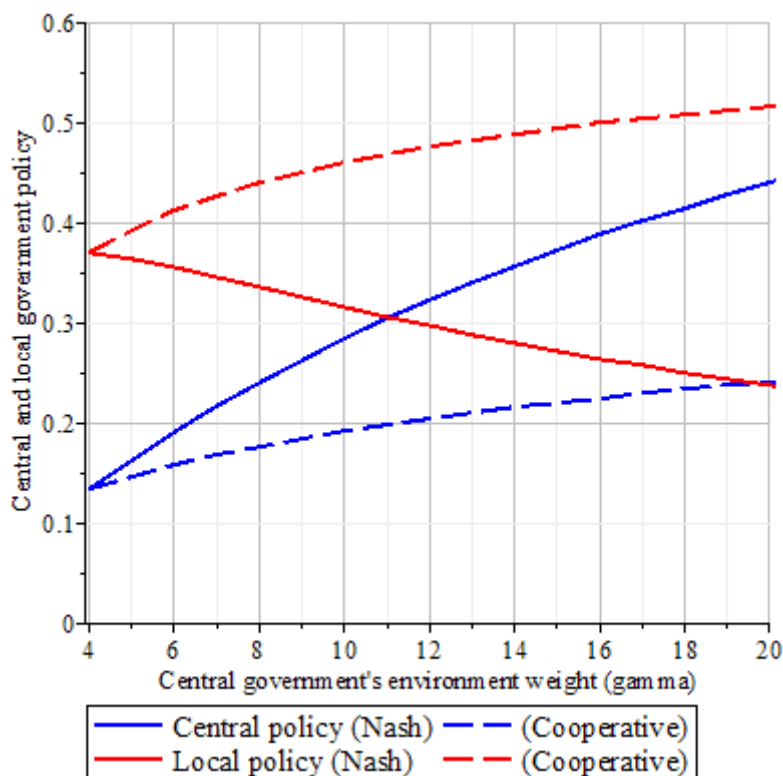


Fig. 2 – Cooperation, land devoted to environment and central government expenditure

Figure 2 shows that in the case of a non-cooperative equilibrium the amount of land (government expenditure) devoted to environment is lower (higher) than in the case of a cooperative equilibrium. Differences, and thus inefficiency, increase in the weight placed by the central government on environment (environment weight). Therefore, the effects of central and local policies on the environmental protection are not trivial. The policies of the two governments are substitutes in case of non-cooperation, whereas they are complements in a Nash cooperative equilibrium.

¹⁶ Qualitative results are robust with respect to different calibrations (results are available upon request). We choose this span because it is consistent with equilibrium taxation, i.e., we avoid corner solutions. In other words, the solution is between zero and the whole income.

Figure 3 describes the outcomes of the Nash and cooperative policies. For relatively low weights placed by the central government on environment the public good provision is inefficiently high (over-production or over-protection of the environment). By contrast, for relative high weights the production is inefficiently low (under-production or under-protection of the environment).

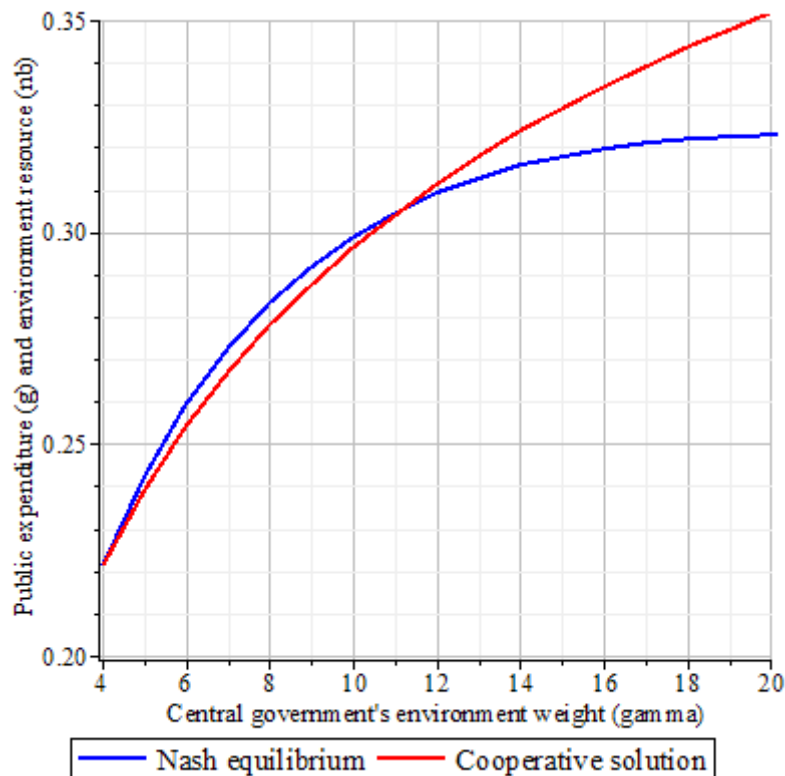


Fig. 3 – Inefficiency in the provision of the public good

4. Conclusions

After surveying the general conflicts arising from the use of land and natural resources, this paper has provided a simple model to formalize the logic of conflicts arising from alternative uses of resources when different levels of governments are considered. We were interested in investigating under what circumstances a lack of coordination might lead to under- or over-provision of natural resources and environment preservation.

We have mainly dealt with conflicts focusing on the global and local nature of environment as a public good. Interventions by a local community on the use of natural resources and preservation of the environment usually have external effects on other (national and/or

international) communities. Environment then takes the nature of a global public good, requiring intervention of another (possibly, an upper level of) government. We have discussed the effects of the interplay of, and conflicts between, different levels governments in determining the use of natural resources and preserving the environment.

We have investigated the realistic case when the local government decides on the part of natural resources to be allocated to preservation of environment and the central government puts its money to equip environment for better fruition and decides on the share of its expenditures to be charged to the local community. As long as environmental policies are set by multiple decision makers – at local, national and, possibly, international levels – the existence of several layers of governance may encourage welfare conflicts and thus strategic behavior, as each policymaker attempts to enhance its own position (Caillaud *et al.*, 1996). The policy interplay can have two important and interlinked outcomes: first, substitutability or complementarity of the action of the different policymakers; second, under-provision of environment services as a public good.

Complementarity or substitutability between the policies of the two authorities depends on two facts.

1. Whether the two authorities cooperate or not. Cooperation (non-cooperation) entails complementarity (substitutability).
2. Whether local citizens are charged or not for the public expenditures devoted by the central government to the local environment. The former (latter) case amounts to a form of non-cooperation (cooperation) and there is substitutability (complementarity); a kind of conflict and (non-)cooperation arise.

As a result, (the optimal level of) environment protection largely depends on convergence of efforts by authorities of different levels of government. When the weight given to environment by the central government is not much higher than that of the local authority, non-cooperation implies over-provision of environment services, whereas under-provision results from higher weights of the central government. Cooperation always ensures the highest welfare, by avoiding inefficiencies deriving from both over- and under-production.

Extensions of our model to consider aspects of the problem we have disregarded, such as issue linkages with questions different from land use or side payments, are possible. We leave them to future research.

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