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The effects of social norm sensitivity in a PES mechanism

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Abstract

In this paper, we study the effects of heterogeneous sensitivities to social norms when an environmental regulator designs a mechanism for land retirement. We show that when the social norm exceeds the personal norm, as expected, landowners who are relatively sensitive to social norms (``conformists'') retire more land. However, when the social norm is below the personal norm, landowners who are more sensitive to personal norms (``individualists'') conserve more. Endogenizing the social norm shows that the efficient provider might not supply the efficient quantity of land retirement.

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1 Introduction

To offset ecosystem degradation and prevent climate change, many governments have adopted payments for environmental services (PES) programs. PES programs pay private providers, such as landowners, to protect the environment. For example, in 1985 the US Congress introduced the Conservation Reserve Program (CRP) to address soil erosion and water quality. The CRP pays landowners to retire unproductive land for a certain amount of time, such as 10 to 15 years. Another prominent example is China's Sloping Land Conversion Program (SLCP) (Langpap et al., 2018; Lu and Yin, 2020; Wunder et al., 2020).

In addition to PES, conservation decisions might be affected by social norms, such as other people's behavior and expectations (Cialdini et al., 1990; Cialdini and Goldstein, 2004; Clayton and Brook, 2010). Deutsch and Gerard (1955) distinguish between injunctive social norms (what others expect one to do) and descriptive social norms (what people observe from others' behavior). Several studies find that social norms can increase conservation in terms of household energy consumption (Kim and Kaemingk, 2021; Allcott, 2011), towel reuse (Goldstein et al., 2008), water conservation (Jessoe et al., 2021; Jaime Torres and Carlsson, 2018; Ferraro and Price, 2011), and recycling (Schultz, 1999). Farrow et al. (2017) and Carlsson et al. (2021) review the literatures relating social norms and moral green nudges to conservation.

In this paper, we ask how a regulator should design a mechanism for land retirement when: (1) Personal and social conservation norms decrease the private retirement cost; (2) The landowners have unobserved sensitivities to social relative to personal norms (Fischbacher et al., 2001; Fischer and Huddart, 2008; Dessart et al., 2019). We find that when the social norm exceeds the personal norm, as expected, landowners who are relatively sensitive to social norms retire more land. Intuitively, landowners who are more sensitive to social norms try harder to live up to or surpass the social norm, so their conservation costs are lower. In contrast, when the personal norm exceeds the social norm, landowners who are more sensitive to personal relative to social norms have lower retirement costs and retire more land. Finally, when we endogenize the social norm by assuming that it equals the average level of land retirement, we find that the regulator can optimally decrease even the efficient type's retirement (to reduce information rents).

The paper contributes to the literature on the effects of social norms on conservation (Innes et al., 1998; Farrow et al., 2017) and conservation policy (Bowles and Hwang, 2008; Ulph and Ulph, 2021; Meunier and Schumacher, 2020). Smith and Shogren (2002) study the optimal mechanism when landowners are privately informed about their conservation value. However, they do not consider the effects of social norms. Banerjee and Shogren (2012) derive the optimal mechanism when landowners value conservation and their reputation for protecting the environment. However, they focus on the crowding-out effect of monetary payments. Qin and Shogren (2015) assume that personal and social norms reduce conservation costs. However, they study the effects of heterogeneous personal norms rather than heterogeneous sensitivities to social norms. Fischer and Huddart (2008) study the effects of heterogeneous sensitivities to social norms on industrial organization but do not consider the optimal design of conservation mechanisms.

2 Exogenous social norms

Land retirement can reduce soil erosion and increase water quality and biodiversity. Following Qin and Shogren (2015), we assume that a regulator designs a mechanism to maximize the benefits from ecosystem services via land retirement. The benefits are denoted $B(a)$, where $B'(a) > 0$ and $B''(a) < 0$. Following Fischer and Huddart (2008) and Qin and Shogren (2015), the landowners' retirement cost is $f(a - N)$, where $f'(.) > 0$, $f''(.) > 0$, and N is a weighted average of personal (P) and social (S) conservation norms:

$$N = (1 - \alpha)P + \alpha S \tag{1}$$

The personal and social norms might reflect, respectively, intrinsic preferences and beliefs about community expectations for land retirement (Farrow et al., 2017). Including the norm in the cost function captures the idea that, when a landowner increases norm conformity, the psychological or emotional cost decreases compared to the case when there are no personal or social norms (Fischer and Huddart, 2008; Qin and Shogren, 2015).[1]

The landowner population is continuous and normalized to one. Each of the landowners has either high or low sensitivity to social norms: $\alpha \in \{\overline{\alpha}, \underline{\alpha}\}$. $q = Pr(\alpha = \overline{\alpha})$ denotes the proportion of "high" types and $(1 - q)$ denotes the proportion of "low" types. The high types retire $\overline{a}$ acres and receive $\overline{T}$ per acre. The low types retire $\underline{a}$ acres and receive $\underline{T}$ per acre. The reservation utilities are denoted ξ. The social cost of funds is $1 + \lambda > 1$.

2.1 Full-information benchmark

In the full-information benchmark, the regulator maximizes the social benefit of land retirement minus the social cost:

$$MaxW_{\overline{a},\underline{a},\overline{T},\underline{T}} = B(q\overline{a} + (1-q)\underline{a}) - q(f(\overline{a} - (1-\overline{\alpha})P - \overline{\alpha}S) + \lambda\overline{T}\overline{a}) - (1-q)(f(\underline{a} - (1-\underline{\alpha})P - \underline{\alpha}S) + \lambda\underline{T}\underline{a}) \tag{2}$$

s.t.

$$\overline{T}\overline{a} - f(\overline{a} - (1-\overline{\alpha})P - \overline{\alpha}S) \geq \overline{\xi} \tag{3}$$

$$\underline{T}\underline{a} - f(\underline{a} - (1-\underline{\alpha})P - \underline{\alpha}S) \geq \underline{\xi} \tag{4}$$

The first-order conditions for the high and low types are:

$$\frac{B'(\overline{a})}{1+\lambda} = f'(\overline{a} - (1-\overline{\alpha})P - \overline{\alpha}S). \tag{5}$$

$$\frac{B'(\underline{a})}{1+\lambda} = f'(\underline{a} - (1-\underline{\alpha})P - \underline{\alpha}S). \tag{6}$$

which equate the marginal social benefits and costs of retirement.

[1] Replacing the cost function $f(a - N)$ with the generalized function $f(a, N)$, where $\frac{\partial f(a,N)}{\partial a} > 0$, $\frac{\partial f^2(a,N)}{\partial a^2} > 0$, $\frac{\partial f(a,N)}{\partial N} < 0$, $\frac{\partial f^2(a,N)}{\partial N^2} > 0$, and $\frac{\partial f^2(a,N)}{\partial a \partial N} < 0$ produces similar results.

2.2 Asymmetric information

When the regulator does not observe the social-norm sensitivities, the following proposition characterizes the optimal mechanism:

PROPOSITION 1: *In the optimal mechanism:*

(i) *If the social norm exceeds the personal norm, the high-sensitivity landowner retires the efficient quantity of land and receives information rents. The low type's retirement is smaller and downward distorted.*

(ii) *If the social norm is below the personal norm, the low-sensitivity landowner retires the efficient quantity of land and receives information rents. The high type's retirement is smaller and downward distorted.*

(iii) *If the personal norm equals the social norm, the landowners retire the efficient quantities and do not receive information rents.*

Proof. See the appendix. □

The intuition for Proposition 1(i) is that when the social norm exceeds the personal norm, landowners who are relatively sensitive to social as opposed to personal norms have smaller marginal conservation costs. Therefore, they are the most efficient conservation providers. In turn, consistent with the standard mechanism-design result that the regulator implements the efficient quantity for the low-cost provider, the regulator implements the efficient quantity for the sensitive type. As the low-cost provider (sensitive type) has incentives to pretend to be high-cost provider (insensitive type) to receive more payments, the regulator distorts the insensitive type's conservation downward to reduce the sensitive type's information rent (Laffont, 1995). In Proposition 1(ii), conversely, when the social norm is below the personal norm, landowners who are relatively insensitive to social norms have smaller conservation costs. Therefore, the regulator implements the efficient quantity for the insensitive type and distorts the sensitive type's conservation downward. Finally, Proposition 1(iii) reflects that when the personal and social norms are the same, the fact that the landowners have heterogeneous sensitivities to social relative to personal norms does not affect their cost functions. Thus, the regulator solves the full-information problem.

3 Endogenous social norms

In this section, following Fischer and Huddart (2008) and Qin and Shogren (2015), we assume that the social norm S equals the average level of land retirement. This average is endogenous to the regulator but exogenous to landowners.

3.1 Full-information benchmark

In the full-information benchmark, the regulator solves (2) subject to (3), (4), and $S = q\overline{a} + (1-q)\underline{a}$. The first-order conditions are:

$$\frac{B'(\overline{a})}{1+\lambda} = (1-\overline{\alpha}q)f'(\overline{a}-(1-\overline{\alpha})P-\overline{\alpha}S) - \underline{\alpha}(1-q)f'(\underline{a}-(1-\underline{\alpha})P-\underline{\alpha}S) \quad (7)$$

$$\frac{B'(\underline{a})}{1+\lambda} = (1-\underline{\alpha}(1-q))f'(\underline{a}-(1-\underline{\alpha})P-\underline{\alpha}S) - \overline{\alpha}qf'(\overline{a}-(1-\overline{\alpha})P-\overline{\alpha}S) \quad (8)$$

where $\overline{a}$ or $\underline{a}$ indicates the announcement of landowners' type and $\overline{\alpha}$ or $\underline{\alpha}$ indicates landowners' true type. In (7), the first term on the right-hand side is the high type's marginal cost of retirement when the social norm is endogenous: Increasing the high type's retirement increases the social norm, which reduces the high type's marginal cost by $\overline{\alpha}qf'$. The second term is the effect of increasing the high type's retirement on the low type's marginal cost: Due to the endogenous norm, the low type's marginal cost decreases by $\underline{\alpha}(1-q)f'$ (Qin and Shogren, 2015). Analogously, (8) shows that increasing the low type's retirement decreases both types' marginal costs compared to the exogenous-norm case.

3.2 Asymmetric information

The following proposition describes the optimal mechanism when the norm is endogenous:

PROPOSITION 2: *Assume that the social norm is endogenously determined by the average level of land retirement. In the optimal mechanism:*

(i) *If the social norm exceeds the personal norm, unlike in the exogenous-norm case, the land retirement of the high-sensitivity landowner can be distorted. Nonetheless, the high-sensitivity landowner still receives information rents and retires more land than the low-sensitivity type.*

(ii) *If the social norm is below the personal norm, unlike in the exogenous-norm case, the land retirement of the low-sensitivity landowner can be distorted. Nonetheless, the low-sensitivity landowner still receives information rents and retires more land than the high-sensitivity type.*

(iii) *If the personal norm equals the social norm, as in the exogenous-norm case, the landowners retire the efficient quantities and do not receive information rents.*

Proof. See the appendix. □

The main effect of endogenizing the social norm is that, in contrast to textbook mechanism design models, the efficient provider might not supply the efficient quantity (Laffont, 1995; Qin and Shogren, 2015). The reason is that, under endogenous norms, the efficient type's information rent depends on the efficient type's output and not just the inefficient type's output. Therefore, the regulator generally distorts both outputs to reduce information rents. When the social norm exceeds the personal norm in Proposition 2(i), the high type's information rent depends on the high type's output as follows:

$$\frac{dR_{\overline{\alpha}}}{d\overline{a}} = -\underline{\alpha}qf'(\underline{a}-(1-\underline{\alpha})P-\underline{\alpha}S) + \overline{\alpha}qf'(\underline{a}-(1-\overline{\alpha})P-\overline{\alpha}S) \quad (9)$$

which has an ambiguous sign. The first term reflects that increasing the high type's land retirement increases the social norm, which decreases the low type's retirement cost. This allows the regulator to reduce the low type's payment, which decreases the high type's temptation to imitate the low type. However, the second term shows that the increase in the social norm also decreases the high type's imitation cost, which increases the temptation to imitate. In the numerical simulation in Figure 1 (Case A), we find that the second effect is larger. Thus, the regulator distorts the high type's land retirement downward.

In Proposition 2(ii), similarly, the low type's information rent depends on the low type's output as follows:

$$\frac{dR_{\underline{\alpha}}}{d\underline{a}} = -\overline{\alpha}(1-q)f'(\overline{a} - (1-\overline{\alpha})P - \overline{\alpha}S) + \underline{\alpha}(1-q)f'(\overline{a} + (1-\underline{\alpha})P - \underline{\alpha}S) < 0 \quad (10)$$

Since this expression is unambiguously negative, if the high type's land retirement $\overline{a}$ were at the efficient level, the regulator would distort the low type's retirement upward. However, since $\overline{a}$ might be downward distorted (causing the social norm to be lower and the low type's marginal cost to be higher), $\underline{a}$ is not necessarily upward distorted. In the simulation in Figure 1 (Case B), $\underline{a}$ is upward distorted for some parameters.

4 Conclusion

In this paper, we studied the optimal design of conservation contracts for regulators when (1) personal and social conservation norms reduce landowners' cost of retiring land and (2) the regulator does not observe the landowners' sensitivities to social norms. The results suggest that when social norms exceed personal norms, landowners who are more sensitive to social norms self-select into larger conservation contracts. Intuitively, these landowners benefit the most from living up to or exceeding the social norm. In contrast, when the personal norm exceeds the social norm, landowners who are more sensitive to personal norms - and less sensitive to social norms - choose larger contracts. Finally, when we endogenize the social norm by assuming it equals the average level of land retirement, we find that the regulator can distort even the efficient type's retirement to reduce information rents. In future research, one could assume an interval of landowner types, heterogeneous personal norms, and study the joint determination of social and personal norms.

From a policy perspective, our results suggest that higher personal and social norms for land conservation reduce landowners' cost of retiring land. When landowners' sensitivity to social norms is unknown, regulators can benefit from offering a menu of contracts. If the social norm exceeds the personal norm, the regulator can offer the low-sensitivity type a higher compensation rate and buy fewer acres from this type. If the social norm is below the personal norm, the regulator can offer the high-sensitivity type a higher compensation rate and buy fewer acres from this type. These lessons could potentially be extended to other contexts, such as energy conservation.

Figure 1: Simulation for the endogenous social norm case

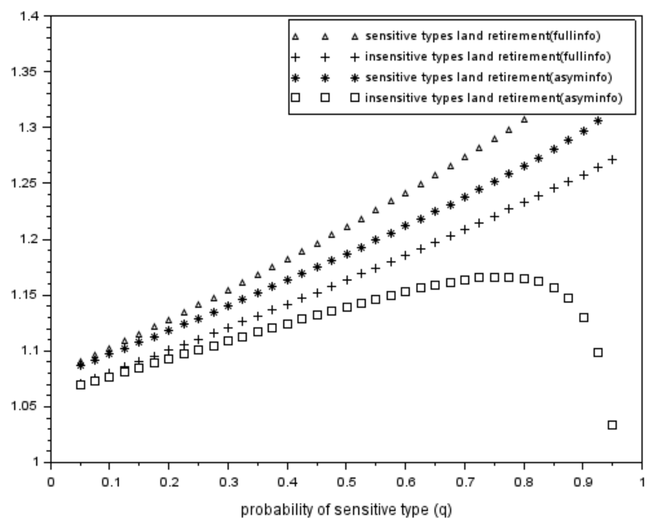
$$B\left(q\overline{a}+(1-q)\underline{a}\right)=ln\left(q\overline{a}+(1-q)\underline{a}\right)$$

$$f(a-N)=e^{(a-N)}\Rightarrow f'(a)=e^{(a-N)}$$

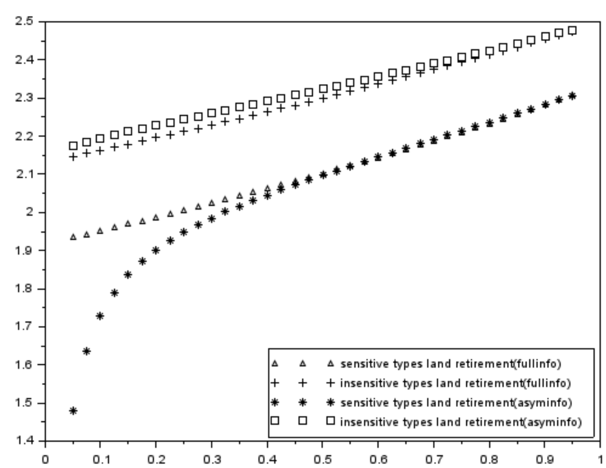
$$N=(1-\alpha)P+\alpha S$$

$$S=q\overline{a}+(1-q)\underline{a}$$

CASE A: S>P ($P=1$, $\overline{\alpha}=0.5$, $\underline{\alpha}=0.25$, $\lambda=0.2$)



CASE B: S<P ($P=3$, $\overline{\alpha}=0.5$, $\underline{\alpha}=0.25$, $\lambda=0.2$)



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