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Asymmetric information may protect the commons: *The welfare benefits of uninformed regulators*☆

Ana Espínola-Arredondo [1], Félix Muñoz-García *

School of Economic Sciences, Washington State University, Pullman, WA 99164, United States

HIGHLIGHTS

- We examine an entry-deterrence model in the commons.
- We investigate if asymmetric information becomes welfare improving.
- Under certain conditions, the regulator should not monitor natural resources.
- In other contexts, he has incentives to disseminate information about the stock.

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ABSTRACT

We examine an entry-deterrence model in the commons. We investigate in which contexts asymmetric information among firms becomes welfare improving, and in which settings an uninformed regulator may prefer to assess and disseminate information about the available stock among firms.

1. Introduction

Governments are often actively engaged in assessing the scarcity of common pool resources in order to prevent overexploitation. This paper, however, suggests that uninformed regulators should not necessarily conduct such efforts, since a larger welfare may arise when firms exploiting the commons operate in a context of asymmetric information about the available stock.

This result is especially relevant in industries where the incumbent firm has access to more accurate information about the resource than the potential entrant. In this setting, the incumbent uses its exploitation to reveal or conceal information about the stock, and thus deter entry.[2] While this strategic exploitation might be welfare improving in certain contexts, it can become welfare reducing otherwise. In particular, when the environmental damage from exploiting the commons is relatively low, we show that a complete information context is welfare superior, regardless of the state of the stock. However, when such environmental damage is higher, maintaining an incomplete information structure yields a larger social welfare due to the incumbent's strategic behavior. Our results suggest, hence, that in an entry-deterrence

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* Correspondence to: 103G Hulbert Hall, Washington State University, Pullman, WA 99164-6210, United States. Tel.: +1 509 335 8402; fax: +1 509 335 1173.
E-mail addresses: anaespinola@wsu.edu (A. Espínola-Arredondo), fmunoz@wsu.edu (F. Muñoz-García).
[1] 111C Hulbert Hall, Washington State University, Pullman, WA 99164, United States.

[2] For examples of fishing grounds behaving as prescribed by this equilibrium prediction, see Mason and Polasky (1994) and Espinola-Arredondo and Munoz-Garcia (2011).

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context regulatory authorities do not need to closely monitor and publicize the stock of natural resources.

Several studies have analyzed the role of information in promoting the overexploitation of natural resources or, instead, reducing its appropriation below socially optimal levels; see Ostrom (1990), Mason and Polasky (1994), Polasky and Bin (2001), and Laurent-Lucchetti et al. (2011).[3] Unlike these articles, we examine an entry-deterrence game in which firms compete to exploit the same commons. In this context, firms underexploit the resource under certain conditions; as shown in Espinola-Arredondo and Munoz-Garcia (EM, 2011, 2013). However, after characterizing equilibrium results, they only compare appropriation levels under different information contexts. In this paper, we explicitly evaluate the welfare properties of incomplete information in the commons, which allows us to identify more precise policy recommendations, such as the acquisition and dissemination of information by uninformed regulators. The following section describes the model, Section 3 analyzes the welfare arising when the stock is low or high; while Section 4 discusses policy implications.

2. Model

Following EM (2011), consider a common pool resource, initially exploited by an incumbent (e.g., a fishery), threatened by a potential entrant. In the first stage, the incumbent observes the available stock in the commons, either high, θ_H, or low, θ_L, where $\theta_H > \theta_L$, but the entrant does not. Upon observing the level of the stock, the incumbent chooses a first-period appropriation, $x > 0$. The market is perfectly competitive and the price is normalized to one. The firm faces a cost function of $\frac{x^2}{\theta_K}$, where $K = \{H, L\}$, thus yielding first-period profits of $x - \frac{x^2}{\theta_K}$. At this point, the potential entrant observes the incumbent's first-period appropriation, and updates its beliefs about the available stock being high, $\mu(\theta_H|x) \in [0, 1]$. As in similar entry-deterrence games, assume that entry is only profitable when the stock is high. If entry does not occur, the incumbent maintains its monopoly power, and chooses a second-period appropriation, $q > 0$, that maximizes its profits $q - \frac{q^2}{\theta_K - (1-\beta)x}$. Intuitively, the cost function is increasing and convex in second-period appropriation, q, decreasing in the regeneration rate of the resource, $\beta \in [0, 1]$, and increasing in first-period appropriation, x.[4] If, instead, entry ensues, incumbent and entrant compete for the resource. In this setting, every firm $i = \{1, 2\}$ simultaneously and independently selects a second-period appropriation level, $q_i > 0$, that maximizes $q_i - \frac{q_i(q_i+q_j)}{\theta_K - (1-\beta)x}$ for $j \neq i$, where firm i's costs are increasing in its opponent's appropriation, i.e., exploiting the resource becomes more difficult as the competitor increases its appropriation.

Finally, assume that the regulator's social welfare function in each period is $W \equiv \gamma CS + PS - ED$, where $CS \equiv \int_0^Q p(y)dy$ denotes consumer surplus, and $p(Q) = a - Q$ represents the inverse demand function where $Q \equiv q_i + q_j$; PS is the producer surplus from all firms exploiting the commons; and ED denotes the environmental damage (e.g., biodiversity loss) associated to the exploitation of the resource, which is convex in the aggregate appropriation level in each period, i.e., dx^2 in the first period and dQ^2 in the second period. In addition, $\gamma \in [0, 1]$ is the share of appropriation that is sold domestically, while $d \in [0, 1]$ indicates the severity of the environmental damage from appropriation. For simplicity, we assume no discounting of future payoffs.

3. Signaling in the commons

3.1. Low stocks

In a complete information setting, if the available stock is low, the entrant stays out. Under an incomplete information context, however, EM (2011, 2013) show that a separating equilibrium can be sustained in which the low-stock incumbent has incentives to underexploit the commons (relative to a complete information benchmark) in order to reveal its stock to potential entrants, thus preventing entry. The next lemma demonstrates that, while first-period appropriation is lower, the increase in second-period appropriation yields an overall increase in the exploitation of the resource.

Lemma 1. *When the available stock is low, first-period (second-period) appropriation is lower (higher, respectively) in the separating equilibrium (SE) than under complete information (CI), i.e.,* $x^{L,CI} > x^{L,SE}$ *but* $q^{L,CI} < q^{L,SE}$. *Overall exploitation is larger in the separating equilibrium than under complete information, i.e.,* $x^{L,SE} + q^{L,SE} > x^{L,CI} + q^{L,CI}$, *under all parameter values.*

This result suggests that incomplete information entails the emergence of three type of welfare effects (one positive, and two negative). Specifically, incomplete information produces: (1) an increase in consumer surplus, since overall appropriation is larger; (2) a reduction in the incumbent's profits, given that the firm needs to underexploit the commons to deter entry;[5] and (3) an increase in the environmental damage, which originates from a larger overall production in the separating equilibrium. For compactness, we hereafter refer to these welfare effects as (1)–(3). The next proposition identifies under which conditions the positive effect from a larger consumer surplus, in (1), dominates the two welfare losses, which emerge from lower profits, in (2), and larger environmental damages, in (3); ultimately yielding a welfare improvement.

Proposition 1. *When the available stock is low, social welfare is larger under incomplete than under complete information if and only if* $\gamma > \overline{\gamma}$ *(see the Appendix for* $\overline{\gamma}$*).*

Fig. 1 depicts cutoff $\overline{\gamma}$,[6] thus generating two regions of (γ, d)-pairs: one in which the separating equilibrium is welfare improving (above cutoff $\overline{\gamma}$, in the shaded area), and another in which it is welfare reducing (below $\overline{\gamma}$).

Intuitively, when the exploitation of the commons does not entail environmental damages, i.e., $d = 0$ in the vertical axis, the separating equilibrium only produces welfare effects (1) and (2), but does not give rise to (3). In contrast, when all appropriation is sold overseas, $\gamma = 0$ along the horizontal axis, the introduction of incomplete information only yields the welfare losses in (2) and (3). Finally, when both γ and d are strictly positive, all welfare effects (1)–(3) are present, and the separating equilibrium becomes welfare improving if the welfare benefit from (1) is sufficiently large (high values of γ) and the welfare loss from (3) is relatively low (small values of d).[7]

[3] For a comprehensive review of the literature on common pool resources, see Faysse (2005).

[4] In addition, when the stock fully regenerates, $\beta = 1$, the same amount of stock is available in the first- and second-period game. In this context, the incumbent faces the same cost function in both periods.

[5] The incumbent maintains its monopoly power both under complete and incomplete information. However, deterring entry becomes more costly in the latter (where the firm needs to underexploit the resource) than in the former (where the incumbent does not need to deviate from profit-maximizing appropriation levels).

[6] The figure considers stock levels $\theta_H = 10$ and $\theta_L = 5$, $a = 10$, and a regeneration rate of $\beta = \frac{6}{10}$. Other parameter values yield similar results, and can be provided by the authors upon request.

[7] In addition, cutoff $\overline{\gamma}$ is decreasing in θ_L, and in the regeneration rate, β. Hence, the region in which the separating equilibrium is welfare improving (above the