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ANALYSIS

The pricing of protected areas in nature-based tourism: A local perspective

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Abstract

This paper extends the literature on optimal pricing of recreation in protected areas by introducing price discrimination between groups of visitors and, given that the agency charges different prices to subsets of visitors, by including a distributional dimension that is particularly relevant for a national park agency receiving visitors from different origins. Other issues related to optimal entrance fees, including negative ecological impacts and positive spillover effects on local communities resulting from changes in visitation, are also discussed. Based on this model, the paper provides an estimation of optimal entrance fees and revenues for the Costa Rican system of protected areas.

Keywords: Optimal prices; Price discrimination; Recreation; Protected areas; Costa Rica

1. Introduction

Most countries have reserved a portion of their territories to the protection and preservation of natural environments. There are different categories and levels of conservation, but in general all protected areas are created in order to "…promote the persistence of species, communities or ecosystems that would otherwise decline or become extinct in the wild" (Lunney et al., 1997, p. 138). A second main purpose in the creation of protected natural environments is the preservation of landscapes of outstanding beauty that provide opportunities for recreation or scientific study (USNPS, 1996).

In this paper, I seek to provide the theoretical underpinnings for the optimal pricing of protected areas used in recreational activities, from the perspective of a local park agency interested in maximizing welfare. The approach in this paper extends the existing literature on pricing of protected areas by introducing price discrimination between different groups of visitors. This allows for a more efficient adjustment to the distortions imposed by, for example,

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a cost recovery restriction. Another innovative element in the theoretical model is that, given that the agency charges different prices to different subsets of visitors, the model also includes a distributional dimension that is particularly relevant for a local park agency receiving visitors from different origins or of different nationalities. Finally, I discuss several other issues related to optimal entrance fees, including ecological impacts of increased visitation, the spillover effects of changes in entrance fees on local communities and the treatment of fixed investment costs.

Based on this theoretical foundation, the paper provides an estimation of the optimal entrance fees and associated revenues for the Costa Rican National Park System. Costa Rica is one of the few countries in the world where entrance fees to protected areas have changed several times, allowing for the estimation of the demand for recreational-day-visits using actual visitation data. This input is then used to calculate optimal prices. Although other studies have explored the willingness to pay to enter specific protected areas in Costa Rica and elsewhere, to my knowledge none have attempted to estimate optimal prices based on welfare maximization, and only one (Chase et al., 1998) has calculated entrance fees that at least maximize revenues from foreign visits.

Given the reduced availability of public funds, user fees for recreation in protected areas are an increasingly relevant source of funds to a park agency. A well-designed system of fees can make these areas more financially self-sufficient, thereby sending a positive signal to the government authorities regarding the value of land dedicated to conservation. If the required information is available, user fees can also be used to manage visitation in order to avoid imposing an excessive burden on the natural environment, reduce congestion in some parks and smooth the seasonal pattern of visitation. A related issue is that if the protected area is located in a relatively poor host country and entrance fees are small and below the amounts that foreign visitors are willing to pay for enjoying the resource, then the perverse consequence is that the host country will be subsidizing recreation for visitors from richer countries (Laarman and Gregersen, 1996).

As in any other typical developing country, the Costa Rican system of national parks is under constant threat from the lack of funds to manage the resources properly, and the pressure to exploit them in alternative commercial activities (Eagles et al., 2002; SINAC–MINAE, 2003). On the other hand, in the last 15 years, Costa Rica has experienced a large increase in international tourism. Most of this increase is due to Costa Rica's system of national parks, which encompasses approximately 24% of the national territory and a vast array of different types of marine and land ecosystems. According to a survey of the Costa Rican Institute of Tourism, 71% of all holiday visitors to Costa Rica visit at least one national park, and most of the activities of foreign visitors are highly related to natural attractions in the country (ICT, 2000a,b, 2002).

Despite the importance of nationally protected areas for tourism in Costa Rica, the increase in tourism activities has not lead to a matching increase in the government budget dedicated to managing and protecting these resources for recreational activities (SINAC–MINAE, 2003). In 1994, the government decided to recover the costs of managing the parks for recreation, and started to price discriminate based on nationality. Since then, there have been several changes in price to foreign visitors, but little or no formal criteria have been used in the determination of price changes (Bermúdez, 1996). An improvement in the criteria for setting the entrance fee is important not only for Costa Rica, but for the rest of the countries in the region, and potentially for other regions of the world attempting to develop an ecotourism strategy for their protected areas.

2. The economic model

Assume that a local park agency is in charge of managing the system of protected areas. In particular, it sets the price for recreational visits to the park system,[1] pursuing the objective of maximizing welfare from the consumption of recreational services. For simplicity, assume that the park agency treats all parks as a single composite good, i.e., the price is the same for all parks. This was the situation in Costa

[1] An obvious assumption underling the analysis of this paper is that it is possible to charge an entrance fee to enter the parks and, furthermore, that the costs of managing this fee are not prohibitive.

Rica until 2002 and is therefore consistent with the available data.[2]

In the absence of the cost recovery restriction, the traditional first best optimal pricing strategy requires the price to be set equal to marginal cost plus a correction for external effects. If the park agency faces a binding budget balancing requirement, the price should be equal to the average cost or a two-part price should be implemented.

Given that the government is concerned with distributional issues, particularly regarding national and foreign visitors, and can exercise price discrimination between the two groups, then the maximization of weighted social welfare from visitation will result in pricing rules that take into account the differences between the two groups of visitors, and will therefore depart from the first best rule mentioned above. Accordingly, the park agency sells the same good to two types of consumers: national (n) and foreign (f) visitors. Hence, it can identify the separate demands (x_n and x_f) and charge different prices to each group. Also, the park agency follows a weighted utilitarian social welfare function, and assigns a weight of $\alpha \in [0,1]$ to the consumer surplus of foreign tourists (Baumol and Bradford, 1970; Feldstein, 1972). The optimal prices for national and foreign visitors to the protected areas, p_n and p_f, respectively, are obtained from the agency's solution to the following social welfare maximization problem:[3]

$$\begin{aligned} \text{Max}: S = {} & \alpha \int_{p_f}^{\infty} x_f(v)\mathrm{d}v + p_f x_f(p_f) \\ & + \int_{p_n}^{\infty} x_n(v)\mathrm{d}v + p_n x_n(p_n) - C(x_f, x_n) - I \\ & - g(x_f, x_n) + T(x_f, x_n) \end{aligned}$$

subject to :

$$\begin{aligned} &\text{i. } p_f x_f + p_n x_n - C(x_f, x_n) - I - R \geq 0 \\ &\text{ii. } x_f, x_n > 0. \end{aligned} \qquad (1)$$

The first four additive terms in S are the weighted Marshallian consumer surplus and the producer surplus of foreign visitors, followed by the consumer and producer surplus of national visitors. The next four terms correspond to the park agency's total costs of recreation, $C(x_f, x_n)+I$, the social costs at the ecosystem level caused by visitation to the protected area, $g=g(x_f, x_n)$, and the social positive spillover effect from visitation, $T=T(x_f, x_n)$.

The demand of group i ($i=f$, n) for recreation-visitor-days is given by $x_i=x_i(p_i)$. Note that since income effects are expected to be small, then the Marshallian surplus is an exact measure of welfare change.

Throughout this paper, I assume constant marginal costs of recreation, i.e., $C(x_f, x_n)=cx_f+cx_n$. This assumption seems quite realistic for nature-based tourism in the Costa Rican system of national parks (Bermúdez, 2001), and probably for ecotourism in protected areas in general. The term I captures all costs of recreation regarded by the park authority as not related to the number of visits (like trail clearing, signs, fire prevention, park rangers). This term also includes any expenditure aimed at increasing the quality of the recreational experience, as long as it does not varies with changes in visitation. In this model, investment in quality is not treated as a decision variable for several reasons. First, the aim is to obtain optimal pricing rules for foreign and national visitors for any given level of fixed costs; in this sense, changes in fixed costs, I, will affect the level of the optimal prices, but not the optimal pricing rule. Second, the park authorities can perceive investment in quality as a lumpy decision variable and therefore not freely adjustable, at least in the short run, to changes in visitation. Finally, there are natural (and legal) limitations to investment in a protected natural area.

In most countries, the park agency faces a cost recovery condition like the one included in Eq. (1), which requires the agency's revenues from recreation to cover at least the fixed and variable costs of this activity. Furthermore, in some occasions the government might impose a minimal revenue constraint, captured by R, which reflects the government intention of recovering some of the costs strictly attributable to the conservation effort via entrance fees to visitors. Obviously, recreational visitors not only

[2] A drawback of this assumption is that no differential pricing of parks is possible. Entrance fees could be used to drive visitors away from highly visited parks, if information about cross–price elasticities and carrying capacities were available. A further extension of this model to include cross-price effects among several parks in a system is an obvious next step. Wilman (1988) develops a model where the park agency is treated as a multiproduct monopoly, and obtains optimal Ramsey prices.

[3] Appendix A includes a table summarizing the notation used throughout the paper.

enjoy the trails they walk on, but also some of the public services provided by the natural environment. Still, it could be regarded as unfair to charge visitors the full costs of creating and managing a protected area for conservation and recreational purposes (Beal, 1996; Dixon and Sherman, 1991; Anas, 1988).

In addition, I assume that the protected area has a positive ecological carrying capacity of visitation, and that this capacity is not exceeded. Still, visitation can impact a wide array of ecosystem functions in ways that might affect the resilience and basic functioning of the ecosystem. Negative impacts on breeding and feeding patterns of wildlife have been amply documented (Ceballos-Lascurain, 1996). This impact on ecological systems is expected to create mainly social costs inasmuch as it complicates the conservation effort of the park agency. Although there is limited literature on how much of this impact is privately perceived by visitors themselves, the evidence (and the author's extensive discussions with experts in ecotourism) suggests that visitors mainly notice aesthetic impacts, like litter, that may have little ecological importance. Impacts that are ecologically important, like erosion and wildlife disturbance, may not be noticed at all by visitors. Hence the ecological impact, captured by $g=g(x_f, x_n)$ is here treated as social external costs.

Finally, the term $T=T(x_f, x_n)$ captures the positive social spillover effect of visitation on areas and populations surrounding the protected areas, with $T'_{x_i}>0$. Nature-based tourism is, in many cases, the only source of income for the population living in the areas surrounding the parks, and the decision regarding optimal management of recreational activities cannot be made in isolation from the impact of those management practices on rural development.[4]

For simplicity in the presentation of results, A denotes the total social external effects of visitation from any of the two groups, such that $A=-g(x_f+x_n)+T(x_f+x_n)$. In the absence of additional information and for the sake of simplicity, I have assumed that national and foreign visitors have the same ecological impact and spillover effects. This assumption, although questionable regarding the spillover effects, greatly simplifies the analysis of the optimal pricing rules, by concentrating the attention on the relative price sensitivity of both groups. Still, I will resort to a more general formulation whenever it provides interesting insights, and Appendix B provides the optimal pricing rules under this general formulation.

Accordingly, the net marginal external effect of a change in visitation from any of the two groups is given by:

$$\frac{\partial A}{\partial x_i} = A' = A'_f = -\frac{\partial g}{\partial x_f} + \frac{\partial T}{\partial x_f} = -\frac{\partial g}{\partial x_n} + \frac{\partial T}{\partial x_n} = A'_n. \quad (2)$$

Hence, A' will be larger than zero if the positive marginal spillover effect on the surrounding communities prevails over the ecological impact associated with a marginal increase in visitation.[5]

The optimal prices to national and foreign visitors result from the solution to the restricted social welfare maximization problem described in Eq. (1). To find this solution, I use the Lagrangian method (see Sydsaeter and Hammond, 1995) from which the following first-order conditions are derived:[6]

$$\frac{\partial L}{\partial p_f} = (1-\alpha)x_f + \left(p_f - c + A'\right)*x'_f + \lambda\left[x_f + \left(p_f - c\right)*x'_f\right] = 0, \quad (3)$$

$$\frac{\partial L}{\partial p_n} = \left(p_n - c + A'\right)*x'_n + \lambda[x_n + (p_n - c)*x'_n] = 0, \quad (4)$$

$$\frac{\partial L}{\partial \lambda} = p^*_f x_f - c\left(x_f\right) + p^*_n x_n - c(x_n) - I - R \geq 0, \quad (5)$$

$$\lambda \geq 0, \quad (6)$$

$$\lambda*\left(p^*_f x_f - c\left(x_f\right) + p^*_n x_n - c(x_n) - I - R\right) = 0 \quad (7)$$

[4] Note that rural development might be crucial in the long-term success of a protected area, by reducing the pressure on the natural environment (see Leitman, 1998, for further discussion).

[5] An increase in visitation leads to an increase in the social costs associated with the ecological impact (hence: $(\partial g)/(\partial x_i)>0$) and to an increase in benefits to the local communities (hence: $(\partial T)/(\partial x_i)>0$).

[6] The Lagrangian (L) is given by: $L(p_f, p_n, \lambda)=S+\lambda*[p_f*x_f-c(x_f)+p^*_n x_n-c(x_n)-I-R]$, where λ is the Lagrange multiplier. In addition, from now on, I will use $(\partial x_i)/(\partial p_i)=x'_i<0$ and $(\partial c/\partial x_i)=c>0$.

By rearranging these first-order conditions, I will be able to find equations for the optimal entrance fees under different assumptions regarding the welfare weights and the external effects. For example, if the cost recovery restriction is not binding, i.e., Eq. (5) holds with strict inequality, then Eq. (7) requires that the Lagrange multiplier be set equal to zero, $\lambda=0$, and it follows immediately from Eq. (4) that $p_n=c-A'$, and from Eq. (3) we have the following optimality condition for p_f:

$$\frac{p_f-c+A'}{p_f}=(1-\alpha)\frac{1}{\varepsilon_f}, \quad (8)$$

Where ε_f is the price elasticity of demand for foreign visitors.[7] Then, if the consumer surplus of national and foreign visitors has the same weight, i.e., $\alpha=1$, then the usual marginal cost pricing rule holds for both groups (price equal to marginal cost plus externalities). If $0\le\alpha<1$, optimality requires a larger deviation from the marginal cost-pricing rule the closer α is to 0, ultimately resulting in a simple monopoly-pricing rule for foreign visitors. The park agency is able to recover more than the variable costs, and if $R>0$, potentially make a profit.

Returning to the case of a binding cost recovery restriction,[8] in order to provide interesting, interpretable results, the rest of the solution will be divided into two cases. In Case 1, the consumer surplus of both groups is weighted equally, i.e., $\alpha=1$, and in Case 2, a weight of zero is assigned to the consumer surplus of foreign visitors, i.e., $\alpha=0$. If the park agency is located in a poor country and receives visitors from richer nations, this might be regarded by the agency as a fairer perspective. The results of the empirical section of this paper will be based on the optimality conditions obtained under this second case.

2.1. Case 1: $\alpha=1$

The park agency exercises third degree price discrimination based on nationality, but still assigns equal weights to the consumer surplus of both groups.[9] A first intuitive result can be obtained by setting $A'=0$, i.e., the case of no external effects. Solving Eq. (4) for λ and rearranging Eq. (3), we reach the following condition for the optimal relative price margin for both consumers groups:

$$\frac{\frac{p_f-c}{p_f}}{\frac{p_n-c}{p_n}}=\frac{\varepsilon_n}{\varepsilon_f}, \quad (9)$$

The relative price margin is relatively higher in the market with relatively lower elasticity, which is a special case of the usual Ramsey rule. Given that nationals generally have a lower income and, most importantly, a higher availability of time and substitutes for recreation, I hypothesize that their price elasticity is higher, and hence the relative price margin will be lower for that consumer group, compared to the foreign visitors.

Going back to the general case of positive or negative external effects, we can again use the first-order conditions to solve for the optimal pricing rules for both foreign and national consumers, which are given by:[10]

$$\begin{aligned}(p_f-c)&=\left[\frac{x_fx_n'-x_f'x_n'A'}{x_n^2x_f'-x_f'x_n'A'(x_n+x_f)+x_f^2x_n'}\right]\hat{I}\\&\quad+\left(\frac{x_n(x_fx_n'-x_f'x_n)}{x_n^2x_f'-x_f'x_n'A'(x_n+x_f)+x_f^2x_n'}\right)A'\\&=\gamma_f\hat{I}+\Lambda_fA',\end{aligned} \quad (10)$$

$$\begin{aligned}(p_n-c)&=\left[\frac{x_nx_f'-x_f'x_n'A'}{x_n^2x_f'-x_f'x_n'A'(x_n+x_f)+x_f^2x_n'}\right]\hat{I}\\&\quad+\left(\frac{x_f(x_nx_f'-x_n'x_f)}{x_n^2x_f'-x_f'x_n'A'(x_n+x_f)+x_f^2x_n'}\right)A'\\&=\gamma_n\hat{I}+\Lambda_nA'.\end{aligned} \quad (11)$$

[7] $\varepsilon_i=x_i'(p_i)/(x_i)$; $i=f, n$.

[8] In what follows, I shall refer to $\hat{I}=I+R$ as a fixed cost, and refer to cost recovery restriction even though R includes costs not related to recreation.

[9] Wilman (1988) provides a numerical example of this case, given no external effects, $(A'=0)$.

[10] I assume that the following conditions hold: i. $A'>\frac{x_f}{x_f'}$; ii. $A'>\frac{x_n}{x_n'}$; or iii. $A'>\frac{x_n}{x_n'}\left(\frac{x_n}{x_n'+x_f}\right)+\frac{x_f}{x_f'}\left(\frac{x_f}{x_n'+x_f}\right)$. Hence the denominators in all four terms in Eqs. (10) and (11) are always negative, and the numerators in the square brackets are also always negative. All three conditions restrict the range of the net marginal external cost, A', at a very large negative number, such that no practical implications are expected from this assumption.

Prices both to foreign and to national visitors have to deviate from the first best marginal cost pricing rule to account for the cost recovery requirement and the external effects generated by the visits. Price discrimination allows the park agency to minimize the welfare cost of this adjustment by taking into account the price sensitivity of both groups, relative to their total visitation. For example, in correcting for the distortion imposed by the cost recovery condition, the aim is to raise revenues while minimizing the impact on visitation. This is achieved by increasing the price charged to the group with the lowest price sensitivity, provided there are enough visits from this group to raise the required revenues. On the other hand, in correcting for negative marginal external effects of visitation, the pricing rule should decrease visitation in such a manner that profits are reduced as little as possible. This can be achieved with an increase in the price charged to the group with the highest relative price sensitivity. As mentioned in the Introduction, I expect and assume that national visitors have a higher sensitivity to price than foreign visitors, i.e., $\varepsilon_n > \varepsilon_f$. Hence, if, as expected, the entrance fee to foreigners is higher than for nationals ($p_f > p_n$), then the following condition, henceforth Condition (1), holds: $(-x_n'/x_n) > (-x_f'/x_f)$.[11] Then the previous discussion indicates that foreign visitors should be targeted in order to raise most of the funds required by the cost recovery restriction, while visitation should be managed mostly via changes in the price to national visitors. Accordingly, if Condition (1) holds, the terms in the square brackets on the RHS of Eqs. (10) and (11), denoted γ_i, will be such that $\gamma_f > \gamma_n$.

The term in round brackets, Λ_i, in the right hand side (RHS) of Eqs. (10) and (11) is a further correction for the external effects generated by visitors to the park. Again, if Condition (1) holds, then we would have $\Lambda_f > 0$ and $\Lambda_n < 0$. Assume that the negative marginal costs of ecosystem degradation prevail, such that the overall net marginal external effect is negative ($A' < 0$), then Eqs. (10) and (11) show that we have to increase the price to nationals to correct for the external effects, while even decreasing the price to foreigners in order to balance the budget. This result is driven by the first-order condition that $\lambda > 0$, i.e. the cost recovery restriction must hold with equality. Note that a minimum profit requirement of R is still included in that condition. The optimal pricing rules provided here are the typical second best solutions, which are a balance of the two distortions. Appendix B provides the optimal pricing rules for the case of different marginal external costs for the two types of visitors, i.e., $A_f' \neq A_n'$.

2.2. Case 2: $\alpha = 0$

The park authority maximizes only national welfare, assigning a weight of zero to the consumer surplus of foreign visitors. By setting $\alpha = 0$ and rearranging Eq. (3), one obtains the following optimality condition for the price to foreigners:

$$p_f = \frac{x_f - x_f' c}{-x_f'} - \frac{A'}{(1+\lambda)}, \tag{12}$$

Given that $\lambda \geq 0$, we have that $(1/1+\lambda) \leq 1$. The second term in the RHS of Eq. (12) is a correction from the usual monopoly price, due to the externality. Hence we have that $p_f|_{A'<0} > p_f|_{A'=0} > p_f|_{A'>0}$, where $A' < 0$ if the negative marginal social costs from ecological damage prevails over the positive spillover effect on surrounding areas resulting from increased visitation.

I will first derive the case for $A' = 0$, i.e., the case with no external effects. Since the empirical section of this paper does not attempt to deal with the estimation of externalities due to the lack of information about these effects, this case will be the basis for estimation of optimal prices. The optimal pricing rule for foreign visitors is given by

$$p_f - c = \frac{x_f}{-x_f'}, \tag{13}$$

which is the usual inverse elasticity rule, namely $p_f - c / p_f = 1/\varepsilon_f$. From now on, denote this pricing rule as $p_f - c|_{A'=0}$, i.e. this is the optimal deviation from marginal costs for foreign tourists under the cost recovery restriction and no external effects. Inserting Eq. (13) into the first-order conditions (5) and rearranging, one obtains:

$$(p_n - c)|_{A'=0} = \frac{-\left[\dfrac{x_f^2}{-x_f'} - \hat{I}\right]}{x_n}. \tag{14}$$

[11] From $\varepsilon_n > \varepsilon_f \rightarrow (-x_n' p_n)/(x_n) > (-x_f' p_f)/(x_f)$ and $p_f > p_n > 0$ we have that $((-x_n')/(x_n)) > ((x_f')/(x_f))$ holds.

The term in square brackets in the numerator of the RHS of Eq. (14) is a measure of the revenues collected from entrance fees to foreigners netted of variable costs (c) and all fixed costs, $\hat{I}$. Hence when these net revenues are positive, they could even be used to subsidize the price charged to national visitors, so that $p_n < c$. When revenues from foreign visitors do not fully cover the fixed costs, the price charged to nationals has to recover all remaining fixed costs as well as its own variable costs. This result arises from the fact that the price to foreigners is the profit maximizing one, and any deviation from it will result in less fixed costs recovered. Interestingly, if the government increases the revenue constraint, R, and given that prices were previously at their optimal levels, this will not affect the foreign visitors, but will rather result in a higher entrance fee for nationals. In summary, the profits obtained from charging a "monopoly" price to foreign visitors allow the public park agency to move closer to the first best marginal cost pricing of national visitors. Under $\alpha = 0$, a comparison to a uniform average cost price is straightforward.[12] By exercising price discrimination, the price to nationals will definitely be lower than the uniform average price, thereby increasing national visitation and welfare.

Using Eq. (12) and the first-order conditions one can obtain the optimal pricing rules for national and foreign visitors for the case of non-zero external effects, which are given by:[13]

$$p_n - c = \left\{ \frac{(x_n)^2 - A' x_n' x_n}{(x_n)^2 - A' x_n' (x_n + x_f)} \right\} \left(\frac{ - \left(\dfrac{x_f^2}{- x_f'} - \hat{I} \right) }{x_n} \right) + \left[\frac{x_n x_f}{(x_n)^2 - A' x_n' (x_n + x_f)} \right] A' \tag{15}$$

and

$$p_f - c = \left\{ \frac{(x_n)^2 - A' x_n' x_n}{(x_n)^2 - A' x_n' (x_n + x_f)} \right\} \left(\frac{x_f}{- x_f'} \right) + \left[\frac{- \left(x_n^2 + x_n' \hat{I} \right)}{(x_n)^2 - A' x_n' (x_n + x_f)} \right] A'. \tag{16}$$

Note that the terms in round brackets in Eqs. (15) and (16) correspond to the rules for optimal deviations from marginal cost, given no marginal external effects, namely $p_f - c|_{A'=0}$ and $p_n - c|_{A'=0}$. These basic rules are augmented to correct for the presence of external effects. The coefficients in front of $p_f - c|_{A'=0}$ and $p_n - c|_{A'=0}$ in Eqs. (15) and (16) are the same, i.e., both baseline cases are adjusted multiplicatively by the same factor, henceforth called ϕ.[14] The coefficient in square brackets in Eq. (15), henceforth called φ_{p_n}, is always positive.[15] Hence for analytical purposes, Eq. (15) can be rewritten as:

$$(p_n - c) = \phi^* (p_n - c)|_{A=\alpha} + \varphi_{p_n} {}^* A'. \tag{15'}$$

If $A' > 0$, i.e., the positive marginal externality prevails over the negative marginal impact of visitation, then we have that $0 < \phi < 1$. Hence, both baseline-pricing rules should be scaled down, thereby attracting more visitors. Alternatively, if the negative externality prevails, $A' < 0$, then $\phi > 1$, and both baseline prices should be scaled up, thereby discouraging visitation. To summarize the results for the optimal pricing rule for national visitors, if the negative marginal external effect is larger than the positive ($A' < 0$), then the optimal pricing rule calls for a scaling up ($\phi > 1$) of the baseline pricing rule given by $(p_n - c)|_{A'=0}$.

Our analysis is typically second best in the sense that several distortions affect the optimal level of entrance fees. Hence the scaling up of both the price to nationals and foreigners in response to a negative externality might bring more revenues and hence requires a decrease in the price to nationals in order to

[12] Note also that, given the assumption of constant marginal costs, the average cost price is equivalent to a two-part tariff composed of a fixed "membership" payment to cover fixed costs and entrance fees equal to marginal costs.

[13] The derivation of Eqs. (15) and (16) is cumbersome and would take too much valuable space from the analysis. The full derivation can be provided upon request.

[14] As A' tends to $(x_n^2)/((x_n + x_f)x_n')$ from the right, ϕ tends to infinity, i.e., both entrance fees become infinitely high. I therefore impose the restriction that A' is larger than that negative threshold level.

[15] The numerator is always positive and given the previous footnote, the denominator is also positive.

balance the budget, i.e., so that the restriction is met with equality. Therefore, the pricing rule (15′) also calls for an additive correction, which slightly lowers the price to nationals ($\varphi_{p_n}>0$) when the negative external effect prevails ($A'<0$), in an attempt to balance the budget. The opposite holds if $A'>0$.

Eq. (16) can also be written as:

$$(p_f - c) = \phi^*(p_f - c)|_{A=a} + \varphi_{p_f}{}^*A'. \qquad (16')$$

The coefficient in square brackets in Eq. (16), henceforth called φ_{p_f}, will be negative if $x_n^2 > -x_n' \hat{I}$. If this is the case, then a negative net marginal effect will call for an increase in price, and vice versa. If the condition does not hold, for example if fixed costs are very large, then $\varphi_{p_f}>0$, and a negative marginal effect will call for a decrease in price, and vice versa. This result appears intuitive given that $(p_f-c)|_{A'=0}$ is the pricing rule that achieves the highest revenues for the park agency and any deviation from that price will reduce funds to cover the fixed costs. Therefore, if fixed costs are large such that $\varphi_{p_f}>0$ holds, then the scaling up of $(p_f-c)|_{A'=0}$ due to a negative net marginal externality must be counteracted by the additive reduction. The opposite holds for a positive net marginal effect; the scaling down of $(p_f-c)|_{A'=0}$ must be counteracted by an additive increase in the price. In summary, if fixed costs are large, the park agency will attempt to set the price as close to $(p_f-c)|_{A'=0}$ as possible. If fixed costs are not large, i.e., $\varphi_{p_f}<0$, then the additive and multiplicative correction to the optimal pricing rule will reflect the sign of the net marginal external effect, such that a negative net marginal external effect will cause an increase in the baseline price.

Again, both corrections arise due to the second best nature of the analysis, and are a balance between the distortion imposed by the cost recovery restriction and the presence of externalities. Intuitively, the multiplicative increase in the price to nationals and foreigners under $A'<0$ raises further revenues for the park agency. In order to balance the budget, the park agency can and should slightly lower p_n. The price to nationals serves here primarily to deal with the problem of externalities and secondarily could be adjusted to balance the budget. The price to foreign visitors has one clear purpose. It should be close to the monopoly price, in order to gather as much revenues as possible. This is particularly so when fixed costs are large. Once the price to foreigners is set close to the monopoly level, the agency must resort to the price to nationals to balance the budget, reducing the price when there is a surplus or increasing it when revenues from foreign visitors fail to cover all the fixed costs.

Appendix B contains the derivation of optimal prices for the case of differing external costs depending on the type of visitors. These results serve to illustrate further the second best nature of the pricing rules.

3. Application to international tourism in Costa Rica

This section contains an empirical application of the theoretical model presented above. The objective is to compute optimal prices for foreign and national visitors to the Costa Rican system of protected areas. Given the absence of information about external effects, this application will be based on the optimal pricing rules provided in Eqs. (13) and (14). The main input into the computation is the estimation of the demand of foreign visitors for recreation-day-visits as a function of the entrance fee. In addition, an estimate of marginal (c) and fixed (I) costs is also required. Only if the profits from the foreign tourist group do not cover the fixed costs, will the price to nationals deviate from the marginal cost-pricing rule, in which case demand information will also be needed for that group.

The empirical part of this paper is an application using actual changes in the price to enter the Costa Rican system of national parks. As mentioned in the Introduction, Costa Rica is one of the few countries were entrance fees have changed several times, which provides enough information to estimate the demand for protected areas. In those cases where direct demand information is not available as input for the theoretical model, the most common method of estimating the demand for a recreational site, as a function of visitation costs, is the Travel Cost Method. As in Riera (2000), I partition the vacation planning decision into two, and study the demand for day-visits given that the tourists have chosen Costa Rica as their vacation destination. Intrinsic in the empirical analysis is the assumption that changes in the entrance fee to national parks do not affect the decision to visit Costa

Rica. This assumption seems reasonable given that entrance fees are expected to represent a relatively small share of the total vacation budget, and the fact that the country offers a myriad of other possibilities for doing nature-based tourism outside the protected areas.[16] Still, daily entrance fees are relevant in determining how many parks to visit and how many days to spend there, and as such might not be a negligible share of the on site vacation budget.

The crucial information about price changes and visitation was obtained from Bermúdez (1996, 2001). From 1991 to 1999, the Costa Rican system of national parks (SINAC) changed entrance fees to foreigners seven times by decree, setting it sometimes in USD and other times in colones. The price was always the same for all parks with the exception of a few months, and was changed at the same time; it ranged from USD 0.8 to USD 15. Visitors could pay in dollars or colones, and the average monthly exchange rate was used. Park visitation data contained monthly information on foreigner visits to the most important national parks, from the January 1991 to December 1999 period. Only 12 parks contained complete information for that period. Visitation for these parks was aggregated into a variable that reflected monthly foreign visits to the national parks system. This was required since there is no information about substitution effects in the data, given the governmental policy of a single price for the whole system. In addition, data on the monthly international flow of tourists were obtained from the Costa Rican Tourism Board (ICT, 2000a,b).

After several specification tests, the following econometric model was selected:

$$\log(x_t) = b_1P_t + b_2\log(x_{t-1}) + b_3\log(x_{t-12}) + b_4\log(V_t) + d_1SHI + d_2S + d_3Aug94, \tag{17}$$

which is also a reflection of the informational requirements of the theoretical model. The visits of foreigners to the park system, x_t, and to the country as a whole, V_t, are introduced as logarithms into the model, following the results of a Box-Cox specification. I expect that changes in international conditions will affect the demand for recreation in the protected areas through changes in the arrival of international tourists to Costa Rica, V_t. In addition, using a P–E test, the hypothesized logarithmic transformation of P_t can be rejected at a significance level of 6%, so the price is introduced as a linear variable. In addition, the demand equation includes three dummy variables, where SHI = 1 for the high season, which is between December and April; S = 1 for July and August, the medium-high season; and Aug94 = 1 for August 1994, i.e., the month immediately after the highest, unannounced increase in price, which stands as a clear outlier in the data. Lags are introduced to capture observed autocorrelation in the data, and possible stochastic seasonal effects. Notice that the demand equation does not include the price of substitute goods. As mentioned above, Costa Rica offers several other possibilities for doing nature-based tourism. Still, most of these options are openly available (beaches are a clear example) and there are very few privately owned natural reserves, such that no significant substitution effects are expected.[17]

Several other formulations of this demand equation were estimated and rejected in favor of the one presented here. More important is the fact that the estimated prices varied little from one econometric specification to another.

By rearranging Eq. (17) one obtains the long-run demand function, given by:

$$x_t = \left(e^{\Psi(b_1\mathrm{SHI}+b_2S+b_3\mathrm{Aug94})}V_t^{\Psi b_4}\right)e^{\Psi b_1 P} = \mathrm{W}e^{\Psi b_1 P}, \tag{18}$$

where $\Psi = ((1)/(1-b_2-b_3))$. From Eq. (18), it is easy to derive the following expressions for the long-run elasticity of visitation, $\varepsilon_{\mathrm{LR}} = \Psi b_1 P$, as well as the optimal price rule, $p = (-x)/(x') + c = (-1)/(\Psi b_1) + c$.

[16] Alberto Salas, the chief of promotion at the Costa Rican Tourism Board, confirmed the validity of this assumption based on marketing studies by the board (Salas, 2002).

[17] In any case, the Monteverde Cloud Forest is Costa Rica's most popular private reserve, and its entrance fee has systematically been above those of national protected areas.

Table 1 presents the results of the estimation of Eq. (17), using the available information, and some fitness statistics.

The econometric analysis contains the required information about the demand of foreigners for day-visits to the Costa Rican system of national parks. The average long-run price-elasticity of foreign visits is $\varepsilon_{LR}=0.68$, which reflects the high substitutability between the protected areas and other natural beauties in the country.

I focus next on the other required information for the estimation of optimal entrance fees. Unfortunately, SINAC has no accurate information about the fixed and variable cost per visitor to the national parks, and there is no clear way to separate expenses related to recreation from those related to the provision of the park's public services. According to Bermúdez (2001), the constant recreational costs are between USD1 and USD3 per visitor. Therefore, Table 2 provides different estimates of the optimal price charged to foreigners given different marginal costs, as well as their 95% confidence intervals estimated using the Delta method.

Optimal prices range from USD10 per day-visit for the case of zero marginal costs, to USD15 for the case of $c=4$. Since May 2002, the entrance fee to the national parks has been USD7, which is below the 95% confidence interval for the optimal prices calculated using the model in this paper, even for the case of zero marginal costs. However, according to the model of Section 2, the optimal prices might be smaller than the ones presented in Table 2 if the positive marginal spillover effect dominates the negative externality,[18] or if the park authority assigns a positive weight, $\alpha>0$, to the consumer surplus of foreign visitors (see Eq. (8)). In addition past events indicate that the lobbying efforts of tour operators are successful in keeping the entrance fees low. The last row of Table 2 therefore provides the implied weights (α) calculated using Eq. (8), under the assumption of zero net externalities and for different marginal costs (Ross, 1984). For a marginal cost of two, the current price implies a value of $\alpha=0.5$, i.e., the revenues relinquished due to the lower price imply the acceptance of a welfare transfer from Costa Rica to the international visitors at a rate of 1 to 2.

Eq. (14) shows that the price to nationals has to be set equal to marginal costs plus any fixed costs not recovered via the profits from foreign customers. If fixed costs are recovered (or in the absence of a budget restriction), then the price to nationals can be set equal to the marginal costs of recreation. Table 2 also contains the expected profit under optimal pricing to foreign customers after covering all variable costs. This can then be compared to budget information from SINAC in order to approximately determine whether the price to nationals should deviate from the marginal costs. Finally, Table 2 also contains the econometric model's predicted profit for the current entrance fee of USD7.

As mentioned before, unfortunately there is no information about the fixed costs of the recreational activities within the Costa Rican System of national parks. Still, there is information for some parks, particularly for the Irazú Volcano National Park, one of the three most visited and most developed parks in the system. The total budget in 1999 for this park was USD130,000, including all recreational and conservation costs during that

Table 1
Results for Eq. (17)

Variable	Coefficients	*P*-values
Price	−0.0479	0.000
Lag-1 of log(X_t)	0.0696	0.050
Lag-12 of log(X_t)	0.5359	0.000
Log(visits to CR)	0.3745	0.000
Season Hi	0.1710	0.000
Season Med	0.1068	0.016
Aug94	0.6907	0.000

Fitness statistics	
Adjusted R^2	0.92
Breusch–Pagan (Ho: homoskedasticity)	$\chi^2_{calc}=4.363$, with 6 *df*
Test for normality (Ho: residuals are normal)	$\chi^2_{calc}=1.74$, with 2 *df*
Godfrey's Test for group autocorrelation (Ho: no autocorrelation)	$\chi^2_{calc}=21.09$ with 18 *df*

[18] There is some evidence that the government is particularly sensitive to the well-being of the people living immediately around the parks.

Table 2
Optimal prices and average monthly profit, in 2002 USD

	$c=0$	$c=1$	$c=2$	$c=3$	$c=4$
Optimal prices to foreign visitors	9.9 (7.9–11.9)	11.1 (9.1–13.1)	12.3 (10.3–14.3)	13.5 (11.5–15.5)	14.7 (12.7–16.7)
Profit	170,326	150,832	133,567	118,279	104,742
Profit under today's prices	161,283	133,476	105,668	77,860	50,053
Implied α-value under today's prices	0.29	0.41	0.53	0.65	0.78

year.[19] Hence, the budget balancing condition will be approximately satisfied with the profits of 1 and a half months using the optimal prices provided above for a marginal cost of two. This is an indication that the price to nationals could follow the first best optimal marginal cost-pricing rule. Currently, the price to national visitors is slightly lower than USD2 per visit; that is, very close to the marginal cost suggested by the experts of SINAC.

There are other previous studies that inquire into the willingness to pay of foreign visitors for entering a national park in Costa Rica. Using contingent behavior analysis, Chase et al. (1998) find that the WTP for the three most popular parks are between USD21 and USD25. In addition, they calculate revenue-maximizing fees that range from USD7 to USD13 for those three parks, all in 1995 dollars. Our estimates lie in that range. Finally, Schultz et al. (1998) conducted a CVM study aimed at establishing optimal differentiated entrance fees to Costa Rican national parks. They found that WTP for entering the most popular parks ranges from USD14 to USD23.

4. Conclusions

This paper suggests a theoretical model for the optimal pricing of a system of protected areas used for recreation, by stressing the possibility of third degree price discrimination based on the visitor's nationality, and by stressing the distributional fairness of assigning different welfare weights to the consumer surplus of different groups of visitors. Price discrimination allows for a more optimal adjustment to the distortions created by a cost recovery requirement, and to possible external effects from changes in visitation.

If the park authority assigns zero welfare weights to the consumer surplus of foreign visitors, the optimal price to foreign visitors follows a monopoly-pricing rule. When revenues from foreign visitors do not fully cover the fixed costs, the price charged to nationals has to recover the remaining fixed costs as well as its own variable costs. If externalities are introduced, then the pricing rules described before have to be adjusted. A negative marginal externality, for example, will require an upward multiplicative adjustment in the pricing rules provided before. In line with the welfare weights assumed, the additional revenues will allow a decrease in the price to nationals in order to balance the budget. Furthermore, in Appendix B, I allow for different marginal external effects from the two types of visitors. In particular, I present what I believe is a realistic scenario, i.e., one in which the marginal external effects from foreign visitation cancel out ($A'_f=0$) due to their positive marginal spillover effects, whereas local visitors generate marginal damage to ecosystems, i.e., social costs and small spillover effects on the surrounding areas. In this case, the optimal pricing rules are reduced to the case of no external effects discussed above.

Since May 2002, the Costa Rican park agency has set the prices for entering a national park at USD7 per foreign visitor and approximately USD2 per national visitor. Our analysis indicates that the practice of price discrimination can successfully raise revenues and achieve a more optimal pricing policy. If the local authorities aimed at max-

[19] This budget excludes the initial costs of establishing the area for conservation. Most of these costs are borne by residents in terms of the social costs of tax revenues dedicated to expropriation and population resettlement, if necessary, but also in terms of the opportunity cost of dedicating the land to agriculture or livestock production when no expropriation is involved.

imizing only local welfare from recreational activities, then the empirical application of our model indicates that prices to foreign visitors could be raised to USD10–15 depending on the approximate estimate of marginal costs. On the other hand, prices to nationals seem to follow the optimal pricing rule already, given that the increase in revenues from foreign visitors under the proposed optimal prices will most likely cover the fixed costs of recreation.

An additional issue is the estimation of the external costs caused by damages to ecosystems and the positive spillover benefits on the surrounding areas from changes in visitation. There is some evidence that the local communities surrounding the protected areas depend more and more on tourism, and one can expect that a strong increase in price might have a negative impact on the surrounding areas. Regarding ecological impacts, there is no clear indication of the likely importance of it, although some parks have very high visitation rates during most of the year and damages to the ecosystem are certainly feared. I acknowledge that the inclusion of external effects might have an impact on the estimated optimal prices.

Finally, the assumption that the park agency treats all parks as a single commodity is certainly a limitation of the theoretical analysis, although it closely reflects the likely price setting behavior of a park agency with no available information on cross price elasticities. Furthermore, this is currently the case in Costa Rica. This assumption might be fairly realistic for a country with several areas that are close substitutes in recreation, or a large country or area with only one park. A further extension of the model could treat the park agency as a multiproduct firm.

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Appendix A. Table summarizing the paper's notation

Table A1
Notation used in the paper

Symbol	Interpretation
n	Subscript used for national tourists
f	Subscript used for foreign tourists
x_i	Demand of group i (i=f,n) for recreation-visitor-days
p_i	Price or entrance fee for group i (i=f, n)
$\alpha \in [0,1]$	Welfare weights on the welfare of foreign tourists
S	Utilitarian social welfare function
$C(x_f, x_n)=cx_f+cx_n$	Variable costs of recreation, with constant marginal costs (c).
I	Fixed costs of recreational activities
R	Minimal revenue constraint
$\hat{I}=I+R$	Total fixed costs to be recovered
$g=g(x_f, x_n)$	Social costs of ecological impact
$T=T(x_f, x_n)$	Social positive spillover effect
$A=-g(x_f+x_n)+T(x_f+x_n)$	Total social external effect
λ	Lagrange multiplier

Appendix B. Optimal prices with differing marginal external effects

Interesting results can be obtained by exploring a more general formulation of the marginal external effect than the one provided in the main text (Eq. (2)). Although both types of visitors most likely generate similar marginal social costs due to ecosystem damages, it is possible that they differ in terms of their impact on the areas surrounding the parks; in particular, the spending of foreign visitors in accommodation and lodging is likely to be larger than that of national visitors, even if they come from distant origins.

Assume the following general formulation for the external effects:

$$A = -g\left(x_f, x_n\right) + T\left(x_f, x_n\right),$$

with

$$A'_f = -\frac{\partial g}{\partial x_f} + \frac{\partial T}{\partial x_f} \neq -\frac{\partial g}{\partial x_n} + \frac{\partial T}{\partial x_n} = A'_n.$$

Then the optimal pricing rules provided in Eqs. (10) and (11), for the case that the park authorities set equal weight to both consumer groups ($\alpha=1$), have to be corrected and are provided below:

$$(p_f-c)=\left[\frac{x_f x_n' - x_f' x_n' A_f'}{x_n^2 x_f' - x_f' x_n'\left(x_n A_n' + x_f A_f'\right) + x_f^2 x_n'}\right]\hat{I} + \left(\frac{x_n\left(x_f x_n' A_n' - x_n' x_f' A_f'\right)}{x_n^2 x_f' - x_f' x_n'\left(x_n A_n' + x_f A_f'\right) + x_f^2 x_n'}\right), \quad (\text{A}-10')$$

$$(p_n-c)=\left[\frac{x_n x_f' - x_f' x_n' A_n'}{x_n^2 x_f' - x_f' x_n'\left(x_n A_n' + x_f A_f'\right) + x_f^2 x_n'}\right]\hat{I} + \left(\frac{x_f\left(x_n x_f' A_f' - x_f' x_n' A_n'\right)}{x_n^2 x_f' - x_f' x_n'\left(x_n A_n' + x_f A_f'\right) + x_f^2 x_n'}\right). \quad (\text{A}-11')$$

If we allow for different marginal external effects, i.e., $A_f' \neq A_n'$, the optimal pricing rules for the case of $\alpha=0$ would be given by:

$$p_n - c = \left\{\frac{(x_n)^2 - A_n' x_n' x_n}{(x_n)^2 - x_n'\left(x_n A_n' + x_f A_f'\right)}\right\} \times \left(\frac{-\left(\frac{x_f^2}{-x_f'} - \hat{I}\right)}{x_n}\right) + \left[\frac{x_n x_f}{(x_n)^2 - x_n'\left(x_n A_n' + x_f A_f'\right)}\right] A_f' \quad (\text{A}-15'')$$

and

$$p_f - c = \left\{\frac{(x_n)^2 - A_n' x_n' x_n}{(x_n)^2 - x_n'\left(x_n A_n' + x_f A_f'\right)}\right\}\left(\frac{x_f}{-x_f'}\right) + \left[\frac{-\left(x_n^2 + x_n'\hat{I}\right)}{(x_n)^2 - x_n'\left(x_n A_n' + x_f A_f'\right)}\right] A_f'. \quad (\text{A}-16'')$$

Eqs. (A-15″) and (A-16″), although more complicated, have a similar interpretation to that of Eqs. (15) and (16) in the main text. Hence, I will only provide an example of the effect of relaxing the assumption of equal marginal external costs. A possible scenario is $A_f'=0$and $A_n'<0$, i.e., one where the marginal cost of ecological impact and the spillover effect of foreign visitation cancel out, and national visitors mostly generate marginal cost of ecological impact. In this case, the optimal pricing rules are given by $p_f-c=(x_f)/(-x_f')$ and $(p_n-c) = -\left[\frac{x_f^2}{-x_f'} - \hat{I}\right]/x_n$, which are equal to Eqs. (13) and (14) for the case of no external effects. This result is a typical second best in the sense that, if foreign visitation generates no marginal external effects, then the park agency's best policy is to maximize revenues from foreign visitation by charging the usual monopoly price. Given the above, the price to nationals can only be used to balance the budget, disregarding the external effects generated by national visitors.

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