PRICE DISCRIMINATION AND DIFFERENTIAL PRICING OF SOUTH AFRICAN NATIONAL PARKS

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Introduction

- To date, the park pricing policy is underutilized:
  - Money-making behavior is not part of the usual administrative culture for public authorities in charge of parks and wildlife
  - Most professional rewards are tied to program development, not entrance receipts
  - The majority of sites for NBT cannot become self-financing, even under the most intelligent of pricing strategies
  - Visitors do not expect public nature reserves to be managed as businesses

Preferences as a starting point

- The economist's answer on WTP is only a starting point for the administrator of the national parks and wildlife agency, who has numerous interests to serve and criteria to weigh
- The setting fees for NBT is complex because of multiple pricing objectives, visitor categories, NBT activities and fee instruments
- The context of charging fees is often surrounded by philosophical and legislative debates
- The agency's perspective on a new or elevated fee begins with reasons to impose it i.e. pricing objectives

Pricing objectives

- The revenue goal is an obvious one for private NBT suppliers, and for public suppliers whose budgets are constrained
- The collection of revenue from NBT indicates that natural areas have financial value, which is important in political discussions of land use
- If revenues from fees can be made to increase, this may enable public agencies to gain increasing independence from outside influences; greater financial autonomy may lead to greater policy autonomy

Pricing objectives cntd

- Fees can be designed to reduce subsidization of groups perceived to receive unfair advantages, and fee policy may deliberately subsidize target groups or activities, especially if natural history is considered a merit good
- This can be a deliberate step to restrain total visitation, and to ration it to a selected socioeconomic element (eg the relatively high-spending tourists)
- Fees can be a management tool to relieve crowding if fees are elevated during peak times and for congested sites

Pricing objectives cntd

- Fee policy for publicly owned NBT sites can be designed to stimulate private business and regional economic development
- A frequent assumption is that NBT visitors are more respectful of their surroundings if they have to pay for them: vandalism, littering and other negative behaviors decrease when visitors pay for use
- Implementation of a new fee is wisely accompanied by monitoring and evaluation to determine actual impacts. The information collected for feasibility and later for evaluation provides profiles on visitor numbers, composition and likes and dislikes

Pricing objectives cntd

- At the time of fee collection, information can be presented verbally or in writing to explain why fees are being collected; even though such information can be presented separately, its combination with fee payments is efficient for the agency, and helps visitors understand what they receive in exchange for their money

The model

- It is assumed that:
  - the parks agency operates in an environment with unique attributes such that it can afford to operate as a price discriminating monopolist, and
  - the suite of national parks within its portfolio may be substituted for each other
- In order to determine the optimal entrance fees we need to know the pricing objectives of the parks agency
- It is assumed that the parks agency sets entrance fees with the aim of maximizing national welfare

The model

- The parks agency differentiates between two types of consumers, namely foreign (*F*) and national (*N*) visitors
- Alpizar (2006) deals with a simple case where the parks agency operates one national park, which will be visited by the two consumer types
- The vectors of demands and associated prices for the two consumers groups are (XF, XN) and (PF, PN) respectively
- The park authority follows a weighted utilitarian social welfare function where the consumer surplus of foreign visitors is given the weight of $\alpha \in [0,1]$

The model

- The optimal entrance fees for both national and foreign visitors are obtained from a solution to the following social welfare maximization problem:

$$\underset{PF,PN}{Max} \quad S = \alpha \int_{PF}^{\infty} XF(PF)dPF + \int_{PN}^{\infty} XN(PN)dPN$$

$$+ PF.XF(PF) + PN.XN(PN) - C(XF, XN) \qquad (1)$$

- Subject to

$$PF.XF(PF) + PN.XN(PN) - C(XF, XN) \geq 0 \qquad (2)$$

- The Lagrangian method is used to solve the restricted social welfare maximization problem

$$L = S + \lambda[PF.XF(PF) + PN.XN(PN) - C(XF, XN)] \qquad (3)$$

The model

- An assumption made is that the national park has a positive ecological carrying capacity of visitation and that this capacity has not been exceeded

$$\frac{dL}{dPF} = (1-\alpha)XF + (PF - \frac{dC}{dXF})\frac{dXF}{dPF} + \lambda\left[XF + (PF - \frac{dC}{dXF})\frac{dXF}{dPF} \right] = 0 \quad (4)$$

$$\frac{dL}{dPN} = (PN - \frac{dC}{dXN})\frac{dXN}{dPN} + \lambda\left[XN + (PN - \frac{dC}{dXN})\frac{dXN}{dPN} \right] = 0 \quad (5)$$

$$\frac{dL}{d\lambda} = [PF.XF + PN.XN - C] = 0 \quad (6)$$

- Assume the parks agency does not consider the consumer surplus of foreigners (i.e. α =0 in (4))

The optimal pricing rule

$$\frac{dL}{dPF} = XF + (PF - \frac{dC}{dXF})\frac{dXF}{dPF} + \lambda\left[XF + (PF - \frac{dC}{dXF})\frac{dXF}{dPF}\right] = 0 \quad (7)$$

$$\frac{dL}{dP} = X + \lambda X + (P - \frac{dC}{dX})\frac{dX}{dP} + \lambda(P - \frac{dC}{dX})\frac{dX}{dP} = 0 \quad (8)$$

$$\frac{dL}{dP} = (1+\lambda)X + (1+\lambda)(P - \frac{dC}{dX})\frac{dX}{dP} = 0 \quad (9)$$

$$(P - \frac{dC}{dX})\frac{dX}{dP} = -X \quad (10)$$

$$P = \frac{dC}{dX} - \frac{X}{X'} \quad (11)$$

$$\varepsilon = -\frac{dX}{dP}\frac{P}{X} = -\frac{X'}{X}P \Rightarrow -\frac{X}{X'} = \frac{P}{\varepsilon}; P - \frac{dC}{dX} = -\frac{P}{\varepsilon} \Rightarrow \frac{P - C'}{P} = \frac{1}{\varepsilon} \quad (12)$$

The data

- The next step would be to use historical data to estimate the foreigners' visitation function
- Those estimates will provide the price elasticity which is a crucial ingredient in the optimal price computations for foreigners
- Alpizar (2006) estimates the following model:

$$\log(x_t) = b_1 P_t + b_2 \log(x_{t-1}) + b_3 \log(x_{t-12}) + b_4 \log(V_t) + d_1 SHI + d_2 S + d_3 Aug94$$

- V_t is international arrivals to country; SHI is dummy for high season; S is dummy for medium season; Aug94 is dummy for entrance fee adjustment date
- The long run price elasticity is $\frac{1}{1-b_2-b_3} b_1 P$

$$\frac{P-C'}{P} = \frac{1}{\varepsilon} \Rightarrow P = C' + \frac{P}{\varepsilon} = C' + \frac{1-b_2-b_3}{b_1} \quad (13)$$

The data

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	

The data

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

Other data needs

- Social positive spillover effect from visitation, T(XF,XN)
- Social costs at the ecosystem level which are caused by visitation to the protected area, G(XF,XN)
- The parks agency's variable costs of providing recreation, C(XF,XN)
- The parks agency's autonomous costs of providing recreation, I i.e. trail clearing, signs, fire prevention, park rangers, etc
- The parks agency's expected cost recovery condition, R

Extension of the model

- We will now deal with a case where the parks agency operates two national parks, each of which will be visited by the two consumer types
- We will state the general *k*-parks result afterwards
- The vectors of demands and associated prices for the two national parks and two consumers groups are (XF1, XF2, XN1, XN2) and (PF1, PF2, PN1, PN2) respectively

Extension of the model

$$\underset{PF1,PF2,PN1,PN2}{Max} \quad S = \alpha \int_{PF1}^{\infty} XF1(PF1,PF2)dPF1 + \alpha \int_{PF2}^{\infty} XF2(PF1,PF2)dPF2$$

$$+ \int_{PN1}^{\infty} XN1(PN1,PN2)dPN1 + \int_{PN2}^{\infty} XN2(PN1,PN2)dPN2$$

$$+ PF1.XF1(PF1,PF2) + PF2.XF2(PF1,PF2) + PN1.XN1(PN1,PN2) + PN2.XN2(PN1,PN2)$$

$$- C_1(XF1,XN1) - C_2(XF2,XN2) \qquad (1)$$

- Subject to

$$PF1.XF1(PF1,PF2) + PF2.XF2(PF1,PF2) + PN1.XN1(PN1,PN2) + PN2.XN2(PN1,PN2) -$$

$$C_1(XF1,XN1) - C_2(XF2,XN2) \geq 0 \qquad (2)$$

Extension of the model

- For the two national parks case, the entrance fees for the foreigners should satisfy:

$$\left[\frac{PFi-(dC_i/dXFi)}{PFi}\right]=\frac{1}{\varepsilon_{ii}}-\left[\frac{PFj-(dC_j/dXFj)}{PFi.XFi}\frac{XFj.\varepsilon_{ij}}{\varepsilon_{ii}}\right] \quad (16)$$

- For the *k* national parks case, the entrance fees for the foreigners should satisfy:

$$\left[\frac{PFi-(dC_i/dXFi)}{PFi}\right]=\frac{1}{\varepsilon_{ii}}-\left[\sum_{j\neq i}^{k}\frac{PFj-(dC_j/dXFj)}{PFi.XFi}\frac{XFj.\varepsilon_{ij}}{\varepsilon_{ii}}\right] \quad (17)$$

- These pricing rules now require information on own price elasticities and cross price elasticities

Extension data requirements

- A typical foreigners' visitation demand function is as follows:

  $$V_{it} = f(V_{it-1}, P_{it}, Q_t, C_{it}, V^{RSA}{}_t, \ldots)$$

- V_{it} is the visits to a particular park in period/month t
- P_{it} is entrance fee to a particular park in period t
- Q_t is a vector of entrance fees to other parks in period t
- C_{it} are park attributes (park size, big5, etc) in period t
- $V^{RSA}{}_t$ is the international arrivals in period t
- Dummies to capture national events in period t
- Dummies to capture seasonality

Extension data requirements

- The data on park characteristics and profitability were not available
- Quarterly data on international tourist arrivals was obtained from the South African Tourism
- Quarterly park visitations data was collected from SANParks for 12 national parks for the period June 2005 to March 2009
- The data gives the visitations by three categories of visitors namely South African residents, SADC nationals and international (excluding SADC) visitors
- The SADC visitors category is quite small

Extension data requirements

- The park entrance fees are also available for all the categories of visitors
- These fees are reviewed on an annual basis even though they might be kept unchanged for some parks
- Generally, there have been some variability in the prices over the period in question
- To infuse more variability into the pricing data, the entrance fees, which are always quoted in South African Rands, were divided by the Euro exchange rates
- All data are interpolated to give monthly data and a sample size of 48 periods

Estimation challenges

- If one has a lot of data points, one could include the prices of the other k-1 parks in the demand function and find out which ones come out as significant substitutes or complements
- For South Africa, which has 22 national park, having only 48 data points presents a challenge for the proper estimation of all the 21 cross-price elasticities for any particular park's demand function
- Thus, to estimate a correct demand function for each park, one needs to know which parks are substitutes or complements from a tourist's perspective; include their prices in the demand function for the park of interest

Additional data requirements

- One can do a survey to find out which parks tourists consider to be substitutes or complements
- One can then use data for just these parks to estimate the respective demand functions
- The survey Johane Dikgang has been conducting during March/April asks tourists at Kruger, Kgalagadi, Augrabies which parks they consider to be subsistutes or complements
- Proper estimation of demand functions for visiting the Kruger, Kgalagadi and Augrabies will be conducted taking cues from the South African survey data

Kgalagadi foreigners

- Consider the function for foreigners in Kgalagadi just to demonstrate the nature of results required

Linear regression

Number of obs =	36
F(8, 27) =	166.27
Prob > F =	0.0000
R-squared =	0.9369
Root MSE =	.1166

lxfkga	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
lxfkga						
L3.	-.8237985	.1393123	-5.91	0.000	-1.109644	-.5379532
L6.	-.7385727	.1533771	-4.82	0.000	-1.053277	-.4238688
L9.	-.6681189	.1574973	-4.24	0.000	-.9912767	-.344961
L12.	.2549959	.1721089	1.48	0.150	-.0981423	.6081341
lepfkga	-4.556718	1.214974	-3.75	0.001	-7.049639	-2.063798
lepfkru	(dropped)					
lsaarriv	.3470781	.8399155	0.41	0.683	-1.376286	2.070442
summer	-.0744193	.0704941	-1.06	0.300	-.2190612	.0702226
lepfaug	3.411701	1.051503	3.24	0.003	1.254195	5.569207
_cons	18.79109	11.4669	1.64	0.113	-4.737051	42.31922