

Uncertainty, Crowding Aversion and Tourism Aversion in Tourism Destinations

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Forthcoming in Tourism Economics

Abstract

We analyze the implications of crowding aversion and tourism aversion on the economic performance of tourism destinations in the case of uncertain tourist inflows. We analytically characterize all possible scenarios, showing how different preferences of tourists (towards crowding) and residents (towards tourism) interact and affect the economic outcome. We show that when tourists are crowding averse (lover), uncertainty deteriorates (improves) economic performance, while uncertainty does not affect performance at all when tourists are crowding indifferent. However, assessing how this will be reflected in welfare changes is more complex, since it depends also on the degree of tourism aversion of local residents.

Keywords: Uncertainty, Tourism Specialization, Crowding Aversion, Tourism Aversion

JEL Classification: O40, O41

1 Introduction

Tourism has recently been gaining more and more importance in modern economies, both in developed and developing countries. Its (beneficial and costly) effects on economic development are well-known and extensively documented (see Brida and Pulina, 2010, for a recent survey). A large share of the literature analyzes the implications of tourism specialization on economic development, both in the short and long run, by applying econometric techniques to conduct empirical investigations. Much smaller is the portion of studies tackling the issue from a theoretical point of view (among others, see Schubert, 2010, and Schubert et al., 2011). In particular two main approaches have been proposed to explain the relationship between tourism and growth: the most popular uses dynamic models of trade to show that a terms of trade effect determines whether growth and tourism move in the same direction (Hazari and Sgro, 1995; Lanza et al., 2003); a different and most recent approach relies on hedonic prices to understand how resident' choices may affect tourist' inflows, determining income and thus wellbeing (Cerina, 2007; Lozano et al., 2008). To the best of our knowledge, no study extends the analysis to consider how the uncertainty about the evolution of tourism demand and tourist inflows may affect the growth process of tourism destinations. This is absolutely relevant if we consider that tourism evolution is to a large extent unpredictable, and thus determining how to react to such randomness is essential to contrast (exploit) eventual harmful (beneficial) events. In order to shed some light on this issue, we follow the latter approach to consider how a stochastic tourism dynamics will affect economic performance and wellbeing in tourism-based economies.

Thus, the model we adopt relies upon the framework proposed firstly by Cerina (2007), and later analyzed also by Lozano et al. (2008) and Marsiglio (2014). Specifically, we consider a small economy producing

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only tourism services, supplied in an international tourism market populated by a large number of tourism economies; the notion of tourism services should be interpreted as a bundle of goods and services able to satisfy a wide range of tourism consumers (Candela and Figini, 2010). The tourist flows come from the international market and thus there is no distinction between resident and non-resident tourists. International demand for tourism is infinite at the price level corresponding to tourists' willingness to pay and nil for any other price level; thus, the equilibrium quantity of tourism is totally determined by the supply side¹. Residents are characterized as traditional macroeconomic household-firm agents, who wish to maximize their lifetime utility given the dynamic evolution of tourism capital and tourist inflows. This formalization of the tourism market is very convenient, since it permits to describe the tourism-economic problem as a standard macroeconomic (Ramsey-type) problem.

We depart from Cerina's (2007) approach in three different ways: we do not consider environment for the sake of simplicity; we allow for the utility of residents to depend also on the number of visitors entering the local economy; we assume that tourist inflows follow a stochastic process. Not considering environmental issues allows to maintain the model as simple as possible and to fully characterize the implications of uncertainty on economic performance and wellbeing. Moreover, this implies that tourists' willingness to pay depends only on tourism services and the number of other visitors present in the host country²; this allows to assess how a different degree of crowding aversion may affect the economic outcome. Introducing the number of tourists in the utility function of the residents permits to capture three alternative situations: residents enjoy, are indifferent to or are bothered by the presence of international tourists in the local economy (see Meleddu, 2014, for a survey on residents' welfare in tourism economies). Which of these situations is most relevant may change from country to country according to whether the (income) benefits from tourism specialization are larger than, equal to or smaller than the associated perceived (economic, social and environmental) costs³. Describing the evolution of tourist inflows as a random process allows to directly compare the stochastic and deterministic outcomes, understanding what is the role played by uncertainty on the development of tourism destinations.

Given our framework, as it will become clearer in a while, the nature of the relationship between tourism specialization and economic development (and wellbeing) is all but trivial. Indeed, two main factors, the aversion to crowding of international tourists and the aversion to tourism of local residents, determine the net impacts of tourism development on the hosting community. To the best of our knowledge an explicit investigation of the mutual relationship between tourists and residents' preferences is not present in the literature, thus our paper represents a first attempt at filling this gap. The presence of stochastic shocks on the evolution of international tourist inflows complicates even further the picture. This brief paper proceeds as follows. The stochastic optimization problem is introduced and analytically solved in section 2, where we derive most of our results and we also analyze the deterministic version of the model in order to compare its outcome with the stochastic framework. Section 3, as usual, contains concluding remarks and directions for future research. Most of the technicalities are presented in the appendix A.

¹We are perfectly aware of the limitations of this assumption. However, introducing also a demand side in such a dynamic context would complicate dramatically the model (which results to be already not trivial because of the presence of uncertainty), and it would no longer be possible to obtain analytical solutions.

²McConnell and Sutinen (1984) firstly point out how tourism growth (in the sense of increasing number of visitors) may reduce tourist' inflows when tourists are averse to crowding and facilities are congested (i.e., the tourism product is a snob good). Several papers try to measure visitors' perception about crowding; empirical results are mixed (see Price and Chambers, 2000, and references therein), thus it is important to understand whether and how the results differ when tourists are crowding averse or lover.

³Tourism development may generate costs, such as increased pressure on fragile environments, erosion of sites, unwelcome sociocultural effects, road congestion and the crowding out of attractions (Dwyer and Forsyth, 1997). However, tourism activity may also bring benefits, such as greater awareness of the local environment and culture, conservation of man-made monuments and wildlife preservation (Norton and Roper-Lindsay, 1992). How these benefits and costs are perceived by residents is not obvious, and may change over time. Several papers point out how some local communities have rejected tourism (Aziz, 1995; Sindiga, 1996) while others have embraced it (Oakes, 1999; Wilson, 1994).

2 The Model

The model is a standard Ramsey (1928) model of optimal growth where the social planner seeks to maximize the (expected) welfare of the society (i.e., the residents) taking into account the economic and tourism dynamics. The welfare is the infinite discounted (ρ is the pure rate of time preference) sum of instantaneous utilities; the utility function is assumed to be isoelastic in its two arguments, consumption, $C(t)$, and tourists number, $N(t)$: $u(C(t), N(t)) = \frac{C(t)^{1-\theta} N(t)^{\epsilon(1-\theta)} - 1}{1-\theta}$, where $\theta > 0$ is the inverse of the intertemporal elasticity of substitution and $\epsilon \in [-1, 1]$ represents the weight of tourism in residents' preferences; a negative (positive) value of ϵ represents the case in which residents suffer (enjoy) the presence of international visitors. Thus, ϵ measures the degree of tourism aversion of local residents: if $\epsilon > 0$ residents are tourism lover, if $\epsilon = 0$ tourism indifferent while if $\epsilon < 0$ tourism averse. The tourist inflow is stochastic and is driven by a geometric Brownian motion: $dN(t) = \mu N(t)dt + \sigma N(t)dW(t)$, where $\mu > 0$ is the drift and $\sigma \geq 0$ the variance parameter, while $dW(t)$ is the increment of a Wiener process. The economic constraint is given by the law of motion of tourism capital, which is given by the difference between residents' income, $Y(t)$, and consumption: $\dot{K}(t) = Y(t) - C(t)$. As in Cerina (2007), income totally depends upon tourism revenues, which are given by the product between tourists' willingness to pay for and the quantity of tourism services exchanged on the market. The willingness to pay depends on the stock of tourism services, $K(t)$, and the number of tourists in the tourism destination, and it is assumed to take a Cobb-Douglas form, $P(t) = AK(t)^\alpha N(t)^{-\beta}$, where $\alpha \in (0, 1)$ and $\beta \in (-1, 1)$ measure tourists' sympathy toward tourism facilities and other visitors in the tourism destination, respectively⁴. In particular, if $\beta > 0$ tourists are crowding averse, if $\beta = 0$ crowding indifferent while if $\beta < 0$ crowding lover. For the sake of simplicity, it is assumed that each tourist buys one unit of tourism services, such that $Y(t) = AK(t)^\alpha N(t)^{1-\beta}$.

Taking initial conditions, $K(0)$ and $N(0)$, as given, the planning problem in the tourism-based economy consists of choosing the consumption level, considering the dynamic evolution of tourism capital and tourists number⁵:

$$\max_{C(t)} \quad W = \mathbb{E} \left[\int_0^\infty \frac{C(t)^{1-\theta} N(t)^{\epsilon(1-\theta)} - 1}{1-\theta} e^{-\rho t} dt \right] \quad (1)$$

$$s.t. \quad \dot{K}(t) = AK(t)^\alpha N(t)^{1-\beta} - C(t) \quad (2)$$

$$dN(t) = \mu N(t)dt + \sigma N(t)dW(t). \quad (3)$$

Note that in our model, tourists number is an auxiliary variable, thus it is totally irrelevant for sufficiency issues related to the dynamic optimization problem. If this was not the case, we would need to impose some parameter restriction in order for the maximization problem to be concave, as in Marsiglio (2014). From the previous problem it is clear that the uncertainty about tourist numbers affects the wellbeing of the residents both directly and indirectly. Indeed, tourist numbers influence their instantaneous utility function (what we may label '*utility effect*'), and determines the size of the tourism revenue (what we may refer to as '*income effect*'). These two effects move in the same or opposite direction according to the type of preferences of both the residents (towards tourism, ϵ) and international tourists (towards crowding, β).

Define $J(K, N)$ as the maximum expected value associated with the above stochastic optimization prob-

⁴Alternatively, the parameters α and β can be interpreted in terms of price elasticity of demand for tourism services.

⁵Given Cerina's (2007) specification of tourism activities, the model resembles to a large extent a canonical economic growth Ramsey-type problem, in which $K(t)$ would be traditionally interpreted as physical capital and $N(t)$ as population size.

lem⁶. The Hamilton-Jacobi-Bellman (HJB) equation reads as:

$$\rho J = \max_C \left\{ \frac{C^{1-\theta} N^{\epsilon(1-\theta)} - 1}{1-\theta} + J_K \left[AK^\alpha N^{1-\beta} - C \right] + J_N \mu N + \frac{1}{2} \sigma^2 J_{NN} N^2 \right\}, \quad (4)$$

where subscripts denote partial derivatives of J with respect to the variables of interest. Differentiating (4) with respect to consumption gives the following first order condition:

$$C = J_K^{-\frac{1}{\theta}} N^{-\frac{\epsilon(1-\theta)}{\theta}}, \quad (5)$$

which substituted back into (4) yields:

$$0 = \left(\frac{\theta}{1-\theta} \right) J_K^{-\frac{1-\theta}{\theta}} N^{\frac{\epsilon(1-\theta)}{\theta}} - \rho J + AJ_K K^\alpha N^{1-\beta} + \mu J_N N + \frac{1}{2} \sigma^2 J_{NN} N^2 - \left(\frac{1}{1-\theta} \right) N^{1-\epsilon}. \quad (6)$$

By applying the guess and verify method to the previous equation, it is possible to show that a closed form solution to the problem exists under a particular combination of parameter values (the proofs of the following propositions are presented in the appendix A).

Proposition 1. *Assume that $\theta = \alpha$; then (6) has a solution given by:*

$$J(K, N) = \xi_1 K(t)^{1-\alpha} N(t)^{\epsilon(1-\alpha)} + \xi_2 N(t)^{\epsilon(1-\alpha)+1-\beta} + \xi_3, \quad (7)$$

where:

$$\begin{aligned} \xi_1 &= \frac{\alpha^\alpha}{(1-\alpha) \left\{ \rho - \mu\epsilon(1-\alpha) - \frac{1}{2} \sigma^2 \epsilon(1-\alpha) [\epsilon(1-\alpha) - 1] \right\}^\alpha} \\ \xi_2 &= \frac{(1-\alpha) A \xi_1}{\rho - \mu[\epsilon(1-\alpha) + 1 - \beta] + \frac{1}{2} \sigma^2 [\epsilon(1-\alpha) + 1 - \beta] [\epsilon(1-\alpha) - \beta]} \\ \xi_3 &= -\frac{1}{(1-\alpha)\rho}. \end{aligned}$$

Moreover, the optimal consumption path is:

$$C(t) = \Omega K(t), \quad (8)$$

while the optimal path of tourism capital is:

$$K(t) = e^{-\Omega t} \left[K(0)^{1-\alpha} + (1-\alpha) A \int_0^t e^{(1-\alpha)\Omega s} N(s)^{1-\beta} ds \right]^{\frac{1}{1-\alpha}}, \quad (9)$$

where $\Omega = \frac{\rho - \mu\epsilon(1-\alpha) - \frac{1}{2} \sigma^2 \epsilon(1-\alpha) [\epsilon(1-\alpha) - 1]}{\alpha}$.

Equation (8) states that at equilibrium there exists a linear relationship between the optimal level of consumption and tourism capital. This result and the underlying assumption (the tourists' sympathy toward tourism facilities equals the inverse of the intertemporal elasticity of substitution) are standard in this stochastic optimization setup⁷ (see Smith, 2007). Equation (9) describes the relationship between the

⁶See Chang (2004) for a detailed description of the procedures and methods we may use to solve stochastic maximization problems. Explaining how to derive and obtain an analytical solution to the Hamilton-Jacobi-Bellman equation is beyond the scope of this paper. What we want to stress here, by providing a straightforward application, is that stochastic optimization can be used also to provide interesting insights on tourism-related problems.

⁷Note that in the economic growth literature, $Y(t)$ is mainly interpreted as output while α and β as factor shares. Thus, the condition $\theta = \alpha$ states an equality between the capital share and the inverse of the intertemporal elasticity of substitution. Such a restriction is needed when a production input evolves randomly, and this may be the case of technology (Smith, 2007) or labor (Marsiglio and La Torre, 2012a, 2012b).

stock of tourism capital and the number of tourists, which is crucially affected by the degree of crowding aversion of international tourists and the presence of randomness in the evolution of tourist inflows.

In order to assess the impact of uncertainty on the economic performance of the tourism destination, we need to understand how the tourism capital stock relates to the degree of crowding aversion and the stochastic process driving the evolution of tourist numbers over time. In particular, by relating to Jensen's inequality, we can compare the deterministic and the stochastic outcomes of the model. Indeed the sign of β directly determines whether the random process $N(t)$ is subject to a concave, convex or linear transformation in equation (9), which allows us to directly contrast $\mathbb{E}[N(t)^{1-\beta}]$ and $(\mathbb{E}[N(t)])^{1-\beta}$. It is then straightforward to compare economic performance (as measured by the tourism capital stock, $K(t)^{1-\alpha}$) in the stochastic and deterministic framework. It is therefore possible to prove that:

Proposition 2. *Uncertainty tends to improve the economic performance of a tourism destination whenever tourists are crowding-lover ($\beta < 0$), while it tends to reduce its economic performance whenever tourists are crowding-averse ($\beta > 0$). Instead, if tourists are crowding-indifferent ($\beta = 0$) then uncertainty does not affect economic performance.*

Proposition 2 shows how uncertainty, the type of preferences of international tourists and economic performance (of a tourism destination) are related. If the crowding aversion parameter is positive then uncertainty will be harmful for the economy, if it is negative then uncertainty will benefit the economy, while if it is null uncertainty will not have any influence at all on the economic outcome. Note that using consumption or income as an indicator of economic performance rather than tourism capital will not change the results since from equation (8) there is a one-to-one relationship between consumption and capital, and income monotonically rises with capital. In terms of policy implications, this result suggests that uncertainty about the evolution of tourism does not necessarily hurt the economic system of tourism destinations, and assessing the direction of these effects requires a careful consideration of the characteristics of international tourist' preferences, which determine how income and uncertainty are related (through the income effect).

Note that economic performance and wellbeing are different and not necessarily positively related, since social welfare depends both on consumption and tourists number. Thus, in order to understand how uncertainty will impact the wellbeing of residents we need to understand how equation (1) is affected by tourism shocks. In particular, the sign of β and ϵ determine whether the income and utility effects move in the same or opposite direction, and the magnitude of these parameters determines which of the two effects dominates. When they move in the same direction it is straightforward to assess their impact on wellbeing; when they do not the net effect depends on which effect dominates (further details can be found in the appendix A). This result can be summarized as follows:

Proposition 3. *The effect of uncertainty on the wellbeing of the local residents of a tourism-based economy depends on two factors: the sign and magnitude of the crowding aversion (β) and the tourism aversion (ϵ) parameters.*

Proposition 3 shows that assessing the welfare effects of tourism shocks is particularly complex. The relationship between wellbeing and uncertainty depends on the preferences of two different types of agents: residents and international tourists. In the case in which residents are tourism-averse or indifferent, it is relatively easy to evaluate the direction of welfare effects (apart from the crowding averse case). In the case in which residents are tourism-lover, disentangling the impact of randomness on wellbeing is much more complex, and it requires precise knowledge of the size of the crowding aversion and tourism aversion parameters (see appendix A). Note that these results are derived in a framework where ϵ is simply a parameter, thus constant over time. However as explained by Doxey's Irridex model (1975) and Butler's tourist area life cycle (1980) model, residents' perception of benefits and costs is likely to change over time

according to the stage of tourism development⁸. Thus, in reality when ϵ endogenously evolves over time, assessing net welfare effects will be even more difficult.

2.1 The Deterministic Case: $\sigma = 0$

We now briefly look at what we can add to our previous conclusions by analyzing a special case of the model, that is the deterministic case, namely $\sigma = 0$. If uncertainty does not play any role tourist inflows grow over time at an exogenous (and strictly positive) rate, μ : $\dot{N}(n) = \mu N(t)$. In such a framework, it is possible to analytically derive the solution of equation (9):

$$K(t) = \left\{ \left[K(0)^{1-\alpha} - \frac{(1-\alpha)AN(0)^{1-\beta}}{(1-\alpha)\Omega + (1-\beta)\mu} \right] e^{-(1-\alpha)\Omega t} + \frac{(1-\alpha)AN(0)^{1-\beta}}{(1-\alpha)\Omega + (1-\beta)\mu} e^{(1-\beta)\mu t} \right\}^{\frac{1}{1-\alpha}}.$$

From the previous equation it is clear that in the long run tourism capital, and thus economic performance, will continue to rise for any $\beta \in (-1, 1)$, as long as the trend of tourist inflows, μ , is positive. Indeed, there is a one-to-one relationship between the growth in tourist inflows and the economic growth rate, since along the balanced growth path (BGP) equilibrium⁹ we have:

$$\gamma_N = \mu > 0 \quad (10)$$

$$\gamma = \gamma_K = \gamma_C = \gamma_Y = \frac{1-\beta}{1-\alpha} \gamma_N = \frac{(1-\beta)\mu}{1-\alpha} > 0, \quad (11)$$

where γ_N , γ_K , γ_C and γ_Y represent the growth rate of tourist inflows, tourism capital, consumption and income, respectively. It is definitely more interesting to understand the nature of the relationship between increases in tourist inflows and residents' wellbeing in a deterministic framework. Since in such a case it is possible to explicitly compute also social welfare,

$$W = \frac{(1-\alpha)^{-\alpha} [\rho - \epsilon(1-\alpha)\mu]^{-\alpha} N(0)^{\epsilon(1-\alpha)}}{\alpha^{1-\alpha}} \left[\alpha K(0)^{1-\alpha} + \frac{\alpha(1-\alpha)AN(0)^{1-\beta}}{\rho - [\epsilon(1-\alpha) + 1 - \beta]\mu} \right] - \frac{1}{\rho(1-\alpha)},$$

this requires only to determine the sign of the following derivative:

$$\begin{aligned} \frac{\partial W}{\partial \mu} = & \frac{\epsilon(1-\alpha)^{1-\alpha} [\rho - \epsilon(1-\alpha)\mu]^{-\alpha-1} N(0)^{\epsilon(1-\alpha)}}{\alpha^{-\alpha}} \left[\alpha K(0)^{1-\alpha} + \frac{\alpha(1-\alpha)AN(0)^{1-\beta}}{\rho - [\epsilon(1-\alpha) + 1 - \beta]\mu} \right] + \\ & + \frac{(1-\alpha)^{1-\alpha} [\rho - \epsilon(1-\alpha)\mu]^{-\alpha} AN(0)^{\epsilon(1-\alpha)+1-\beta} [\epsilon(1-\alpha) + 1 - \beta]}{\alpha^{-\alpha} \{\rho - [\epsilon(1-\alpha) + 1 - \beta]\mu\}^2}. \end{aligned}$$

By analyzing the previous expression it is clear that $\frac{\partial W}{\partial \mu} > 0$, $\forall \beta \in (-1, 1)$ as long as $\epsilon \geq 0$. When $\epsilon < 0$, instead, $\frac{\partial W}{\partial \mu} < 0$ if $\epsilon \leq -\frac{1-\beta}{1-\alpha}$, while the sign of $\frac{\partial W}{\partial \mu}$ is ambiguous whenever $\epsilon > -\frac{1-\beta}{1-\alpha}$. In this latter case, the impact of μ on wellbeing depends on the magnitude of several parameters; in particular, not only the type of preferences of tourists (α and β) or the kind of preferences of residents (ϵ), but also the stage of tourism development, in terms of stock of tourism facilities and visitors number ($K(0)$ and $N(0)$), determine the net welfare effect. We have just proved the following result:

Proposition 4. *In the deterministic case, increases in tourist inflows (i.e., rises in μ) lead to improvements in the wellbeing of the tourism destination whenever residents are tourism lover or indifferent ($\epsilon \geq 0$). If residents are tourism adverse ($\epsilon < 0$), this may or may not be the case according to the stage of tourism development ($K(0)$ and $N(0)$), the size of the crowding aversion (β) and the tourism aversion (ϵ) parameters.*

⁸The Irridex (irritation index) model describes how the irritation of residents increases as the number of tourists increases; four stages (euphoria, apathy, irritation and antagonism) are identified, and each stage corresponds to a different number of visitors and a different level of integration between residents and tourists. Similarly, the tourist area life cycle model states that there is a correlation between resident' attitudes and the different phases of development experienced by tourism destinations.

⁹A BGP equilibrium is defined as a situation in which all variables grow at constant (and possibly positive) rates.

The results highlighted by Proposition 4 are intuitive: when residents are not bothered by the presence of visitors an increase in their number will generate higher profits improving residents' wellbeing; when they are tourism averse instead this is not so obvious and other factors need to be taken into account. Moreover, Proposition 4 provides some theoretical foundation to the literature emphasizing how residents' acceptance of tourism development is crucial for the long-term success of tourism in a specific destination (Andriotis and Vaughan, 2003). However, this is only one possibility for tourism growth to be reflected in improvements in residents' wellbeing, since this would represent the case in which income and utility effects move in the same direction increasing welfare. Note that a similar result may occur even if residents are adverse to tourism and ϵ is not too small (see appendix A); this case refers to the situation in which the income effect more than offsets the (negative) utility effect, thus overall rising wellbeing. This suggests that if the aim of policymakers in tourism destinations is not only improve economic performance but also to steadily increase residents' welfare, several elements need to be considered in order to identify the appropriate policy tools to achieve such a goal. Most of the studies in tourism economics do not consider the possible interactions between residents and tourists' preferences, thus the derived policy recommendations often lack a global view of the complex relationship between tourism activities and the hosting economy.

3 Conclusion

This paper tries to shed some light on the relationship between uncertainty and preferences of both local residents and international tourists in tourism destinations. We develop a stylized model that allows to assess how economic development due to tourism specialization will be affected by the randomness in tourist inflows and thus in tourists number. We show that the degree of crowding aversion (in tourist' preferences) determines whether economic performance will result enhanced, unaffected or lowered by such an uncertainty, and this is related to the sign of the income effect. However, how such changes in economic outcomes will be reflected in welfare variations is more complex and it depends also on the degree of tourism aversion (in residents' preferences), which determines the sign of the utility effect. This means that understanding how a tourism-based economy should respond to the increasing uncertainty about future tourism developments in order to improve the wellbeing of its inhabitants is not simple and it requires a wide amount of information (i.e., whether the income or utility effect is larger). We also consider the deterministic case in order to assess how tourism development will affect residents' welfare in absence of uncertainty. We show that if residents are tourism lover or indifferent then their wellbeing will rise as tourism increases, while if they are tourism adverse this may or may not happen according to the magnitude of several parameters, related to preferences (of both tourists and residents) and the stage of tourism development. Thus, even when uncertainty is not an issue, disentangling how the income and utility effects impact residents' wellbeing is all but trivial.

Note that our analysis so far has been intentionally simple in order to stress how any kind of economic evaluation becomes relatively more complex when also uncertainty is taken into account. However, the need for such a simplistic approach precludes us to analyze both environmental and sustainability matters related to tourism specialization, and heterogeneity issues in the characteristics of tourist and resident agents. Thus, it is natural to wonder whether and how our results will change in such more complicated contexts. Moreover, our analysis has been purely theoretical and thus it would be interesting to empirically test our model. In particular, the investigation of how tourists' willingness to pay for (avoiding) crowding affects residents' wellbeing (through the utility effect) is essential in order to prescribe policy recommendations aiming not only to increase economic performance but also social welfare. These further extensions are left for future research.

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A Technical Appendix

In order to derive an explicit solution for the HJB equation, as in (6), we need first to express our guess. Our educated guess (see Smith, 2007) in this framework may take the following form:

$$J(K, N) = \xi_1 K^{\lambda_1} N^{\lambda_2} + \xi_2 N^{\lambda_3} + \xi_3. \quad (12)$$

Substituting its derivatives with respect to K and N into (6), yields:

$$\begin{aligned} 0 = & \left(\frac{\theta}{1-\theta} \right) (\lambda_1 \xi_1)^{-\frac{1-\theta}{\theta}} K^{-\frac{(1-\theta)(\lambda_1-1)}{\theta}} N^{\frac{(1-\theta)(\epsilon-\lambda_2)}{\theta}} + \xi_1 K^{\lambda_1} N^{\lambda_2} \left[-\rho + \mu\lambda_2 + \frac{1}{2}\sigma^2\lambda_2(\lambda_2-1) \right] \\ & + A\lambda_1 \xi_1 K^{\lambda_1-1+\alpha} N^{\lambda_2+1-\beta} + \xi_2 N^{\lambda_3} \left[-\rho + \mu\lambda_3 + \frac{1}{2}\sigma^2\lambda_3(\lambda_3-1) \right] - \left(\frac{1}{1-\theta} \right) - \rho\xi_3 \end{aligned}$$

Now suppose that: $\lambda_1 = 1 - \theta = 1 - \alpha$, $\theta = \alpha$, $\lambda_2 = \epsilon(1 - \theta) = \epsilon(1 - \alpha)$ and $\lambda_3 = \epsilon(1 - \alpha) + 1 - \beta$; then we will have:

$$\begin{aligned} 0 = & \left[\left(\frac{\alpha}{1-\alpha} \right) (1-\alpha)^{-\frac{1-\alpha}{\alpha}} \xi_1^{-\frac{1}{\alpha}} - \rho + \mu\epsilon(1-\alpha) + \frac{1}{2}\sigma^2\epsilon(1-\alpha)[\epsilon(1-\alpha)-1] \right] \xi_1 K^{1-\alpha} N^{\epsilon(1-\alpha)} + \\ & + \left[\xi_2 \left(-\rho + \mu[\epsilon(1-\alpha) + 1 - \beta] - \frac{1}{2}\sigma^2[\epsilon(1-\alpha) + 1 - \beta][\epsilon(1-\alpha) - \beta] \right) + A(1-\alpha)\xi_1 \right] N^{\epsilon(1-\alpha)+1-\beta} + \\ & - \left[\rho\xi_3 + \frac{1}{1-\alpha} \right] \end{aligned}$$

Therefore, for this equation to be verified at each time, $t = 0, \dots, \infty$, the square brackets need to vanish and this may happen when the parameters ξ_1, ξ_2, ξ_3 take the values determined in Proposition 1. The optimal rule for consumption, as in (8), is obtained by replacing J_K and J_N into equation (5) with their expressions from (12). Then by substituting (8) into the state equation, we get:

$$\dot{K}(t) = AK(t)^\alpha N(t)^{1-\beta} - \Omega K(t),$$

which is a (stochastic) Bernoulli-type differential equation. Its solution is given in Proposition 1. Finally, the transversality condition requires that $\lim_{t \rightarrow \infty} E[e^{-\rho t} J(K, N)] = 0$, which because of our guess reads as:

$$\lim_{t \rightarrow \infty} e^{-\rho t} \left(\xi_1 \mathbb{E} \left[K^{1-\alpha} N^{\epsilon(1-\alpha)} \right] + \xi_2 \mathbb{E} \left[N^{\epsilon(1-\alpha)+1-\beta} \right] + \xi_3 \right) = 0.$$

In order for this expression to hold, we need to analyze how the value of β affects the previous equation, and the involved expected values. A sufficient condition for the three terms in the previous equation to converge

to zero independently of the value of β is $\phi \equiv [\epsilon(1 - \alpha) + 2]\mu + \frac{1}{2}\sigma^2[\epsilon(1 - \alpha) + 2][\epsilon(1 - \alpha) + 1] - \rho < 0$. Note that the unique role of the technical condition $\phi < 0$ is to ensure that the transversality condition is met, ruling out explosive paths.

In order to contrast the stochastic and deterministic version of the model, we need to understand how $N^{1-\beta}$ behaves when subject to shocks and when not. By Jensen's inequality, we know that for $\chi = 1 - \beta \in (0, 1)$, that is when $\beta > 0$, the random process N under a strictly concave transformation will show $\mathbb{E}[N(t)^\chi] < (\mathbb{E}[N(t)])^\chi$; this implies that for $K(t)$ we obtain:

$$\begin{aligned} \mathbb{E}[K(t)^{1-\alpha}] &= e^{-\Omega t} \left[K(0)^{1-\alpha} + (1 - \alpha)A \int_0^t e^{(1-\alpha)\Omega s} \mathbb{E}[N(s)^\chi] ds \right]^{\frac{1}{1-\alpha}} \leq \\ &\leq e^{-\Omega t} \left[K(0)^{1-\alpha} + (1 - \alpha)A \int_0^t e^{(1-\alpha)\Omega s} (\mathbb{E}[N(s)])^\chi ds \right]^{\frac{1}{1-\alpha}} = (\mathbb{E}[K(t)])^{1-\alpha}. \end{aligned}$$

For $\chi = 1 - \beta \in (1, 2)$, namely when $\beta < 0$, the results are completely reversed; the random process N under a strictly convex transformation will show $\mathbb{E}[N(t)^\chi] > (\mathbb{E}[N(t)])^\chi$; this implies that $\mathbb{E}[K(t)^{1-\alpha}] \geq (\mathbb{E}[K(t)])^{1-\alpha}$. Finally, for $\chi = 1 - \beta = 1$, that is as long as $\beta = 0$, we have a linear transformation which yields $\mathbb{E}[N(t)^\chi] = (\mathbb{E}[N(t)])^\chi$ and thus $\mathbb{E}[K(t)^{1-\alpha}] = (\mathbb{E}[K(t)])^{1-\alpha}$.

Provided that the parametric restriction in Proposition 1 is met, then the expressions in equations (8) and (9) hold for any $t = 0, \dots, \infty$. Thus, taking into account that the value function reads as in (7), by plugging (8) into (1), and substituting (9) into the derived expression, the expected welfare reads as:

$$W = \mathbb{E} \left[\int_0^\infty \frac{\Omega^{1-\alpha} K(t)^{1-\alpha} N(t)^{\epsilon(1-\alpha)} - 1}{1 - \alpha} e^{-\rho t} dt \right].$$

After some algebra, it is possible to show that the relationship between uncertainty and welfare depends on the sign of the following term: $\psi \equiv \mu[1 - \beta + \epsilon(1 - \alpha)] + \frac{1}{2}\sigma^2\{\epsilon(1 - \alpha)[\epsilon(1 - \alpha) - 1] - \beta(1 - \beta)\}$. Specifically, uncertainty will increase or decrease welfare according to whether $\frac{\partial \psi}{\partial \sigma}$ is positive or negative. Thus, it is convenient to analyze welfare implications of uncertainty under three alternative scenarios.

(i) Consider first that tourists are crowding lover ($\beta < 0$). If residents are tourism-averse or tourism-indifferent ($\epsilon \leq 0$), uncertainty will increase welfare; if residents are tourism-lover ($\epsilon > 0$), uncertainty will increase welfare if ϵ is large enough ($\epsilon \geq \frac{1}{1-\alpha}$), otherwise how uncertainty and welfare are related will depend on whether the income or the utility effect prevails.

(ii) Consider the case in which tourists are crowding indifferent ($\beta = 0$). If residents are tourism-averse ($\epsilon < 0$), uncertainty will increase welfare; if residents are tourism-indifferent ($\epsilon = 0$), uncertainty will not affect welfare; if residents are tourism-lover ($\epsilon > 0$), uncertainty will increase welfare if ϵ is large enough ($\epsilon > \frac{1}{1-\alpha}$), decrease welfare if it is small enough ($\epsilon < \frac{1}{1-\alpha}$), not affect welfare if $\epsilon = \frac{1}{1-\alpha}$.

(iii) Finally, consider the crowding averse tourists case ($\beta > 0$). If residents are tourism-averse ($\epsilon > 0$), how uncertainty and welfare are related will depend on whether the income or the utility effect is larger; if residents are tourism-indifferent ($\epsilon = 0$), uncertainty will decrease welfare; if residents are tourism-lover ($\epsilon > 0$), uncertainty will decrease welfare if ϵ is small enough ($\epsilon \leq \frac{1}{1-\alpha}$), otherwise how uncertainty and welfare are related will depend on whether the income or the utility effect prevails.

Intuitively, these results are related to the direction and intensity of the income and utility effects.