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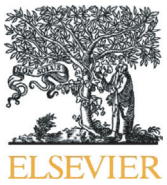

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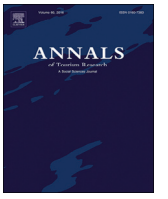

Full Length Article

Modeling uncertainty in tourism markets

Juan Antonio Duro, António Osório *, Alejandro Perez-Laborda

Universitat Rovira i Virgili and ECO-SOS, Dept. Economics, Av. Universitat 1, 43204 – Reus, Spain

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ABSTRACT

In the recent years the tourism sector has been hit by a number of uncertainty events. This paper studies how uncertainty impacts on the tourism markets and on the destinations price and promotion decisions. We consider a two-stage model with two reference destinations and product differentiation. Specifically, we distinguish between traveling and production costs/inputs uncertainty, and between informative and persuasive advertising. We found that uncertainty tends to increase prices as destinations pass uncertainty to consumers. However, in order to minimize the negative effect of higher prices in their bookings, destinations tend to intensify their promotion efforts. Altogether, uncertainty typically affects more consumers than destinations, which in most cases see their profits increase because of the increase in prices.

Introduction

The tourism sector is particularly susceptible to external factors such as natural disasters, economic downturns, conflict or political instability (Ridderstaat & Nijkamp, 2016; Ritchie, 2004; Williams & Bálaz, 2016). In fact, in the recent years the tourism sector has been hit by a number of uncertainty events like the COVID-19, energy prices, supply chain disruptions, etc., which have led to significant demand and supply uncertainty (Papatheodorou, 2021; Škare, Soriano, & Porada-Rochoń, 2021; Yang, Zhang, & Chen, 2020). The present and the future of the touristic sector seems surrounded by uncertainty (García Esteban, Gómez Loscos, & Martín Machuca, 2023).

In particular, the COVID-19 pandemic alone has disrupted the tourism industry everywhere. One of the consequences was a significant decline in the demand for travel and tourism (UNWTO, 2021a, 2021b), with many consumers hesitant to travel due to safety concerns and travel restrictions (UNWTO, 2020; WTTC, 2020). Uncertainty about future tourism demand made difficult for destinations to plan, and many tourism businesses had to adjust their prices to the changing market conditions (Gössling, Scott, & Hall, 2021; Hall, Scott, & Gössling, 2020; Kreiner & Ram, 2020; Navarro, Ortega, & Torres, 2020; Xiang, Magnini, & Fesenmaier, 2015). Similarly, supply chain disruptions led many tourism businesses to face shortages of goods and services, leading to price increases for some products (WTTC, 2020), business closures and reductions in international travel (Buhalis & Law, 2008). The COVID-19 pandemic led also to significant changes in consumer behavior, with destinations adapting their promotion and advertising strategies to the changing market conditions (Deb, Nafi, & Valeri, 2022; Duro, Osório, & Perez-Laborda, 2023; Duro, Osório, Perez-Laborda, &

* Corresponding author.
E-mail addresses: juanantonio.duro@urv.cat (J.A. Duro), antonio.osoriodacosta@urv.cat (A. Osório), alejandro.perez@urv.cat (A. Perez-Laborda).

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Rosselló-Nadal, 2023; Euromonitor International, 2020; Luo, Hu, Wan, & Yi, 2023). Together, with price, advertising is a crucial strategic variable that destinations have instantaneously available to deal with uncertainty events.

In this paper, we question how uncertainty impacts on the tourism market, and how destinations adjust their pricing and advertising strategies during uncertainty events. The joint study of these competitive forces will help us better understand and prevent the negative effect of uncertainty shock in the tourism industry.

In this context, we propose a two-stage Hotelling model with product differentiation in which two destinations compete in prices and advertising to attract tourists in order to study whether different types of uncertainty lead to different market outcomes (Fig. 1 below provides a graphical and intuitive illustration). In this paper, consumers and destinations managers/decision makers are risk averse. Therefore, uncertainty adversely affects their utility functions.

Within this framework we consider two types of uncertainty. First, traveling uncertainty, which is motivated by the COVID-19 pandemic, impacts first and directly on consumers utility and leads to demand uncertainty. Second, production cost/input prices uncertainty, which is motivated by the input prices uncertainty experienced mainly between 2022 and 2023, and leads to supply uncertainty. In this paper, we also distinguish between informative and persuasive advertising. This is important because during the COVID-19 uncertainty most touristic destinations changed their advertising and promotion strategies (Arbulú, Razum Ova, Rey-Maquieira, & Sastre, 2021; Duro, Osório, Perez-Laborda, & Fernández-Fernández, 2022; Duro, Perez-Laborda, & Fernandez, 2022; Duro, Osório, & Perez-Laborda, 2023; Duro, Osório, Perez-Laborda, & Rosselló-Nadal, 2023; Luo et al., 2023; Papatheodorou, 2021; Škare et al., 2021; Yang et al., 2020).

In this context, we consider three different modelling approaches: 1) One in which touristic destinations compete in prices and informative advertising, 2) another one in which touristic destinations compete in prices and persuasive advertising, and finally, 3) one in which the touristic destinations compete in prices, informative and persuasive advertising simultaneously. This joint model aims to check the robustness of the results obtained in 1) and 2), and the existence of complementarity and substitution effects between different forms of advertising.

In terms of results, we found that production costs/input prices uncertainty tends to increase prices because destinations tend to pass uncertainty to consumers through higher prices. Simultaneously, the persuasive advertising intensity increases as destinations attempt to recover the lost consumers due to higher prices. However, the informative advertising intensity is not affected by uncertainty in the supply side of the market.

On the other hand, traveling uncertainty tends to lower prices for high levels of uncertainty, as observed during the COVID-19 pandemic (Duro, Osório, & Perez-Laborda, 2023). However, traveling uncertainty may also increase prices when uncertainty is not too large because destinations can pass the uncertainty to consumers through higher prices. Therefore, the level and type of uncertainty are crucial to determine whether prices will increase or decrease. Moreover, the informative advertising intensity increases as destinations search for new tourists in a scenario of declining demand due to traveling uncertainty. However, under traveling uncertainty the persuasive advertising intensity tends to decreases as it becomes less effective and because tourists are less motivated to travel in these circumstances. The exception occurs if the level of traveling uncertainty is high in which case competition for consumers intensifies in all dimensions including persuasive advertising, as destinations search for ways to fill their empty accommodations.

Altogether, we also found that uncertainty tends to benefit destinations and penalize consumers, as uncertainty is passed to the consumers through higher prices and consequently lower utility. This is a particular robust finding across all models and types of uncertainty. The obtained results are also robust to the degree of differentiation between destinations.

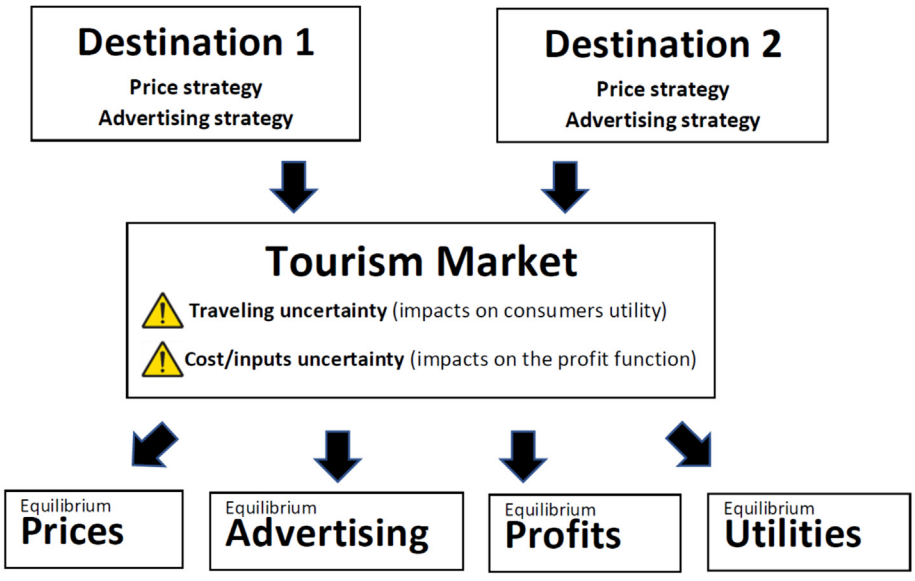

Fig. 1. Schematic structure of the model in this paper.

Literature review

In what follows, we present a brief literature review in order to better integrating the present paper and to highlight the importance of studying uncertainty and competition in the tourism industry.

Uncertainty in tourism markets is a growing research topic. For instance, in Song and Li (2008) the uncertainty created by SARS reduced touristic demand, in Ming and Liu (2021) political instability has significantly decreased tourism arrivals, while in Beerli and Martin (2004) tourists choose destinations that are perceived as safe and secure. The supply side of the tourism industry is highly affected by uncertainty such as weather conditions, tourism infrastructure, airline schedules, economic instability and political conflicts (Altinay, Paraskevas, & Jang, 2015; Demir & Gözgör, 2018; Gozgor & Ongan, 2017; Hall & Jenkins, 1995; Song & Li, 2008), but also depends on a variety of supply chains, including transportation, accommodation, food and other activities, which introduce significant levels of uncertainty into the market (Buhalis & Foerste, 2015). This paper is the first that makes a clear separation between demand and supply uncertainty shocks.

In this paper, we also distinguish between informative and persuasive advertising because those are the tools that destinations have to adapt to the uncertainty shocks. For example, during the COVID-19 pandemic most destinations changed their advertising and promotion strategies (Arbulú et al., 2021; Duro, Osório, et al., 2022; Duro, Perez-Laborda, & Fernandez, 2022; Duro, Osório, & Perez-Laborda, 2023; Duro, Osório, Perez-Laborda, & Rosselló-Nadal, 2023; Luo et al., 2023; Papatheodorou, 2021; Škare et al., 2021; Yang et al., 2020). In this context, persuasive advertising intends to convince and influence potential tourists to visit a particular destination (Buhalis & Law, 2008; Font & McCabe, 2017; Xu, Murphy, Chen, & Pearce, 2022), while informative advertising involves providing potential tourists with information about a particular destination (Goossens, 2000; Hosany & Witham, 2010; Kim, Hwang, & Fesenmaier, 2005). The tourism industry is passing through great transformation in terms of advertising and promotion with a tendency for more persuasive advertising approaches (Deb, Nafi, & Valeri, 2022; Jiang, Tan, Liu, Wan, & Gursoy, 2020; Li, Lyu, Park, & Choi, 2023). Some studies suggest that informative advertising is more effective in times of uncertainty because customers are more interested in practical information and advice (Stepchenkova & Zhan, 2013), while other studies suggest the opposite (Buhalis & Foerste, 2015). The literature has no clear answer. This paper attempts to progress on this issue.

There are some examples of theoretical approaches to tourism markets involving promotion decisions (e.g., Candela & Cellini, 2006; Duro, Osório, & Perez-Laborda, 2023; Tavares, de Vargas Mores, & Tomazzoni, 2015; Van Zyl, 2012; Zirulia, 2011). See Kuokkanen and Bouchon (2021) for a recent survey. However, up to our knowledge, this is the first study addressing strategic competition in prices and advertising between tourism destinations under different types of uncertainty. In our perspective, the tourism economics literature suffers from the lack of theoretical approaches to support empirical hypotheses. This observation is even more true in the context of risk and uncertainty. In this context, this paper contributes to fill a gap in the literature by offering a novel microeconomic perspective on how destinations behave and adapt strategically to demand and supply uncertainty, such as the COVID-19 pandemic or the 2022–2023 inflation/prices uncertainty. The proposed model is general and can be applied to study other types of uncertainty.

Methodology

In this section, we formalize our approach with a two-stage Hotteling model in which two destinations compete in prices and advertising to attract tourists. Destinations may decide between informative or persuasive advertising (Belleflamme & Peitz, 2015; Grossman & Shapiro, 1984). In addition, we consider traveling uncertainty and production cost/input prices uncertainty. Traveling uncertainty impacts first and directly on the consumer utility and leads to demand uncertainty. Production cost/input prices uncertainty impacts on the destinations objective function and leads to supply uncertainty.

In this context, we consider a unit mass of tourists who are uniformly distributed over the interval $[0, 1]$. There are two destinations competing for those tourists. Destination 1 is located at l_1, while, Destination 2 is located at l_2, where $l_1 \leq l_2$. The more distant they are, the more differentiated they are.

The consumer with preferences located at point x derive utility $u_i(x) = f\left(b\alpha_i - p_i + \tilde{t}|x - l_i|\right)$ if she travels to destination i located at l_i, where $f(x)$ denotes some general functional form. The parameter p_i denotes the price charged by destinations i.

In the **persuasive advertising model,** the variable $\alpha_i \in [0, 1]$ denotes the amount of persuasive advertising made by destination i to attract tourists. The parameter b denotes the impact of persuasive advertising on consumer i utility. The higher the amount of advertising the higher is the persuasion effect.

The consumers utility from traveling depends on the parameter $\tilde{t}$. The larger this parameter, the higher is the utility from traveling. However, there is **traveling uncertainty**, e.g., flights might be cancelled, a major conflict or a natural disaster may occur, or even an event like the COVID-19 pandemic. In this context, let $\tilde{t}$ be a normal distributed random variable with mean t and variance σ_t^2.

In order to have a clear and tractable framework, consumers are risk averse with Constant Absolute Risk Aversion (CARA) utility function. In other words, the tourist x utility from buying vacations in destination i is given by $u_i(x) = -\ exp\ (-\rho_t(b\alpha_i - p_i + \tilde{t}|x - l_i|))$, where the parameter ρ_t is the consumers coefficient of absolute risk aversion. The higher this coefficient the more risk averse is the consumer.

The chosen exponential utility function is conveniently used in decision theory to model risk and uncertainty, because of the following result: let a and b be some constants, and $c \sim N(C, \sigma^2)$. Then $E[-\ \exp\ (-a(b + c))] = -\ \exp\ (-a(b + C) + a^2\sigma^2/2)$. Therefore, we capture uncertainty in a single parameter (i.e., the standard deviation). Up to our knowledge, our approach is novel and delivers a clear and tractable framework.

In this context, consumer x objective is to maximize the expected utility, which is given as follows:

$$E[u_i(x)] = -\exp\Big(-\rho_t(b\alpha_i - p_i + t|x - l_i|) + \rho_t^2\sigma_t^2(x - l_i)^2/2\Big).$$

Note that $\rho_t\sigma_t^2(x - l_i)^2/2$ is the risk premium of consumer x from buying vacations in destination i. Note also that the risk premium increases with the distance between the tourist preferred location x and the destination location. Therefore, risk-averse tourists derive disutility from the uncertainty associated with traveling to more distant locations.

At this stage, without loss of generality, and in order to reduce the number of parameters, we set $t = 0$ and denote $R_t = \rho_t\sigma_t^2/2$ as the **traveling uncertainty measure**, which includes the consumers risk aversion ρ_t and the variance parameter σ_t^2.

The consumer will prefer to spend her vacations in location 1 if $E[u_1(x)]>E[u_2(x)]$, and will prefer to spend her vacations in location 2 if $E[u_1(x)] < E[u_2(x)]$. Consequently, the indifferent consumer $x \in [0, 1]$ solves $E[u_1(x)] = E[u_2(x)]$, which is equivalent to solve:

$$b\alpha_1 - p_1 - R_t(x - l_1)^2 = b\alpha_2 - p_2 - R_t(l_2 - x)^2.$$

Since the destinations location is not endogenous, in order to simplify the analysis, we let $l_1 = 1/2 - \tau$ and $l_2 = 1/2 + \tau$, where the parameter $\tau \in [0, 1/2]$ captures the level of horizontal differentiation between destinations. In other words, if $\tau = 0$ both destinations are similar in terms of what they offer to tourists, i.e., there is no differentiation. An example would be competition between two similar coastal destinations. On the other hand, if $\tau = 1/2$ both destinations are very different in terms of what they offer to the tourists, i.e., there is maximum differentiation. An example would be competition between one coastal and one city/town destination in which there is a clear difference in touristic terms.

Therefore, after having solved the previous equation, the indifferent tourist is given by:

$$x_i \equiv x = \frac{1}{2} - \frac{p_i - p_{-i} + b(\alpha_{-i} - \alpha_i)}{4\tau R_t}. \tag{1}$$

The obtained expression is the destination i demand in the persuasive advertising model, while the destination $-i$ demand is given by $x_{-i} \equiv 1 - x$.

In the **informative advertising model,** advertising leads to more informed tourists. In this context, we let a share α_i of consumers know about destination i, while a share $1 - \alpha_i$ of consumers do not know about destination i. In other words, there are $\alpha_i\alpha_{-i}$ consumers that are considering whether to spend their vacations in destination i or destination $-i$. Consequently, both destinations will have to compete for them. And there are $\alpha_i(1 - \alpha_{-i})$ consumers that will spend their vacations in destination i, because they are not informed about what destination $-i$ has to offer. These consumers are faithful to destination i, and their traveling intentions will depend only (negatively) on the price p_i charged by destination i. Therefore, the destination i demand function is the sum of these two different types of consumers, and is given by:

$$x_i = \alpha_i\alpha_{-i}x_{b=0} + \alpha_i(1 - \alpha_{-i})/p_i. \tag{2}$$

where $x_{b=0}$ denotes expression (1) evaluated at $b = 0$ in order to remove the persuasive effect.

In this paper, we are also interested in studying the impact of uncertainty in the consumers welfare. Therefore, in order to obtain an aggregate utility indicator of the tourists traveling to destination i, we consider the following transformation of the utility expression:

$$U_i = \int_0^{x_i} b\alpha_i - p_i - R_t(x - l_i)^2 dx. \tag{3}$$

Since the utility function is monotonically increasing this transformation makes the welfare analysis more tractable and easier to follow.

In the supply side of the market, two destinations compete for tourists. Each destination is represented by a risk-averse manager/decision-maker that aims to maximize the destination benefits:

$$\pi_i = p_i x_i - c_\alpha\alpha_i^2/2 - \tilde{c}x_i.$$

where $\tilde{c}x_i$ is the total cost of production with the parameter $\tilde{c}$ controlling the marginal cost of production (costs/input prices used in the production process), while $c_\alpha\alpha_i^2/2$ is the total cost of advertising with the parameter $c_\alpha \le 1$ capturing the cost of advertising. The total cost of advertising is quadratic in order to express the fact that advertising spending is beneficial but with decreasing impact. In this context, we introduce **production costs/input prices uncertainty** in the cost function by letting $\tilde{c}$ be a normal distributed random variable with mean c and variance σ_c^2.

The managers are risk-averse because wrong decisions have consequences in their chances of reappointment, re-election and career. In this context, we consider the CARA utility function which is given by $u(\pi_i) = -\exp(-\rho_c\pi_i)$, where the parameter ρ_c captures the manager coefficient of absolute risk aversion. The higher this value the more risk averse is the manager. Therefore, the manager of destination i objective is to maximize the expected utility:

$$E[u(\pi_i)] = -\exp\Big(-\rho_c\Big(p_i x_i - c_\alpha\alpha_i^2/2 - cx_i\Big) + \rho_c^2\sigma_c^2x_i^2/2\Big).$$

Which is equivalent to maximize $(p_i x_i - c_\alpha \alpha_i^2/2 - cx_i) - \rho_c \sigma_c^2 x_i^2/2$ because the exponential function is a monotonically increasing function.

Note that $\rho_c \sigma_c^2 x_i^2/2$ is the risk premium associated to the costs/inputs price uncertainty and increases with the output. Therefore, the higher the number of touristic reservations, the higher the risk faced by destinations.

Since we have already introduced uncertainty, without loss of generality and in order to reduce the number of parameters, we set $c = 0$ and denote $R_c = \rho_c \sigma_c^2/2$ as the **production costs/input prices uncertainty measure**, which includes the managers/decision-makers risk aversion ρ_c and the variance parameter σ_c^2.

Therefore, the managers/decision-makers objective function is given by:

$$p_i x_i - c_\alpha \alpha_i^2/2 - R_c x_i^2. \tag{4}$$

While the destinations profit, i.e., the objective function with uncertainty removed is given by:

$$\pi_i = p_i x_i - c_\alpha \alpha_i^2/2. \tag{5}$$

This risk-neutral indicator is useful to study the destinations welfare.

Finally, we consider a two-stage game. In the first stage, both destinations simultaneously chose their advertising intensities. In the second stage, both destinations simultaneously chose their prices.

Results

In this section, we study how uncertainty impacts on the destinations strategic decision and how it affects competition. The objective is to understand how traveling and inputs/costs uncertainty influence the destinations pricing and informative and persuasive advertising strategies.

Firstly, we consider the informative and persuasive advertising models separately to understand how these two types of advertising strategies interact with the prices and competition in general. Finally, we consider a joint model in which both types of advertising are possible in simultaneous. The objective is to check for the existence of complementarity and substitution effects while keeping the analysis simple but complete.

Uncertainty under price competition and informative advertising

In this subsection, we consider the informative advertising model (Grossman & Shapiro, 1984). Informative advertising involves providing potential tourists with information about a particular destination or travel product, increases awareness of a destination, establishes trust and credibility, and leads to positive word-of-mouth recommendations.

The informative advertising model is solved by backwards induction, which is the method used to derive the subgame perfect Nash equilibrium of the two-stage game proposed in this paper. It involves solving the problem from the end to the beginning. The following result summarizes our findings:

Proposition 1. *In the informative advertising model, the symmetric equilibrium price and informative advertising levels are given by*:

$$p_i^* = 2\tau R_t + R_c(1 + c_\alpha - \tau R_t)^2, \tag{6}$$

and

$$\alpha_i^* = 1/(1 + c_\alpha - \tau R_t), \tag{7}$$

respectively, where $c_\alpha \geq \tau R_t$. The equilibrium profit and aggregate utility measure are given by replacing p_i^* and α_i^* into Eqs. (3) and (5).

Prices are positive but the condition $c_\alpha \geq \tau R_t$ must be satisfied in order for the equilibrium levels of advertising to be in the interval $[0, 1]$. In other words, if the informative advertising cost parameter is larger than the traveling uncertainty indicator not all consumers will be informed, i.e., $\alpha_i^* \leq 1$. Otherwise, firms will provide the maximum possible amount of informative advertising, i.e., $\alpha_i^* = 1$, and all consumers are informed. Under such advertising intensity prices will tend to decrease.

Subsequently, we analyse how variations in the traveling uncertainty R_t, cost uncertainty R_c, differentiation levels τ and advertising costs c_α affect the obtained equilibrium prices p_i^* and advertising α_i^*. Along the way, we will also comment on profits π_i^* and consumers utility U_i^*. We leave those expressions in the proof in order to reduce the number of mathematical expressions appearing in the main text.

Proposition 2. *In the informative advertising model, an increase in the traveling uncertainty* R_t:

a) Increases prices if $1 > R_c(1 + c_\alpha - \tau R_t)$, *and the opposite otherwise.*

b) Increases informative advertising.

An increase in the traveling uncertainty impacts on the demand side of the market. P2a states an increase in prices, as uncertainty is passed to consumers through higher prices (and consumers' utility may fall). According to the condition $1>R_c(1+c_\alpha-\tau R_t)$, the exception in P2a occurs when the cost/inputs prices uncertainty (R_c) is high or the traveling uncertainty (R_t) low, in which case we observe a fall in prices (P2a) and an increase in informative advertising (P2b) which may benefit consumers. Note also that according to the condition in P2a, consumers may also end up benefiting from lower prices if advertising costs (c_α) are high and the degree of differentiation between the competing destinations (τ) is low. In those cases, competition moves towards prices because of the high advertising costs and the low differentiation, respectively. While if advertising costs are low, competition stays mainly in advertising and prices increase.

This effect was also observed by Duro, Osório, and Perez-Laborda (2023) during the COVID-19 pandemic, with destinations decreasing prices and increasing their informative advertising intensity in the end of 2020 and beginning of 2021 in an attempt to secure the summer of 2021 bookings.

Finally, note that traveling uncertainty may increase the destinations profits, which might be an arguable result, in particular if we consider the COVID-19 pandemic as our reference. The COVID-19 is a very particular event because of its characteristics and time length, and because we do not consider scale and occupation/capacity restrictions that are important in touristic markets. Nonetheless, such result holds on the idea that destinations can pass part of the traveling uncertainty to the consumers, which may not be always the case.

Proposition 3. *In the informative advertising model, an increase in the cost uncertainty* R_c:

a) Increases prices.

b) Has no effect on informative advertising.

An increase in the costs/input prices uncertainty impacts on the supply side of the market. In this case, P3a states an increase in prices (and in the destinations' profits) as uncertainty is passed to consumers through higher prices. Simultaneously, the consumers utility may fall. In this context, part of the increase in the touristic prices and destinations profits observed during 2022 and 2023 was due to the increase in the price of the costs/inputs used in the touristic services because of the observed inflation uncertainty. In other words, higher costs/input prices uncertainty imply higher touristic prices, with destinations adjusting their margins to protect themselves against potential adverse scenarios, which increases their profits.

Interesting is the fact that on the contrary to P2 in which traveling uncertainty has pushed advertising up, P3b states that supply uncertainty is passed directly to consumers without affecting the destinations informative advertising strategies. This is an interesting result. In other words, the inflation and supply-chain uncertainty observed between 2022 and 2023 had no real impact on the destinations informative advertising strategies, only in their price strategies.

Altogether, P2b and P3b imply respectively that traveling uncertainty impact on the destinations informative advertising strategies mainly, while supply side uncertainty is passed to consumers through higher prices without changes in the advertising strategies. Nonetheless, we will see below that supply side uncertainty may lead to changes in the destinations persuasive advertising strategies.

Proposition 4. *In the informative advertising model, an increase in differentiation* τ:

a) Increases prices if $1>R_c(1+c_\alpha-\tau R_t)$, *and the opposite otherwise.*

b) Increases informative advertising.

The first part of P4a states that differentiation between competing tourism destinations reduces competition. This result is in line with the industrial organization literature as differentiation tends to softens price competition. Simultaneously, it is likely that the consumers surplus decreases. The exception occurs when the uncertainty on production costs/input prices (R_c) is high and/or the advertising costs (R_t) are large enough, we may observe a decrease in prices, i.e., an increase in price competition. In other words, in order to compensate for potential increases in the costs of production, and while the cost of advertising (c_α) is high, touristic destinations direct their competitive efforts to price competition. Altogether consumers may end up benefiting from those lower prices.

Simultaneously, P4b states that an increase in differentiation also increases the levels of informative advertising as destinations move away from price competition. Simultaneously, as the demand increases due to more informed tourists the destinations profits increase.

Proposition 5. *In the informative advertising model, an increase in the cost of advertising* c_α:

a) Increases prices.

b) Decreases informative advertising.

An increase in the cost of advertising pushes prices up and reduces the advertising intensity (P5a and P5b). Altogether, higher advertising costs reduce competition on prices and advertising, which increases profits and reduces consumer utility. In other words, the increase in advertisement costs favour destinations and punish consumers. Destinations pass the increase in their advertising costs to consumers. Note that when the advertising costs are very high, a further increase in costs may eventually decrease profits.

Uncertainty under price competition and persuasive advertising

In this subsection, we consider the persuasive advertising model. Persuasive advertising in tourism aims to influence consumer behavior by creating desire or need, and by encouraging them to buy a particular destination. Therefore, persuasive advertising has a more competitive and zero-sum nature than informative advertising: the increase in one destination demand implies a reduction in other destination demand.

The model is solved by backwards induction, which is the method used to derive the subgame perfect Nash equilibrium of the two-stage game proposed in this paper. It involves solving the problem from the end to the beginning. The solution of this procedure delivers the following result:

Proposition 6. *In the persuasive advertising model, the symmetric equilibrium price and persuasive advertising levels are given by*:

$$p_i^* = 2\tau R_t + R_c, \tag{8}$$

and

$$\alpha_i^* = b(4\tau R_t + R_c)/(4c_\alpha \tau R_t), \tag{9}$$

respectively. The equilibrium profit and aggregate utility measure are given by replacing p_i^* and α_i^* into Eqs. (3) and (5).

Subsequently, we analyse how variations in the traveling uncertainty R_t, cost uncertainty R_c, differentiation levels τ and advertising costs c_α affect the obtained equilibrium prices p_i^* and advertising α_i^*. Along the way, we will also comment on profits π_i^* and consumers utility U_i^*. See the proof for the analytical expressions.

Proposition 7. *In the persuasive advertising model, an increase in the traveling uncertainty* R_t:

a) Increases prices.

b) Decreases persuasive advertising.

An increase in the traveling uncertainty is a shock in the demand side of the market. In this case, P7a states an increase in prices as uncertainty is passed to consumers through higher prices. However, traveling uncertainty decreases the persuasive advertising intensity (P7b). This is an interesting result, while P2b showed that informative advertisement may increase under traveling uncertainty, P7b states the opposite, i.e., persuasive advertising decreases. Therefore, traveling uncertainty leads touristic destinations to spend more resources in informative advertising and less in persuasive advertising. The reason is that persuasive advertising is more competitive, with a strong stealing demand effect, than informative advertising that creates new demand. Consequently, in periods of uncertainty, destinations favour informative advertising over persuasive advertising because it is less competitive.

In other words, traveling uncertainty reduces the destinations incentives to compete in terms of price, but also affects the way destinations promote their products. In addition to soften price competition, it also softens the advertising strategies by moving spending from persuasive to informative advertising. Again, note that traveling uncertainty increases destinations profits and penalize consumers because most of the traveling uncertainty is passed to consumers through higher prices and softer competition.

Proposition 8. *In the persuasive advertising model, an increase in the cost uncertainty* R_c:

a) Increases prices.

b) Increases persuasive advertising.

An increase in the production costs/input prices uncertainty is a shock on the supply side of the market. In this case, P8a states an increase in prices as uncertainty is passed to consumers through higher prices. The fundamental idea is that uncertainty is transferred to consumers through higher prices seems to be a consistent and robust result that emerge for any type of uncertainty and model formulation.

If uncertainty is on the supply side of the market, the inflation (price) effect is stronger than when uncertainty is on the demand side, because the increase in prices is doubly fuelled by the higher input prices and the decrease in price competition.

Simultaneously, destinations push their persuasive advertisement efforts up in an attempt to keep their demand (P8b). Consequently, competition is channelled to advertising, which is the opposite of P7b which states that informative advertising decrease. The result in P8 also confirms the idea that in overall terms destinations tend to benefit from uncertainty at expenses of the consumers which is another robust and consistent finding across all models and types of uncertainty.

Proposition 9. *In the persuasive advertising model, an increase in differentiation* τ:

a) Increases prices.

b) Decreases persuasive advertising.

Table 1
Brief summary of the main results - Effects of uncertainty on prices and advertising for different models (Δ means an increase in x, ∇ means a decrease in x, Δ∇ means that both increase and decrease in x are possible depending on the parameters).

	Effect on prices	Effect on informative advertising	Effect on persuasive advertising
Informative advertising model			
Traveling Uncertainty	Δ∇	Δ	
Costs/inputs Uncertainty	Δ	=	
Persuasive advertising model			
Traveling Uncertainty	Δ		∇
Costs/inputs Uncertainty	Δ		Δ
Informative and Persuasive advertising model			
Traveling Uncertainty	Δ∇	Δ	∇Δ
Costs/inputs Uncertainty	Δ	=	Δ

More differentiation between competing touristic destinations reduces competition in prices and advertising (P9a and P9b). This result is not surprising and is in line with the industrial organization literature. Note also that profits increase and consumers utility falls. Therefore, the positive differentiation effect on consumers utility does not compensate the negative increase in prices effect. Destinations differentiate to increase their profits via lower competition, and not to benefit consumers with more variety. Therefore, differentiation may not be good for consumers.

Proposition 10. *In the persuasive advertising model, an increase in the cost of advertising* c_α:

a) Has no effect on prices.

b) Decreases persuasive advertising.

An increase in the cost of advertising does not changes prices because in the symmetric case, the destinations persuasive advertising efforts cancel each other leaving no room for price changes (P10a). In this context, and because advertising is more expensive, persuasive advertising decreases (P10b). Altogether, there is an increase in profits and a reduction in consumer utility. Profits increase because the increase in the advertising cost effect is dominated by the decrease in the advertising effect. The consumers utility decreases because less advertising reduces the consumer sense of satisfaction from traveling.

Extension: Informative and persuasive advertising

We conclude by commenting the case of tourism uncertainty with both informative and persuasive advertising. This approach is interesting because it allows to verify the robustness of the results obtained before and to look at the existence of substitution and complementary effects between different advertising strategies.

In the Appendix, we provide the reader with the information necessary to derive this case. See Proposition 11 and the respective proof in Appendix. Table 1 below provides a summary of the results for this case. In particular, regarding how traveling uncertainty R_t and cost uncertainty R_c affect prices p_i, informative advertising α_{iI} and persuasive advertising α_{iP}, which are the joint model equivalent to Propositions P2, P3, P7 and P8. The objective is to keep the paper simple and let the reader further explore this lead.

Briefly and in general terms, we found that the results obtained in the previous subsections are robust and strongly supported by the joint model. We also found that under traveling uncertainty informative and persuasive advertising are used in a complementary way. Except when traveling uncertainty is low and advertising costs high, in which case destinations may reduce on persuasive advertising to increase on informative advertising.

In the joint model, the equilibrium price and informative advertising expressions are the same as in the informative advertising model. Therefore, when both advertising levels coexist, prices tend to be higher and the informative advertising levels higher than in the individual advertising models, which signals that more advertising instruments relax price competition and channel competition towards advertising. On the other hand, the persuasive advertising levels in the general model are lower than in the persuasive advertising model because informative advertising strategies are preferred to the aggressive persuasive advertising strategies. Altogether, the aggregate spending in advertising is higher but prices are also higher.

Discussion

In this section, we discuss the relation between the obtained results, the existing data, the existing results in the literature, and end up proposing different policies and discussing their implications.

Model predictions and the data

The tourism market current situation offers an exciting context for modeling and interpreting the effect of uncertainty. In this section, we contrast the predictions of the model with some existing data, and suggest some evidence for the obtained predictions.

The proposed model has two types of predictions, about prices and advertising. Firstly, the model predicts variations on prices depending on the type of uncertainty. Thus, to test the consistence of the predictions with real data, we should know the type of uncertainty and its magnitude. In this sense, the COVID-19 pandemic seems to be a particular episode of demand uncertainty because of its magnitude and impact on the touristic markets. The interruption of tourist flows between March and June 2020 and its subsequent effects was an episode of strong demand uncertainty, which extended towards 2021, although in a smaller scale. Also, during 2021, problems in the global supply chain started, promoted by the rebound of the post-2020 tourism activity, and intensified by the effects of the war in Ukraine in 2022. In order to better contextualize our results and obtain a complete and rigorous validation of the theoretical model, we need to know the level of uncertainty. Unfortunately, we do not have such data. Nonetheless, in what follows, we try to offer a preliminary interpretation of the consistency of the obtained predictions by focusing on the pandemic and post-pandemic years.

In particular, for illustrative purposes we consider the summer performance of the Spanish regions during and after the COVID-19 period, considering the status of Spain as major tourism destination and the impact of the COVID-19 pandemic (Álvarez-Díaz, Chamorro-Rivas, González-Gómez, & Otero-Giráldez, 2023; Duro, Osório, et al., 2022). The goal is to interpret the association between the model predictions and the observed data. In this context, we acknowledge that many other factors are likely to have contributed to the results but given the available information we focus on the mechanism in question.

The left panel map in Fig. 2 shows the ratio of 2020, 2021 and 2022 summer hotel travelers to Spanish regions relative to the numbers observed in the 2019 summer, which serves as our pre-shock benchmark year. The right panel in Fig. 2 shows the behavior of the 2020, 2021 and 2022 summer hotel price index relative to the 2019 summer. These figures provide valuable insights into demand and price dynamics within the summer hotels industry, which is the predominant accommodation type in Spain. We rely on August data as a stand-in for the entire summer. August 2020 saw the lifting of mobility restrictions across all Spanish regions, making it suitable for comparing the pandemic's impact on the summer tourism across years. All the data is sourced from the Spanish Statistical Office (INE).

Tourism destinations started the 2020 summer campaign facing large travel uncertainty due to the pandemic, which led to unpredictable fluctuations in the number of tourists. As shown in Proposition 2, travel uncertainty may decrease tourism prices for high levels of uncertainty. Results in Fig. 2 are consistent with this prediction. The COVID-19 seriously reduced 2020 demand in all regions. The number of tourists to top destinations, such as Catalonia, Madrid or the Balearic and Canary Islands, has decreased to barely a quarter of their value in 2019. As shown in Fig. 2, prices felt in most regions, especially in those more oriented towards international

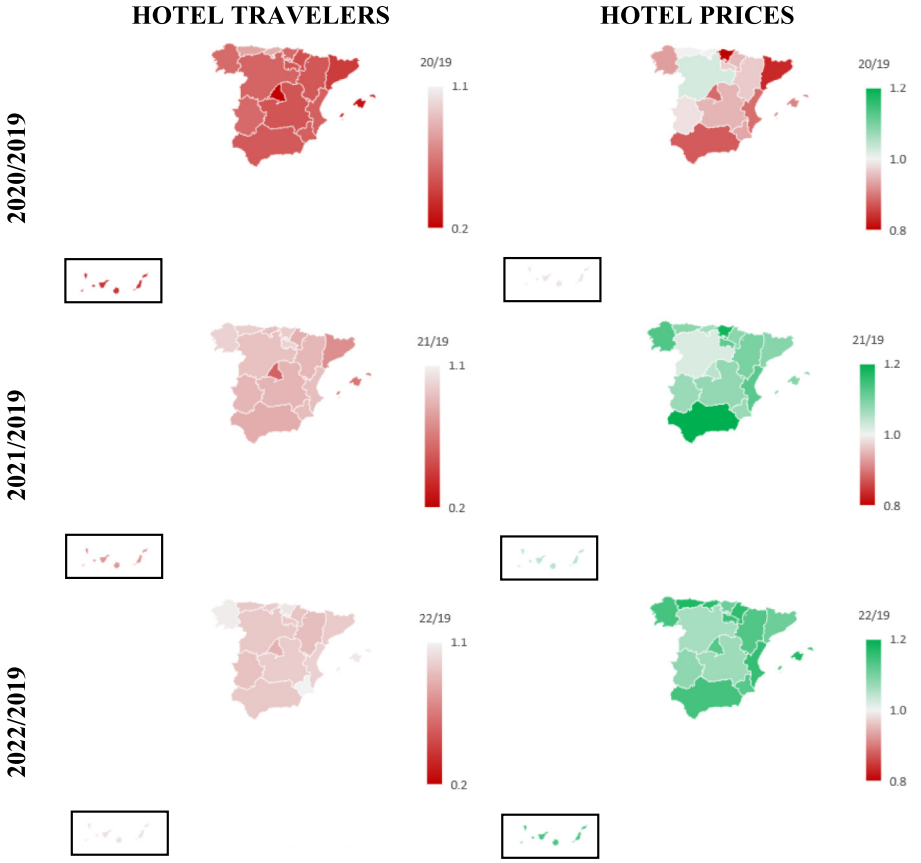

Fig. 2. Hotel Travelers & Prices in the summer of 2020–2022 vs. 2019 in Spanish Regions
The figure shows the ratio of the number of travelers (left panel) and the hotel prices (right panels) in the summer of the respective year (2020, 2021 and 2022) relatively to the respective value in 2019. Values in red (green) indicate decreases (increases) in this relative measure.

markets. In global terms, prices in Spain were reduced by 5.9 % year-on-year in 2020, a historic reduction in the entire available series (Spanish Statistical Office, INE). In relation to the proposed model, the existing evidence seems to suggest that Spanish destinations have placed large efforts in informative advertising, promoting themselves as "safe" destinations, which is consistent with the model prediction (Bull, 2020). Some authors suggest the preference for this type of advertising (informative) by tourists during the 2020 and 2021 years (Duro, Osório, & Perez-Laborda, 2023; Garaus & Hudàkóva, 2022). Obviously, more data is needed to robustly confirm those findings.

Note that the situation was slightly different in the 2021 summer campaign. Demand uncertainty was predictably lower than in 2020. During 2021 the cost/inputs uncertainty starts to emerge determined by difficulties in the supply chains caused in part by the rebound in post-COVID activity. Based on the model's predictions, prices increase in all situations, which are also shown in Fig. 2. Tourism flows recovered in the summer of 2021 in most regions of Spain, but yet still significantly below the 2019 levels. These observations are consistence with the model. Notice that the 2021 prices were generally larger than in 2019, even though demand was lower. In particular, the evolution of hotel prices in Spain as a whole reflected an increase of 12.8 %, clearly higher than the fall observed in 2020 (Spanish Statistical Office, INE). If we assume for 2021 a scenario of cost/inputs uncertainty, prices would grow consistently (See Propositions 2, 3, 7, 8 and Table 1). Again, other factors could have also contributed for these patterns, but the predictions of the model imply clear increases in prices in any context as it is also illustrated in Fig. 2. Specifically, in 2022, the hotel prices have increased by 17 % over 2021 (Spanish Statistical Office, INE). This was a general pattern among coastal destinations but also among rural and city/urban destinations.

A second type of prediction has to do with the evolution of advertising intensity and its typology under each uncertainty episode. Evidence seems to indicate that during and after the 2020 pandemic, all types of destinations (coastal, rural, city/urban, etc.) have increased their advertising efforts, but focusing on the domestic market rather than international market (Duro, Osório, & Perez-Laborda, 2023; Garaus & Hudàkóva, 2022). Thus, the increasing competition led to an expanding promotion spending with the objective of positioning their brand in the touristic market (LaVanguardia, 2020a, 2020b).

We cannot obtain a minimally reasonable test regarding the advertising prediction of our model because of the absence of quantitative data on the evolution of the advertising spending and type. Nevertheless, in general terms the model predicts an increase in the informative advertising spending for 2020, and an increase in the persuasive advertising spending in the following years. In this context, at a global level, some data sources suggest in fact an increase in the global advertising spending during and post-COVID times but without differentiating the type. Also, some authors support the hypothesis of an increase in the digital promotion during and after the COVID period (Ketter & Avraham, 2021; Toubes, Araújo Vila, & Fraiz Brea, 2021).

The results of the model and the existing literature

The paper offers a general framework for interpreting the dichotomy between uncertainty and prices, and the influence of uncertainty in different types of advertising strategies and vice versa. Table 1 provides a brief summary of the main results obtained in Section 0 regarding prices and advertising for different models and types of uncertainty.

As a robust result, we found that uncertainty typically increases prices and profits as uncertainty is passed to consumers through higher prices. Therefore, consumers tend to lose. However, we also found that in case of high traveling uncertainty, uncertainty may reduce prices as in Demir and Gözgör (2018) and Gozgor and Ongan (2017). Therefore, the impact on prices depends crucially on the level and on the type of uncertainty, but there is a tendency towards the idea that uncertainty increase prices.

Simultaneously, uncertainty increases advertising intensity as destinations try to compensate for demand losses due to higher prices. Altogether, uncertainty reduces price competition, but increases advertising competition, which is a softer form of competition. For instance, Toubes et al. (2021) found a clear increase in digital advertising during the pandemics. Uncertainty seems to channel the competition between destinations to advertising. We also found that under traveling uncertainty, touristic destinations seem to prefer informative advertising strategies over persuasive advertising strategies, while under costs/inputs prices uncertainty, tourism destinations prefer more aggressive persuasive advertising strategies. In this regard, Garaus and Hudàkóva (2022) found evidence about the preference for informational advertising over emotional/persuasive advertising during the pandemic years.

Under traveling uncertainty, destinations tend to use both advertising instruments in a complementary way, except when traveling uncertainty is low and/or advertising costs are high, in which case destinations may substitute persuasive advertising by informative advertising an idea that is also supported by Stepchenkova and Zhan (2013). Under costs/inputs prices uncertainty both advertising instruments are used independently, with destinations preferring persuasive advertising strategies, a perspective shared by Buhalis and Foerste (2015). Therefore, it is not clear the superiority or preference of one type of advertising strategy over the other under uncertainty, but it is clear that uncertainty impacts profoundly on the advertising strategies followed by destinations.

Policy and implications

In line with the results obtained in this paper, in order to address the challenges posed by uncertainty in the tourism markets competition, there is a range of (policy) implications that can be of interest for policymakers or destinations managers:

First, the model suggests that destinations (typically) tend to pass uncertainty-related costs to consumers through higher prices. This could lead to concerns about price gouging during times of significant uncertainty. Policymakers might need to think on implementing price regulation mechanisms during these periods to ensure that tourists are not overcharged for essential services.

Second, in particular, under uncertainty, destinations should direct their efforts to establishing consumers' confidence through informative advertising and avoiding the tendency for price increases and the escalation of predatory persuasive advertising strategies.

These objectives are possible only if there exist communication and coordination between destinations. Consequently, it is important that destinations develop ex-ante comprehensive crisis management and communication plans.

Third, understanding the impact of uncertainty on advertising strategies is crucial. Policymakers and tourism boards should develop guidelines and recommendations for destinations on how to effectively use informative or persuasive advertising during crises. Public-private partnerships for advertising campaigns can also be encouraged.

Fourth, it seems reasonable and appealing to test the model predictions with robust empirical evidence. In this regard, it is important to produce indicators of uncertainty, and, in particular, data on marketing efforts by typology. In a general way**,** it seems interesting to support initiatives aimed at better understanding the impacts of uncertainty on the tourism industry. This research can inform evidence-based policy decisions and strategies.

Fifth, the analysis in this paper considers constant marginal cost. Nonetheless, we found the results do not change significantly under different assumptions. For instance, expressions (6) and (7) in P1 are the same under constant or decreasing marginal costs. These observations tell us that in contexts of uncertainty, strategic decisions regarding prices and informative advertising do not depend on the costs structure.

Finally, the paper highlights that the tourism sector is highly susceptible to external shocks like COVID-19). In this context, policymakers should consider ways to enhance the resilience of the tourism industry and be proactive to address uncertainty in the tourism sector. This may involve developing contingency plans, risk and crisis management strategies, pricing regulations, advertising guidelines or investment in infrastructure.

Conclusion

This paper proposes a novel game-theoretical model to study the impact of uncertainty in the tourism destinations strategic decisions and market competition. In particular, we look at the trade-off between price and advertising strategies, and distinguish between informative and persuasive advertising. The first is directed to capture new potential consumers, while the second is directed to capture consumers from competing destinations. On the one hand, price and advertising are the instruments that destinations have instantaneously available to deal with the changing environment. On the other hand, uncertainty has always been a main concern for tourist markets but recent years have further increased these concerns. For that reason, it is crucial their joint interaction.

The paper also establishes a theoretical starting point for studying uncertainty in tourism markets, which is particular helpful to study raising new problems for which there is no available data yet. The uncertainty waves experienced since the 2020 COVID-19 pandemic was one such example. Another contribution is the way it introduces uncertainty in the demand side of the market, i.e., in the consumers' utility function, a modeling approach that to our knowledge is completely new. Similarly, we have also introduced uncertainty in the supply side of the market via the managers/decisionmakers utility/objective function.

In general terms, the paper finds that uncertainty tends to be passed to consumers in the form of higher prices, which reduces their utility. However, traveling uncertainty may lower prices for high levels of uncertainty as observed during the COVID-19 pandemic. Simultaneously and complementary, destinations tend towards informative advertising in case of traveling uncertainty, and to more aggressive formats like persuasive advertising in the case of costs or supply uncertainty. In this context, this paper offers a general framework for interpreting the variety of results often found in the reality in terms of the uncertainty, prices and advertising dichotomies. The obtained results are also robust to the degree of differentiation between destinations. After a brief empirical exploration, we found the model predictions are consistent with the events occurred during 2020–22 in the Spanish tourist market, i.e., the COVID-19 pandemic and the subsequent costs/input prices uncertainty.

The approach and findings in this paper open new research avenues for the study of uncertainty in touristic markets, but they are not the last word on the subject. In order to obtain more granular predictions, it could be interesting to introduce other aspects specific to the tourism industry like a larger number of competing destinations, a minimum profitability scale or the fact that accommodations capacity (supply) is fixed in the short-run. It is also likely that each type of uncertainty is specific and require a different treatment. The uncertainty associated with factors like political instability, conflict, natural disasters, exchange rates, global economic conditions and traveling restrictions are different, and with different impact on tourism prices and advertising strategies, and the profitability of tourism businesses and consumers behavior. Also, it would be interesting to analyse in a more rigorous way the match between predictions and empirical evidence. In this regard, we need more and better data, e.g., on advertising intensities and type, which are not easily available.

To conclude, this paper provides an effective and intuitive introduction to the increasingly important issue of risk and uncertainty in tourism markets, but also in economics and business. Regarding this aspect, we hope the analysis in this paper can guide researchers and decision-maker better understanding, deciding and predicting market outcomes in contexts of uncertainty in tourism markets.

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CRediT authorship contribution statement

Juan Antonio Duro: Validation, Investigation, Data curation. **António Osório:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Alejandro Perez-Laborda:** Visualization, Investigation, Data curation.

Data availability

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Results and proofs of propositions

Proof of Proposition 1. As explained in the discussion preceding Proposition 1, the informative advertising model is solved by backwards induction, i.e., from the end to the beginning. In the second stage, each destinations manager/decision-maker i maximize expression (4) with respect to price p_i, with demand function given by expression (2) evaluated at $b = 0$, i.e.:

$$\max_{p_i} \alpha_i \alpha_{-i} p_i \left(\frac{1}{2} - \frac{p_i - p_{-i}}{4\tau R_t}\right) + \alpha_i(1 - \alpha_{-i}) - \frac{c_\alpha \alpha_i^2}{2} - R_c\left(\frac{1}{2} - \frac{p_i - p_{-i}}{4\tau R_t}\right)^2.$$

In order to solve the obtained system of first-order conditions, we impose equilibrium symmetry, i.e., we replace p_{-i} by p_i, and solve for p_i to obtain after some algebra:

$$p_i = \frac{(R_c + \alpha_i \alpha_{-i} 2\tau R_t)}{\alpha_i \alpha_{-i}}.$$

Then, replace those prices back into the above maximization, and note that in the first stage, each destination i maximizes this new expression with respect to advertising α_i, i.e.:

$$\max_{\alpha_i} (R_c/2 + \alpha_i \alpha_{-i} 2\tau R_t)/2 + \alpha_i(1 - \alpha_{-i}) - c_\alpha \alpha_i^2/2.$$

In order to solve the obtained system of first-order conditions, we impose again equilibrium symmetry, i.e., replace α_{-i} by α_i, and then solve for α_i to obtain after some algebra we obtain the equilibrium expression (7) in Proposition:

$$\alpha_i^* = 1/(1 + c_\alpha - \tau R_t).$$

Now replace this expression back into the above price expression to obtain the equilibrium expression (6) in Proposition 1.

Note that the second-order condition of the price maximization is given by $-\alpha_i \alpha_{-i}/(2\tau R_t) - R_c/\left(2(2\tau R_t)^2\right) < 0$, which is always strictly negative. While the second-order condition of the advertising maximization is given by $-c_\alpha$, which is strictly negative.

The equilibrium price p_i^* in expression (6) and advertising α_i^* in expression (7) are then replaced into expression (5) to obtain the equilibrium profit net of uncertainty:

$$\pi_i^* = c_\alpha/2(1 + c_\alpha - \tau R_t)^2 + R_c/2.\# \tag{10}$$

Subsequently, expressions (6) and (7) are replaced back into (3) to obtain the equilibrium aggregate utility measure for the tourists traveling to destination i:

$$U_i^* = -\left(1 + 18\tau + 12\tau^2\right) R_t/24 - R_c(1 + c_\alpha - \tau R_t)^2/2.\# \tag{11}$$

Finally, prices and profits are always positive, but the following condition must be satisfied in order for the equilibrium level of advertising to be a number between 0 and 1, i.e.:

$$1 + c_\alpha - \tau R_t \geq 1.\# \tag{12}$$

■

Proof of Proposition 6. As explained in the discussion preceding Proposition 6, the persuasive advertising model is solved by backwards induction, i.e., from the end to the beginning. In the second stage, each destination manager/decision-maker i maximize expression (4) with respect to price p_i, with the respective demand function given by expression (1), i.e.:

$$\max_{p_i} p_i \left(\frac{1}{2} - \frac{p_i - p_{-i} + b(\alpha_{-i} - \alpha_i)}{4\tau R_t}\right) - \frac{c_\alpha \alpha_i^2}{2} - R_c\left(\frac{1}{2} - \frac{p_i - p_{-i} + b(\alpha_{-i} - \alpha_i)}{4\tau R_t}\right)^2.$$

In order to solve the obtained system of first-order conditions, we impose equilibrium symmetry, i.e., we replace p_{-i} by p_i, and solve for p_i to obtain after some algebra:

$$p_i = \frac{(R_c + 2\tau R_t)(b(\alpha_i - \alpha_{-i}) + 2\tau R_t)}{2\tau R_t}.$$

Then, replace those prices back into the above maximization, and note that in the first stage, each destination i maximizes this new expression with respect to advertising α_i, i.e.:

$$\max_{\alpha_i} \left(\frac{(R_c + 2\tau R_t)(b(\alpha_i - \alpha_{-i}) + 2\tau R_t)}{2\tau R_t}\right)\left(\frac{1}{2} - \frac{b(\alpha_{-i} - \alpha_i)}{4\tau R_t}\right) - \frac{c_\alpha \alpha_i^2}{2} - R_c\left(\frac{1}{2} - \frac{b(\alpha_{-i} - \alpha_i)}{4\tau R_t}\right)^2.$$

In order to solve the obtained system of first-order conditions, we impose again equilibrium symmetry, i.e., replace α_{-i} by α_i, and then solve for α_i to obtain after some algebra we obtain the equilibrium expression (9) in Proposition 6:

$$\alpha_i^* = \frac{b(4\tau R_t + R_c)}{4c_\alpha \tau R_t}.$$

Now replace this expression back into the above price expression to obtain the equilibrium expression (8) in Proposition 6.

Note that the second-order condition of the price maximization is given by $-1/(2\tau R_t) - R_c/\left(2(2\tau R_t)^2\right) < 0$, which is always strictly negative. While the second-order condition of the advertising maximization is given by $\left(b^2(4\tau R_t + R_c) - 8c_\alpha(\tau R_t)^2\right)/\left(8(\tau R_t)^2\right)$, which is strictly negative if $b^2(4\tau R_t + R_c) < 8c_\alpha(\tau R_t)^2$.

The equilibrium price p_i^* in expression (8) and advertising α_i^* in expression (9) are then replaced into expression (5) to obtain the equilibrium profit net of uncertainty:

$$\pi_i^* = (2\tau R_t + R_c)/2 - b^2(4\tau R_t + R_c)^2/\left(32c_\alpha(\tau R_t)^2\right).\# \tag{13}$$

Subsequently, expressions (8) and (9) are replaced back into expression (3) to obtain the equilibrium aggregate utility measure for the tourists traveling to destination i:

$$U_i^* = b^2(4\tau R_t + R_c)/(8c_\alpha \tau R_t) - \left(12R_c + \left(1 + 18\tau + 12\tau^2\right)R_t\right)/24.\# \tag{14}$$

Finally, the following condition must be satisfied for the equilibrium profit with uncertainty and risk aversion in expression (15) to be positive:

$$8\, c_\alpha(\tau R_t)^2 \geq b^2(4\tau R_t + R_c).\# \tag{15}$$

Which is the same as the above second-order condition of the advertising maximization. ∎

Proof of Proposition 2–5. and 7–10: In order to proof the results in Propositions 2–5 and 7–10 just differentiate the equilibrium p_i^* and α_i^*, or α_{iI}^* or α_{iP}^* depending on the case (we can do the same for π_i^* and U_i^*), with respect to R_t, R_c, τ and c_α in order to obtain the parts a) and b) or c) of each Proposition, respectively. Then, evaluate the sign of the obtained derivative in order to identify the directional movement. If the derivative is positive, the associated equilibrium value (price or advertising) increases. If the derivative is negative, the associated equilibrium value (price or advertising) decreases. In some cases, the sign of the derivative depends on some condition that is not implied neither by condition (12) for Proposition 2–5, nor by condition (15) for Proposition 7–10. In those cases, such condition is written in the statement of the Proposition.

For instance, in P2a or P4a after taking the derivative of the equilibrium, price with respect to R_t or τ, respectively, we obtain that the price increases if $1 > R_c(1 + c_\alpha - \tau R_t)$, and the opposite otherwise. This inequality is not guaranteed by condition (12). Therefore, it is written in the text of P2a and P4a.

For instance, regarding U_i^* in the P2 equivalent, an increase in traveling uncertainty R_t, decreases consumer utility if $(1 + 18\tau + 12\tau^2)/(24\tau) > R_c(1 + c_\alpha - \tau R_t)$, and the opposite otherwise. While in the P4 equivalent an increase in differentiation τ decreases consumer utility if $3/4 + \tau > R_c(1 + c_\alpha - \tau R_t)$, and the opposite otherwise. Similarly, regarding the net profit in the P5 equivalent an increase the cost of advertising c_α increases profits if $1 + c_\alpha - \tau R_t > 2\, c_\alpha$, and the opposite otherwise. ∎

Proposition 11. *In the general model, the symmetric equilibrium price, informative and persuasive advertising levels are given by:*

$$p_i^* = 2\tau R_t + R_c(1 + c_\alpha - \tau R_t)^2.\# \tag{16}$$

$$\alpha_{iI}^* = 1/(1 + c_\alpha - \tau R_t).\# \tag{17}$$

and,

$$\alpha_{iP}^{*} = b\left(4\tau R_t + R_c(1 + c_\alpha - \tau R_t)^2\right) / \left(4c_\alpha \tau R_t (1 + c_\alpha - \tau R_t)^2\right), \# \tag{18}$$

respectively, where $c_\alpha \geq \tau R_t$. ∎

Proof of Proposition 11. The proof follows the same arguments as in the proof of Proposition 1 and 6. In terms of notation, the informative advertising level is denoted as α_{il}, and the persuasive advertising level is denoted as α_{iP}. In this context, applying backwards induction in the second stage, each destinations manager/decision-maker i maximize expression (4) with respect to price p_i, with demand function given by expression (2), i.e.:

$$\max_{p_i} \alpha_{il}\alpha_{-il} p_i \left(\frac{1}{2} - \frac{p_i - p_{-i} + b(\alpha_{-iP} - \alpha_{iP})}{4\tau R_t}\right) + \alpha_{il}(1 - \alpha_{-il}) - \frac{c_\alpha \alpha_{il}^2}{2} - \frac{c_\alpha \alpha_{iP}^2}{2} - R_c \left(\frac{1}{2} - \frac{p_i - p_{-i} + b(\alpha_{-iP} - \alpha_{iP})}{4\tau R_t}\right)^2.$$

In order to solve the obtained system of first-order conditions, we impose equilibrium symmetry, i.e., we replace p_{-i} by p_i, and solve for p_i to obtain after some algebra:

$$p_i = \frac{(R_c + \alpha_{il}\alpha_{-il} 2\tau R_t)(b(\alpha_{iP} - \alpha_{-iP}) + 2\tau R_t)}{\alpha_{il}\alpha_{-il} 2\tau R_t}.$$

Then, replace those prices back into the above maximization, and note that in the first stage, each destination i maximizes this new expression with respect to both types of advertising α_{il} and α_{iP}, i.e.:

$$\max_{\alpha_{il}, \alpha_{iP}} \alpha_{il}\alpha_{-il} \frac{(R_c + \alpha_{il}\alpha_{-il} 2\tau R_t)(b(\alpha_{iP} - \alpha_{-iP}) + 2\tau R_t)}{\alpha_{il}\alpha_{-il} 2\tau R_t} \left(\frac{1}{2} - \frac{b(\alpha_{-iP} - \alpha_{iP})}{4\tau R_t}\right) + \alpha_{il}(1 - \alpha_{-il}) - \frac{c_\alpha \alpha_{il}^2}{2} - \frac{c_\alpha \alpha_{iP}^2}{2} - R_c \left(\frac{1}{2} - \frac{b(\alpha_{-iP} - \alpha_{iP})}{4\tau R_t}\right)^2.$$

In order to solve the obtained system of first-order conditions, we impose again equilibrium symmetry, i.e., replace α_{-il} by α_{il}, and α_{-iP} by α_{iP}, and then solve for α_i to obtain after some algebra we obtain after some algebra the equilibrium expression (17) and (18) in Proposition 11:

$$\alpha_{il}^{*} = 1/(1 + c_\alpha - \tau R_t),$$

and,

$$\alpha_{iP}^{*} = \frac{b\left(R_c/(2\tau R_t) + 2/(1 + c_\alpha - 2\tau R_t/2)^2\right)}{2c_\alpha}.$$

Now replace these expressions back into the above price expression to obtain after some algebra the equilibrium expression (16) in Proposition 11.

Note that the second-order condition of the price maximization is given by $-\alpha_{il}\alpha_{-il}/(2\tau R_t) - R_c/\left(2(2\tau R_t)^2\right) < 0$, which is always strictly negative. While the second-order condition of the informative advertising maximization is given by $-c_\alpha$, which is always strictly negative, while the second-order condition of the persuasive advertising maximization is given by $\left(b^2(4\tau R_t \alpha_{il}\alpha_{-il} + R_c) - 8c_\alpha(\tau R_t)^2\right) / \left(8(\tau R_t)^2\right)$, which is strictly negative if $b^2(4\tau R_t \alpha_{il}\alpha_{-il} + R_c) < 8c_\alpha(\tau R_t)^2$. Finally, the determinate of the Hessian matrix is positive when $c_\alpha^2 > b^2\left(1/(1 + c_\alpha - \tau R_t)^2 + c_\alpha\left(\frac{4\tau R_t}{(1+c_\alpha - \tau R_t)^2} + R_c\right) / \left(8(\tau R_t)^2\right)\right)$, which is true if b is sufficiently small, i.e., if the persuasive advertising effect is not too strong.∎

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Juan Antonio Duro is Full Professor in Economics at Universitat Rovira i Virgili. Research interests: tourism economics vulnerability and risk, seasonality and demand modelling.
António Osório is Associate Professor of Economics at Universitat Rovira i Virgili. Research interests: tourism economic uncertainty, sustainability and climate change.
Alejandro Perez-Laborda is Associate Professor of Economics at Universitat Rovira i Virgili. Research interests: econometric modelling, with applications to tourism.