Can Uncertainty Increase Investments in the Hospitality Industry? Understanding Overbuilding and Overcapacity *

Juan Antonio Duro
Universitat Rovira i Virgili and ECO-SOS

António Osório +
Universitat Rovira i Virgili and ECO-SOS

Alejandro Perez-Laborda
Universitat Rovira i Virgili and ECO-SOS

Abstract
The investment in tourism lodging capacity is often done in contexts of great uncertainty because decisions are made well before the demand is known. In this paper, we consider a two-stages theoretical model of capacity investment and strategic competition to study investment under uncertainty. We found a puzzling u-shaped relation between investment and uncertainty. While for low levels of uncertainty capacity investments may decrease with uncertainty, the opposite happens for high levels of uncertainty. In the latter, the ex-ante capacity investments fix the ex-post supply which restricts competition. This restriction increases prices and profits in extreme favourable scenarios proportionally more than in unfavourable scenarios. Anticipating this possibility, touristic operators increase their ex-ante investments to obtain a larger share of this excess demand and consequent profits. Our findings conciliate existing contradictory results, explain the tourism overbuilding phenomena and the hospitality industry tendency for overcapacity.

JEL Classification: Z31, L83, C72
Keywords: Tourism Investment; Uncertainty; Overbuilding; Overcapacity; Competition.

* Financial support from the Generalitat de Catalunya Project SGR2021-00729 and the Spanish Ministry of Science, Innovation and Universities Grant PID2023-153121NB-I00 funded by MICIU/AEI/10.13039/501100011033 and by ""ERDF/EU" is gratefully acknowledged. We would like to thank an anonymous referee for the valuable and insightful comments that helped us improved this paper. The usual caveat applies.

+ Corresponding author: António Osório, Department of Economics; Av. Universitat 1; 43204 – Reus, Spain (Email: antonio.osoriodacosta@urv.cat).

1. Introduction

Investment in tourism hospitality is particularly sensitive to uncertainty. Events such as natural disasters, economic downturns, conflicts, or political instability can significantly impact tourism demand and business profitability, influencing investment decisions (Demir et al., 2020; Işık et al., 2020; Khan et al., 2021; Nguyen et al., 2022; Williams & Baláz, 2015). In addition to this issue is the highly inelastic nature of the hospitality supply in the short-run. Capacity investment decisions must be made at least a couple of years before demand is known, making the industry especially vulnerable to uncertainty (Newell & Seabrook, 2006; Nguyen, 2015). Demand uncertainty and supply inflexibility are defining characteristics of this industry (Ampountolas, 2019; Butters, 2020; Chen & Lin, 2013; Leisten, 2020).

More specifically, demand uncertainty affects not only hotel capacity and investment decisions (Chen & Lin, 2013; Lee & Jang, 2012b), but also other key factors, such as occupancy rates (Butters, 2020), the likelihood of hotel failures (Chen & Yeh, 2012), the success of mergers and acquisitions (Kalnins et al., 2017), the flow of domestic and international tourists (Nguyen et al., 2022; Park, 2025), among others. The entire tourism industry is highly susceptible to uncertainty.

An extreme example of demand uncertainty was felt during the COVID-19 pandemic with most hospitality firms reporting low occupancy rates and low willingness to invest on capacity (Duro et al., 2023b; Gao & Zhang, 2024; Valadkhani, 2024). The uncertainty remained high in the subsequent years, but this time prices and profits increased due to the lack of capacity (Prayag, 2023; WTTC, 2024). Contributing to it was the fact that the supply of rooms and accommodations is fixed, requires large and costly investments, and needs time to build, often up to two or three years before demand is known (Newell & Seabrook, 2006; Hess et al., 2001; Nguyen et al., 2023).

Another example of demand uncertainty that is more specific to capacity investment decisions is observed in cities hosting major events such as Olympic Games or the FIFA World Cup. While it is evident that demand for hotels and accommodation will surge during these events, the post-event demand is uncertain. Despite this ambiguity, hospitality firms must make long-term capacity investment decisions several years in advance, knowing these investments will persist well beyond the event itself (Kim et al., 2006; Solberg & Preuss, 2007).

In this paper, we want to understand how uncertainty affects ex-ante capacity investments in the hospitality industry. In this context, we study how ex-post favourable and adverse market scenarios may affect equilibrium prices and profits, and how these different outcomes shape early investment decisions. To do it, we consider a two-stages game theoretical model of strategic investment and competition under uncertainty. In the first stage, before uncertainty is resolved, hospitality firms determine their rooms and accommodations capacity through costly investments. In the second stage, after uncertainty is resolved firms compete to attract tourists and fill their ex-ante established capacity.

In this sense we follow the theoretical literature on capacity investments that often considers two stages: a capacity investment stage and a price or quantity competition stage (Kreps & Scheinkman, 1983). However, the introduction of demand uncertainty in the price competition framework leads to equilibrium existence problems and difficulties in the interpretation of the results, which has become a main issue in this literature (Hviid, 1991; Reynolds and Wilson, 2000). One way to deal with this difficulty is to consider quantity rather than price competition as in the present paper. In this framework, Gabszewicz & Poddar (1997) have shown equilibrium existence for additively separable demand uncertainty, while Miegham and Dada (1997) have shown that profits and capacity investments are higher under quantity competition than under price competition. Their tradeoffs are like ours, but their analysis and focus are different. For instance, in our context, uncertainty is captured by an increase in the support of the distribution of the potential scenarios. Gabszewicz & Poddar (1997) approach cannot control for uncertainty in a meaningful way, while Miegham & Dada (1997) consider the volatility of a general distribution which is different and potentially difficult to operationalize. Contrary to the existing literature, we have an explicit interest in quantifying uncertainty to understand how capacity investment decisions vary for various levels of uncertainty while also controlling for market size, investment cost, marginal cost of production, number of firms or price sensitivity.

We model the hospitality industry as a capacity-quantity problem because the market is fundamentally driven by the available units. The idea is that once capacity is set, prices adjust based on demand, but the primary competition revolves around how many available units each firm offers to the market. This is particularly true if hospitality firms do not want to devalue their brand. Canina & Enz (2009) analyzed competitive set data and found that occupancy-driven competition precedes pricing adjustments in the U.S. hotel industry. Chiang et al. (2007) reviewed revenue management practices and concluded that hospitality firms optimize revenue through prices only after inventory decisions are made. Typically, a hotel may offer 80% of its capacity at standard rates and adjust prices upward to fill the remaining 20%. In this sense, hospitality firms use prices as a strategic variable but only in the very short-run to meet their occupancy targets (Kalnins et al., 2017). In the same vein, Butters and Hubbard (2023) empirically demonstrated the U.S. hotel industry competition is shaped mostly by quality and quantity competition (Gallagher & Corgel, 2018; Hubbard & Mazzeo, 2019). Without ignoring the importance of pricing decisions, these observations suggest that to understand the capacity and competition phenomena as a whole it might be adequate to model it as a quantity rather than a price competition problem. Another reason why is convenient to consider the capacity-quantity framework is to avoid the analytical and interpretation disadvantages of the capacity-price framework in which we must dwell with nonexistence or mixed strategy equilibria (Hviid, 1991; Reynolds and Wilson, 2000). Moreover, we should not expect significant difference between the capacity-quantity and the capacity-price frameworks in terms of results (De Frutos & Fabra, 2011; Grimm & Zoettl, 2008).

In this context, we found that ex-ante capacity constraints restrict ex-post competition in favourable scenarios but not in unfavourable scenarios. Therefore, since firms cannot expand their supply in the short-run, prices increase enormously in extreme favourable scenarios but do not decrease so much in extreme unfavourable scenarios because competition is not restricted by the supply capacity. In other words, this competition restriction effect increases the touristic operators ex-post profits in the favourable scenarios in an asymmetric and more than proportional way in comparison to unfavourable scenarios. This asymmetric effect becomes stronger when uncertainty is higher in which more extreme scenarios are a possibility. Consequently, to obtain a larger share of the excessive profits in case of extreme favourable scenarios, self-interested touristic operators overinvest ex-ante because the larger their ex-ante capacity, the larger their ex-post share on those potential excessive profits. Altogether, the effect is an increase in the ex-ante investment capacity for high levels of uncertainty. An effect that does not occur for low levels of uncertainty in which capacity investments fall with the uncertainty.

The result is a puzzling u-shaped relationship between capacity investments and uncertainty that conciliates different literature perspectives in this issue. On the one hand, for low levels of uncertainty there is a negative relation between capacity investments and uncertainty in line with many studies in economics and tourism (Carruth et al., 2000; Demir et al., 2020; Khan et al., 2021; Koetse et al., 2009; Soni et al., 2023). On the other hand, for sufficiently high levels of uncertainty there is a positive relation between capacity investments and uncertainty. A result that rationalizes and explains several touristic overbuilding episodes and the hospitality industry tendency for overcapacity rather than for under capacity as shown empirically in several studies (Chen & Lin, 2013; deRoos, 1999; Grenadier, 1996; Lee & Jang, 2012b; Van Mieghem, 2003). According to our findings, when uncertainty is high, touristic operators tend to position themselves in the overinvestment side to benefit from potential highly profitable demand spikes.

These results highlight that investment and competition in the hospitality industry is very particular and unique, making difficult the comparison and generalization with other industries. Despite the large volume of research, we still do not understand how uncertainty affects investment in the tourism industry, especially from the theoretical perspective as pointed out by Williams and Baláž (2015). García-Gómez et al. (2023) argue that more studies are needed to better understand investment under uncertainty in the hospitality industry as inefficiencies like under or overinvestment seem to be exacerbated by uncertainty. This paper also fills this gap in the literature by offering a novel theoretical approach on the relationship between investment and uncertainty that helps to better understand the phenomena of overbuilding and overcapacity investments that profoundly marks the touristic sector (Chen & Lin, 2013; deRoos, 1999; Grenadier, 1996; Lee & Jang, 2012b; Van Mieghem, 2003; Woodworth & Mandelbaum, 2010).

The remaining of the paper is organized as follows. Section 2 describes the model and notation. Section 3 presents the main results. Section 4 provides further intuition and discussion. Section 5 concludes.

2. Model and Notation

In this section, we formalize our analysis with a two-stage theoretical model with demand uncertainty in which n hospitality firms compete in Cournot. In the first stage, before uncertainty is resolved, hospitality firms decide their production capacity, i.e., their maximum available number of rooms or accommodations. In the second stage, after the uncertainty is resolved, given their available capacity and the observed state of nature, i.e., the demand, firms compete in quantities to attract tourists and fill their capacity.

The linear inverse demand function is given by: $p = x - \gamma \sum_{i=1}^{n} q_i$, where $p \geq 0$ denotes the market price, $q_i \in [0, x/\gamma]$ denotes the quantity produced by firm i, $\gamma > 0$ denotes the market price sensitivity to the firm i supply, which is related with the price elasticity, and x is a uniformly distributed random variable over the interval $[\alpha - \varepsilon, \alpha + \varepsilon]$. The random variable x has expected value α and density function $f(x) = 1/(2\varepsilon)$. The parameter $\varepsilon \in [0, \alpha]$ denotes the upper and lower bounds of the random interval and captures the amount of uncertainty. The larger the value of the parameter ε, larger the interval of fluctuation of the potential scenarios and higher the uncertainty, and the opposite otherwise. This approach allows us to control for the level of uncertainty without affecting the mean or any other factor.

To supply the quantity q_i in the second stage, firm i must have previously invested in that capacity in the first stage. Otherwise, the production quantity q_i is not feasible. In this context, let the capacity investment be denoted by $\bar{q}_i$ with $q_i \leq \bar{q}_i$. Naturally, capacity building is costly. The total cost of the capacity investment is given by $k_i \bar{q}_i^{\,2}$ with the parameter $k_i \geq 0$ capturing for the unit cost of investment. In this paper, investment costs are considered sunk and irreversible, which is the most common assumption in the hospitality industry. However, some hospitality investments are heavily concentrated in physical assets, such as property, which are not entirely sunk and may constitute a significant share of the total investment (Butters & Hubbard, 2019; Hubbard & Mazzeo, 2019; Lee & Jang, 2012a). In this context, the degree of investment irreversibility can be represented by the investment cost parameter k_i, where a higher k_i indicates greater investment irreversibility, and a lower k_i suggests the opposite.

Note that the total cost of investment is quadratic to express that each additional unit is increasingly costly. This assumption is standard in the literature. In the tourism context, it expresses the scarcity of land, space, and resources. It is also connected with the idea that the returns to investment are decreasing. Nonetheless, the results in this paper hold true even if the investment cost is linear, i.e., under constant marginal cost of investment.

Note also that although tourism investments are fixed and cannot be relocated, this does not limit competition between geographically distant investments. For instance, a hotel in the Mediterranean coast of Spain competes with nearby hotels but also with other hotels in the Mediterranean coast of Greece or Italy, as some tourists have no specific preference over any of those location.

Given the uncertainty level ε, each hospitality firm $i = 1, \ldots, n$ aims to maximize the expected profit that is given by the following expression, as we will explain in more detail:

$$\pi_i = \int_{x_i^*}^{\alpha+\varepsilon} (x - c_i - \gamma \sum_{i=1}^{n} \bar{q}_i)\bar{q}_i \, dx + \int_{\alpha-\varepsilon}^{x_i^*} (x - c_i - \gamma \sum_{i=1}^{n} q_i) q_i \, dx - k_i \bar{q}_i^{\,2}. \quad (1)$$

Inside the two integrals, we have the revenue from sales net from the production cost. The marginal cost of production $c_i \geq 0$ is assumed constant. Note that the total cost of investment $k_i \bar{q}_i^{\,2}$ is outside the integrals because touristic firms incur on this cost independently of the realized demand.

In the first stage, hospitality firms must decide the optimal investment capacity $\bar{q}_i$ without knowing the realized demand x. They face the following trade-off. On the one hand, if ex-ante they invest less capacity than the ex-post realized demand, they risk not having enough capacity to satisfy the demand and miss potential bookings. This fact is expressed in the first integral component, that is, demand realizations in the interval $[x_i^*, \alpha + \varepsilon]$ correspond to situations for which the touristic firm ex-post supply is going to be restricted by the investment capacity, i.e., $q_i = \bar{q}_i$. In this case capacity and supply coincide. One the other hand, if the hospitality firm ex-ante invests more capacity than the ex-post realized demand, it risks not having enough demand to fill all rooms and accommodations and therefore having empty investments. This fact is expressed in the second integral component, that is, demand realizations in the interval $[\alpha - \varepsilon, x_i^*]$ correspond to situations for which the touristic firm ex-post supply is going to be unrestricted, i.e., $q_i < \bar{q}_i$. In this case, supply is below capacity.

3. Results

Following the model presentation, in this section we derive the main results of the paper. To do it, the first step is to identify the cut-off point x_i^* in expression (1) that separates between the over and under investment cases. In this context, note that at this cut-off point, we must have that $q_i{}^* = \bar{q}_i$. In other words, at this point bookings and available rooms and accommodations must be the same. Moreover, note that in the second stage, once uncertainty is resolved, if $x < x_i^*$ each touristic operator maximizes $(x - c_i - \gamma \sum_{i=1}^{n} q_i) q_i$ with respect to q_i because there are no supply restrictions.

Consequently, in the symmetric case, i.e., for $c_i = c$ and $k_i = k$ for all $i = 1, \dots, n$, we obtain $q_i^* \equiv q^* = (x - c)/(\gamma(n + 1))$ for $i = 1, \dots, n$. More formally, we have the following result:

Proposition 1: *In the symmetric case, i.e., for $c_i = c$ and $k_i = k$ for all $i = 1, \dots, n$, the second stage optimal supply is given by $q^* = (x - c)/(\gamma(n + 1))$ for $x < x_i^*$, and by $\bar{q}_i$ for $x \geq x_i^*$, where the optimal investment cutoff x_i^* solves $q^* = \bar{q}_i$, i.e., $x_i^* = c + \gamma(n + 1)\bar{q}_i$ for all $i = 1, \dots, n$.*

The proof of Proposition 1 follows from the preceding discussion. It is for that reason skipped.

Ex-post, when the realized demand parameter x is below the cut-off x_i^*, the hospitality firms face no capacity constraints and in equilibrium they will have empty rooms and accommodations. However, when the ex-post realized demand parameter x is above the cut-off x_i^*, the touristic firms face capacity constraints and in equilibrium they will have full booking. Consequently, the next step is to determine the ex-ante optimal capacity investment that takes into consideration these trade-offs.

Following backwards induction, given the expressions for x_i^* and $q_i^* \equiv q^*$, and the assumptions regarding the parameters' symmetry in Proposition 1, in the first stage each hospitality firm objective is to maximize the profit function:

$$\pi_i = \int_{c+\gamma(n+1)\bar{q}_i}^{\alpha+\varepsilon} (x - c - \gamma \textstyle\sum_{i=1}^{n} \bar{q}_i)\bar{q}_i \, dx + \int_{\alpha-\varepsilon}^{c+\gamma(n+1)\bar{q}_i} \frac{(x-c)^2}{\gamma(n+1)^2} dx - k\bar{q}_i^{\,2}, \qquad (2)$$

with respect to $\bar{q}_i$. Consequently, the solution of the first stage investment decision problem delivers the following result:

Proposition 2: *In the symmetric case, each hospitality firm optimal investment in capacity is given by:*

$$\bar{q}^* = \frac{(\alpha+\varepsilon-c)\gamma(n+1) + 4\varepsilon k - 2\sqrt{2\varepsilon k((\alpha+\varepsilon-c)\gamma(n+1) + 2\varepsilon k)}}{\gamma^2(n+1)^2}. \qquad (3)$$

Proof of Proposition 2: In order to prove this result simply differentiate the profit function (2) with respect to $\bar{q}_i$ for all $i = 1, \dots, n$, to obtain a system of n first order conditions. Subsequently, impose equilibrium symmetry, i.e., $\bar{q}_i = \bar{q}$ for all $i = 1, \dots, n$, and solve for $\bar{q}$ to obtain the expression of $\bar{q}^*$ given in equation (3). Finally, it is easy to show that the second order condition for a maximum is negative for any $n \geq 1$. ■

To summarize, at this point, we have characterized the hospitality firms' optimal investment capacity decision under uncertainty. In other words, we know the optimal capacity investment $\bar{q}^*$ is given by expression (3) in Proposition 2. Moreover, from Propositions 1 and 2, we know the value of the cut-off x^*, and that the equilibrium supply equals $q^* = \bar{q}^*$ if $x \geq x^*$, and equals $q^* < \bar{q}^*$ if $x < x^*$ as stated in Proposition 1.

The next step is to study the properties of the optimal investment capacity decision.

Proposition 3: *Each hospitality firm optimal investment in capacity $\bar{q}^*$ increases with:*

a) an increase in uncertainty (ε) for $\varepsilon > 2k(\alpha - c)/((1 + n + 2k)\gamma)$, and the opposite otherwise.
b) an increase in the expected market size (α).
c) a reduction in the cost of investment (k).
d) a reduction in the marginal cost of production (c).
e) a reduction in the number of firms (n).
f) a reduction in the price sensitivity (γ).

and the opposite otherwise.

Proof of Proposition 3: To prove this result simply differentiate the optimal investment expression (3) with respect to each of its parameters and verify the respective sign of the derivative to learn the relation between $\bar{q}^*$ and the parameter. Sign verification is more difficult in some cases than in others. For example, in Part a) the derivative of $\bar{q}^*$ with respect to ε, i.e., $d\bar{q}^*/d\varepsilon$, delivers a large expression, which after some algebra in both sides of the inequality are positive providing the inequality $\varepsilon(1+n+2k)\gamma > 2k(\alpha - c)$ holds true, and the opposite otherwise. The proof of the other cases goes along the same lines. The sign verification is simpler with exception of Part e) and f), i.e., the derivative of $\bar{q}^*$ with respect to n or γ, respectively. However, note the effect of these two parameters must be similar as they always appear together. Consequently, we can treat $\gamma(n+1)$ as if it is a single parameter. Consequently, after differentiating $\bar{q}^*$ with respect to $\gamma(n+1)$, we obtain, after some algebra in both sides of the inequality $d\bar{q}^*/d\big(\gamma(n+1)\big) < 0$, the following large expression:

$$\begin{aligned} 8\sqrt{2}(\varepsilon k)^2 + 3\sqrt{2}\varepsilon k(\alpha+\varepsilon-c)\gamma(n+1) \\ &< (\alpha+\varepsilon-c)\gamma(n+1)\sqrt{\varepsilon k\big((\alpha+\varepsilon-c)\gamma(n+1)+2\varepsilon k\big)} \\ &+ 8\varepsilon k\sqrt{\varepsilon k\big((\alpha+\varepsilon-c)\gamma(n+1)+2\varepsilon k\big)}. \end{aligned}$$

Subsequently, to get rid of the square roots, we square both sides and perform the necessary simplifications to obtain that $0 < ((\alpha+\varepsilon-c)\gamma(n+1))^3$, which is always true because $\alpha+\varepsilon > c$. Therefore, the derivative $d\bar{q}^*/d\big(\gamma(n+1)\big)$ is always negative, proving the result in Part e) and f). ■

Despite we are mostly interested in the relation between investment and uncertainty in Part a), Proposition 3 provide us with a series of results. The results obtained in Parts b) to f) of Proposition 3 show the consistency of the proposed modeling approach as they are in line with what we would expect. For instance, in Part b) states that as the expected market demand increases, so thus the tourism firm's willingness to invest. In other words, the larger the market size, the larger the investment in capacity, a result that is reasonable to expect. In Part c) when the cost of investment decreases, the firms' willingness to invest in capacity increases, because it becomes cheaper to invest. Note that in our framework capacity investments are considered sunk and irreversible. Nonetheless, the reversibility and liquidity of these investments could be captured through a lower cost of investment.

Similarly, but through a different mechanism, in Part d) a reduction in the production cost increases the firms' incentives to invest in capacity because it increases profitability, which is the strongest incentive behind capacity investment. In Part e), the effect of the number of firms on the firm's investment is also in line with what we should expect. That is, the larger the number of firms, the more competitive the market is. Therefore, lower the profitability, and consequently lower the incentives to invest in capacity. Finally, in Part f), the lower the price sensitivity of the demand to the quantities supplied, the more inelastic is the demand, and more needy or dependent are tourists from the hospitality goods. Consequently, the larger the supply side incentives to invest in capacity.

Now, let us focus on Part a) of Proposition 3 because our main objective is to study the effect of uncertainty on capacity investments and this relationship is not clear-cut. In normal circumstances we would expect investment to fall with uncertainty, and the higher the uncertainty, the more investment would fall. This is the most natural intuition. However, our results show this pattern is not always true in the hospitality industry where capacity investments require large investments that are decided and executed well before the demand is realized. This is particularly true in the hospitality industry in which investments are initiated more than a couple of years before the market demand is known.

Nonetheless, Part a) states that for sufficiently low levels of uncertainty, capacity investment would fall as expected, i.e., for $\varepsilon < 2k(\alpha - c)/((1 + n + 2k)\gamma)$, but for large levels of uncertainty we observe the opposite, investment increases with uncertainty, i.e., for $\varepsilon > 2k(\alpha - c)/((1 + n + 2k)\gamma)$. Being this cut-off point determined by the number of firms, the price sensitivity, the expected market size, and the investment and production costs.

The results in Part a) are illustrated in Figure 1 which shows a u-shaped relationship between capacity investments and uncertainty. In the example of this figure, it shows that when uncertainty is above $\varepsilon = 0.091$ (that is, when uncertainty is 9.1% of the expected demand) there is a positive relation between investment and uncertainty.

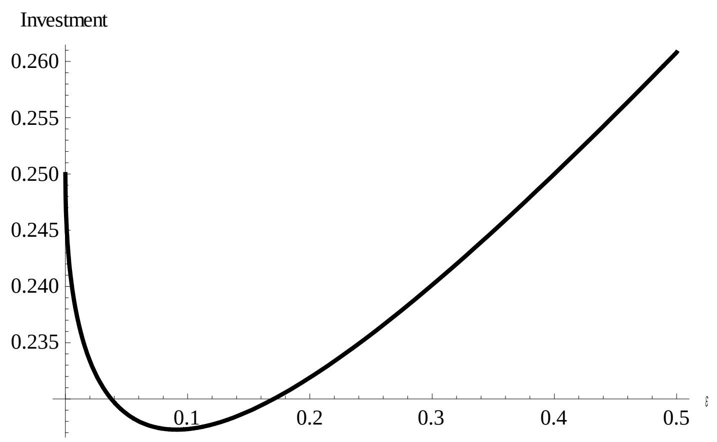

Figure 1: The u-shaped relation between investment and uncertainty ($\alpha = 1, n = 3, k = 0.2, c = 0, \gamma = 1$).

To understand the reason behind this surprising result, note that ex-post realizations of uncertainty might be favorable or unfavorable, but the hospitality capacity investments must be done earlier before these realizations are known. The number of available rooms and accommodation depends on investment decisions initiated, at least, a couple of years before. Consequently, in the event of a favorable ex-post scenario (i.e., a realized demand above expectation), the excess demand over the supply leads to an increase in hospitality prices, in part because the capacity decided ex-ante is lower than required ex-post, which restricts competition and leads to higher profits.

In our context, a competition restriction effect occurs when the realized demand is sufficiently large such that the previously made investments in capacity are not enough to satisfy the demand. Therefore, firms are restricted in terms of competition because even if they want to place more units or lower prices they cannot because they do not have those units. Paradoxically this ex-ante undesirable scenario is ex-post beneficial for the firms because prices and profits are going up.

On the other hand, in the event of an unfavorable ex-post scenario (i.e., a realized demand below expectation), in this case competition is not restricted by the investment capacity. Consequently, there is an excess supply over the demand, and the competition between hospitality firms pushes prices and profits down.

Therefore, in the hospitality industry, favorable and unfavorable scenarios are not symmetric in terms of gains and losses. Favorable scenarios under restricted capacity can be very profitable because of the lack of supply and the subsequent competition restriction effect. Consequently, when uncertainty is high, extremely favorable, and unfavorable scenarios become more likely, with the former positive effects more than compensating for the later negative effects. The implication of this observation is that investment may increase for high levels of uncertainty as hospitality firms try to obtain a larger share of those potential high profits, creating a surprising u-shaped relation between investment and uncertainty in touristic market as shown in Proposition 3 and illustrated in Figure 1. While surprising, this result conciliates different perspectives and evidence regarding the effects of uncertainty on capacity investment, that is, the negative perspective (Carruth et al., 2000; Demir et al., 2020; Khan et al., 2021; Koetse et al., 2009; Soni et al., 2023), and the positive perspective (Chen & Lin, 2013; deRoos, 1999; Grenadier, 1996; Lee & Jang, 2012b; Van Mieghem, 2003).

4. Further intuition and discussion

In order to improve our intuition, consider Figure 2, which illustrates the ex-ante expected profit (black curve), the ex-post realized profit (light gray curve), and the profit in the hypothetical case of firms being able to choose the investment capacity ex-post, i.e., after having observed the realized demand (gray curve), for varying realizations of the demand $x \in [0.5,1.5]$. The later gray curve is an interesting benchmark because it corresponds to the hypothetical no mismatch scenario.

In this example, the expected demand is $\alpha = 1$ and uncertainty is $\varepsilon = 0.5$. Therefore, $x \in [0.5,1)$ correspond to realizations of the demand below the expectation, while $x \in (1,1.5]$ correspond to realizations of the demand above the expectation.

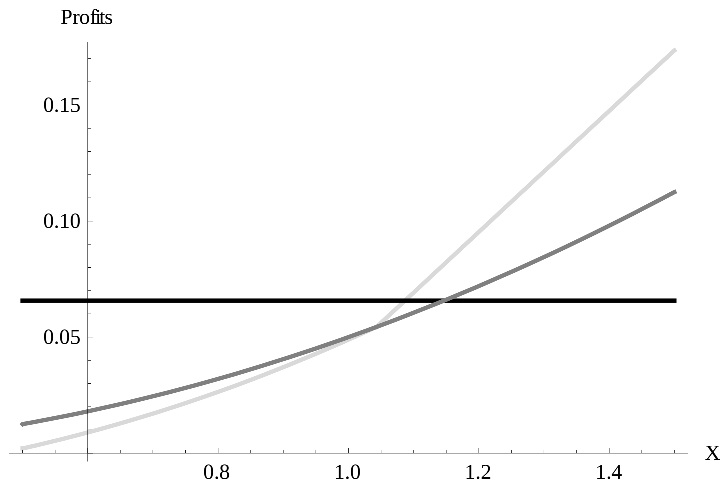

Figure 2: The ex-ante expected profit (black curve), the ex-post realized profits (light gray curve) and the profit in the hypothetical case of firms being able to choose the investment capacity ex-post (gray curve), for varying realizations of the demand $x \in [0.5,1.5]$ with cutoff at $x^* = 1.04$ ($\alpha = 1, n = 3, k = 0.2, c = 0, \gamma = 1, \varepsilon = 0.5$).

In what follows, we decompose the effect of uncertainty to gain a better understanding of the u-shape relation between investment and uncertainty.

The competition restriction effect – The competition restriction effect occurs when firms cannot increase their supply even if they would like to because of capacity constraints. Therefore, forcing them to keep the supply short and prices high. Using the information in Figure 2 we can build a numerical example that illustrates the competition restriction effect. For example, if the economy has experienced a better-than-expected realized demand of $x = 1.25$, then the ex-post profit would be 0.108 (see the light gray curve), which is higher than the ex-ante expected profit of 0.066 (see the black curve), and higher than the hypothetical profit of 0.078 (see the gray curve) in the case of firms being able to choose the investment capacity ex-post. This numerical example illustrates that the competition restriction effect induced by the ex-ante constrained capacity decision increases the theoretical profits from 0.078 to 0.108 in case of a better-than-expected realized demand of $x = 1.25$. While, in the opposite and symmetric unfavorable scenario of a worse-than-expected realized demand of $x = 0.75$ the difference between these two numbers is much smaller. See the distance between the gray and light gray curves at this point in Figure 2. Therefore, the asymmetry between favorable and unfavorable outcomes becomes stronger as we expand ε and allow more extreme scenarios to happen.

To further see this point, compare for example the extreme adverse realization of the demand $x = 0.5$ with the symmetric extreme favorable realization of the demand $x = 1.5$. In Figure 2 it is clear the distance between the gray and light gray curves is even larger. Therefore, the difference between actual and hypothetical profits increases in a very asymmetric way for more extreme realizations. Technically the explanation is in part due to the larger convexity of the ex-post realized profit function (gray curve in Figure 2) which the slopes become steeper after the cut-off point $x^* = 1.04$.

Consequently, when uncertainty increases, extreme realizations become more likely, and the profit asymmetry between adverse and favorable realization becomes more severe because of the competition restriction effect in favorable states. This argument is not true for less extreme realizations of x around $\alpha = 1$. For that reason, in those cases there is a negative relation between capacity investments and uncertainty that holds true for sufficiently low levels of uncertainty.

The strategic effect – Finally, to close the explanation for why capacity investments may increase with uncertainty note that there are greater profits in the favorable states compared to the unfavorable states. Therefore, we would expect hospitality firms to reduce their investments to potentiate the associated competition restriction effect and increase their ex-post potential profits. However, in a competitive and non-cooperative setting the opposite happens. Self-interested and strategic hospitality firms anticipate these potentially excessive profits associated with demand spikes and overinvest ex-ante to obtain a larger share of those profits. The effect is an increase in ex-ante investment for high uncertainty levels. This result helps to understand the phenomena of cyclical overbuilding episodes in touristic markets and the reason why hospitality investments tend to position on the overcapacity side rather than on the under-capacity side as reported in several studies (Chen & Lin, 2013; deRoos, 1999; Grenadier, 1996; Lee & Jang, 2012b; Van Mieghem, 2003; Woodworth & Mandelbaum, 2010).

What about the aggregate investment in capacity? - The following question we make is regarding the aggregate investment in capacity, which is the sum of the investment made by all firms in the market, i.e., $\bar{Q}^* = n\bar{q}^*$. Proposition 3 holds true for aggregate investment as well. In particular, the u-shaped relation between investment and uncertainty remains true. Figure 3 illustrates this point. Another interesting finding is that aggregate investment in capacity increases with the number of firms despite the increase in competition. Therefore, the larger the number of firms, the larger the ex-ante aggregate capacity investment (See Figure 3).

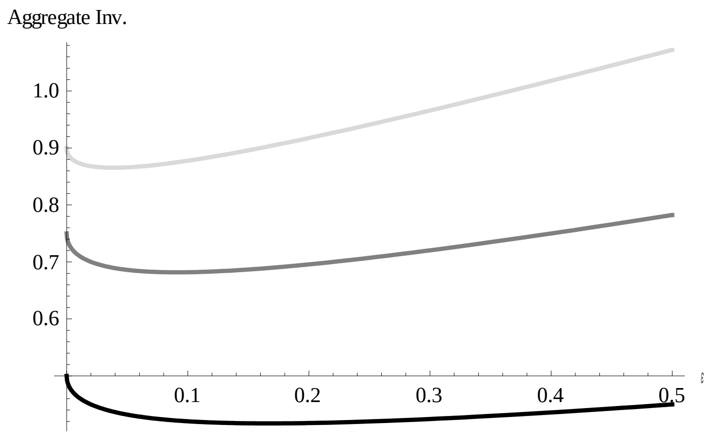

Figure 3: Aggregate capacity investment and the number of firms ($\alpha = 1, k = 0.2, c = 0, \gamma = 1$). Black curve $n = 1$ (monopoly), Gray curve $n = 3$, Light Gray $n = 9$.

In the limit, as the number of firms grow large, $n \to \infty$, i.e., in the perfect competitive case, despite that individual investment converges to zero, i.e., $\bar{q}^* \to 0$, the aggregate investment converges to $\bar{Q}^* \rightarrow (\alpha + \varepsilon - c)/\gamma$, which is a linear function of uncertainty. It means the u-shaped only vanishes in the limit. Therefore, the u-shaped relationship between capacity investment and uncertainty is particularly robust and remains true even in the monopolist case $n \rightarrow 1$ (See Figure 3).

5. Conclusion

This paper proposes a game-theoretical model of strategic competition and capacity investment to study the effect of uncertainty in touristic hospitality investment decisions. We found a puzzling u-shaped relation between capacity investment and uncertainty. In particular, the reason behind the increase in investment under uncertainty is that the ex-ante capacity investment restricts ex-post competition in favourable scenarios but not in unfavourable scenarios. This asymmetry increases the touristic operators ex-post profits in extreme favourable scenarios more than proportionally in comparison with extreme unfavourable scenarios. We call it *the competition restriction effect*. This asymmetric positive effect is particularly strong in the more extreme scenarios. Consequently, in competitive contexts, self-interested and strategic firms may overinvest in capacity ex-ante in order to obtain a larger ex-post share on those potential high profits. We call it *the strategic effect*. Altogether, the composition of these effects explains why for high levels of uncertainty there is a positive relationship between capacity investments and uncertainty, while for low levels of uncertainty we observe the opposite relationship (Carruth et al., 2000; Demir et al., 2020; Khan et al., 2021; Koetse et al., 2009; Soni et al., 2023). These results help us conciliate different literature perspectives on the relationship between capacity investments and uncertainty, and help us better understand observations specific to the tourism hospitality industry like the overbuilding tendency and the hotels systematic preference for overcapacity rather than under capacity (Chen & Lin, 2013; deRoos, 1999; Grenadier, 1996; Lee & Jang, 2012b; Van Mieghem, 2003; Woodworth & Mandelbaum, 2010).

The findings in this paper open new research avenues for the study of the relation between uncertainty and investment in the tourism hospitality industry. In particular, it offers a novel theoretical approach to a literature that is profoundly marked by applied and empirical approaches and by the lack data. In this context, it could be interesting to introduce other aspects specific to the tourism industry, not only from a theoretical but also from an applied and empiric standpoint, like seasonality distortions, minimum profitability scale, different types of risk aversion or different distributions of uncertainty. Nonetheless, we believe the obtained results are quite robust to those features. Similarly, a potentially interesting topic for further research could be the development a theoretical model featuring simultaneously investment and product differentiation under uncertainty, or even the possibility of investment reversibility in a more specific way. It is also likely that each type of uncertainty is specific and requires a different treatment. Supply side uncertainty may lead to different conclusion (Duro et al., 2023a; 2024).

To conclude, this paper provides a simple but intuitive approach to the problem of investment under uncertainty in tourism, but also in economics and business in general. Uncertainty in tourism has become an increasingly important issue since the Covid-19 pandemic. In this context, we hope our results can help researchers and decision-makers better understand non-standard patterns, like the u-shaped relationship found in this paper, and to better predict tourism market outcomes in contexts of uncertainty.

References

Ampountolas, A. (2019). Forecasting hotel demand uncertainty using time series Bayesian VAR models. *Tourism Economics*, *25*(5), 734-756.

Butters, R. A. (2020). Demand volatility, adjustment costs, and productivity: An examination of capacity utilization in hotels and airlines. *American Economic Journal: Microeconomics*, *12*(4), 1-44.

Butters, R. A., & Hubbard, T. N. (2023). Industry Structure, Segmentation, and Quality Competition in the US Hotel Industry. *The Journal of Industrial Economics*, *71*(2), 491-537.

Carruth, A., Dickerson, A., & Henley, A. (2000). What do we know about investment under uncertainty?. *Journal of Economic Surveys*, *14*(2), 119-154.

Chen, C. M., & Lin, Y. C. (2013). The influence of uncertain demand on hotel capacity. *International Journal of Hospitality Management*, *34*, 462-465.

Chen, C. M., & Yeh, C. Y. (2012). The causality examination between demand uncertainty and hotel failure: A case study of international tourist hotels in Taiwan. *International Journal of Hospitality Management*, *31*(4), 1045-1049.

Chiang, W. C., Chen, J. C., & Xu, X. (2007). An overview of research on revenue management: current issues and future research. *International Journal of Revenue Management*, *1*(1), 97-128.

De Frutos, M. A., & Fabra, N. (2011). Endogenous capacities and price competition: The role of demand uncertainty. *International Journal of Industrial Organization*, *29*(4), 399-411.

Demir, E., Gozgor, G., & Paramati, S. R. (2020). To what extend economic uncertainty effects tourism investments? Evidence from OECD and non-OECD economies. *Tourism Management Perspectives*, *36*, 100758.

deRoos, J. A. (1999). Natural occupancy rates and development gaps: A look at the US lodging industry. *Cornell Hotel and Restaurant Administration Quarterly*, *40*(2), 14-22.

Duro, J. A., Osório, A., Perez-Laborda, A. (2024). Modelling uncertainty in tourism markets. *Annals of Tourism Research*, Forthcoming.

Duro, J. A., Osório, A., Perez-Laborda, A. (2023a). Competition for domestic tourism in the COVID-19 pandemic: A characterization using a contest model. *Tourism Economics*, *29*, 378-391.

Duro, J. A., Osório, A., Pérez-Laborda, A., & Rosselló-Nadal, J. (2023b). Are destinations reverting to the pre-pandemic "normal"?. *Tourism Economics*, 13548166231204509.

Enz, C. A., Canina, L., & Lomanno, M. (2009). Competitive pricing decisions in uncertain times. *Cornell Hospitality Quarterly*, *50*(3), 325-341.

Gabszewicz, J. J., & Poddar, S. (1997). Demand fluctuations and capacity utilization under duopoly. *Economic Theory*, *10*, 131-146.

Gallagher, B., & Corgel, J. (2018). Natural occupancy shifts in hotel markets. *Cornell Hospitality Quarterly*, *59*(4), 352-363.

Gao, J., & Zhang, L. (2024). Climate policy uncertainty and corporate investment: evidence from the US tourism and hospitality sector. *Journal of Travel Research*, *63*(2), 517-530.

García-Gómez, C. D., Demir, E., Díez-Esteban, J. M., & Popesko, B. (2023). Investment inefficiency in the hospitality industry: The role of economic policy uncertainty. *Journal of Hospitality and Tourism Management*, *54,* 383-391.

Grenadier, S. R. (1996). The strategic exercise of options: Development cascades and overbuilding in real estate markets. *The Journal of Finance*, *51*(5), 1653-1679.

Grimm, V., & Zoettl, G. (2008). Strategic capacity choice under uncertainty: the impact of market structure on investment and welfare (No. 01/2008). IWQW Discussion Papers.

Hess, R., Liang, Y., & McAllister, R. (2001). An institutional perspective on hotel investing. *Real Estate Finance*, *18*(2), 51-61.

Hubbard, T. N., & Mazzeo, M. J. (2019). When demand increases cause shakeouts. *American Economic Journal: Microeconomics*, *11*(4), 216-249.

Hviid, M. (1991). Capacity constrained duopolies, uncertain demand and non-existence of pure strategy equilibria. *European Journal of Political Economy, 7*(2), 183-190.

Işık, C., Sirakaya-Turk, E., & Ongan, S. (2020). Testing the efficacy of the economic policy uncertainty index on tourism demand in USMCA: Theory and evidence. *Tourism Economics*, *26*(8), 1344-1357.

Kalnins, A., Froeb, L., & Tschantz, S. (2017). Can mergers increase output? Evidence from the lodging industry. *The RAND Journal of Economics*, *48*(1), 178-202.

Khan, K., Su, C. W., Xiao, Y. D., Zhu, H., & Zhang, X. (2021). Trends in tourism under economic uncertainty. *Tourism Economics*, *27*(4), 841-858.

Kim, H. J., Gursoy, D., & Lee, S. B. (2006). The impact of the 2002 World Cup on South Korea: Comparisons of pre-and post-games. *Tourism Management*, *27*(1), 86-96.

Koetse, M. J., de Groot, H. L., & Florax, R. J. (2009). A meta-analysis of the investment-uncertainty relationship. *Southern Economic Journal*, *76*(1), 283-306.

Kreps, D. M., & Scheinkman, J. A. (1983). Quantity precommitment and Bertrand competition yield Cournot outcomes. *The Bell Journal of Economics*, 326-337.

Lee, S. K., & Jang, S. S. (2012a). The real estate risk of hospitality firms: Examining stock-return sensitivity to property values. *International Journal of Hospitality Management*, *31*(3), 695-702.

Lee, S. K., & Jang, S. S. (2012b). Re-examining the overcapacity of the US lodging industry. *International Journal of Hospitality Management*, *31*(4), 1050-1058.

Leisten, M. (2020). Volatility, uncertainty, and hotel capacity. Northwestern University.

Miegham, J. A., & Dada, M. (1997). Capacity Investment under Demand Uncertainty: Price vs. Quantity Competition (No. 1204). Discussion Paper.

Newell, G., & Seabrook, R. (2006). Factors influencing hotel investment decision making. *Journal of Property Investment & Finance*, *24*(4), 279-294.

Nguyen, P. (2015). The Long-Run Supply of Real Estate: An empirical study into the UK hotel market 2003-2013. *Surrey Undergraduate Research Journal*, *1*(1).

Nguyen, P., Binh, P. T., & Su, T. D. (2023). Capital investment in tourism: a global investigation. *Tourism Planning & Development*, *20*(5), 805-831.

Nguyen, P., Thanh, S. D., & Nguyen, B. (2022). Economic uncertainty and tourism consumption. *Tourism Economics*, *28*(4), 920-941.

Park, S. (2025). The differential impact of origin and destination country uncertainty on international tourism. *Tourism Economics*, *0*(0).

Prayag, G. (2023). Tourism resilience in the 'new normal': Beyond jingle and jangle fallacies? *Journal of Hospitality and Tourism Management*, *54*, 513-520.

Reynolds, S. S., & Wilson, B. J. (2000). Bertrand–Edgeworth competition, demand uncertainty, and asymmetric outcomes. *Journal of economic theory*, *92*(1), 122-141.

Solberg, H. A., & Preuss, H. (2007). Major sport events and long-term tourism impacts. *Journal of Sport Management*, *21*(2), 213-234.

Soni, T. K., Singh, A., & Kaushal, V. (2023). Capital investments and firm characteristics: The moderating role of economic policy uncertainty in the hospitality sector. *International Journal of Hospitality Management*, *114*, 103562.

Van Mieghem, J. A. (2003). Commissioned paper: Capacity management, investment, and hedging: Review and recent developments. *Manufacturing & Service Operations Management*, *5*(4), 269-302.

Valadkhani, A. (2024). Investment sensitivity to market uncertainty in the travel and tourism sector. *Tourism Economics*, *30*(1), 236-254.

Williams, A. M., & Baláž, V. (2015). Tourism risk and uncertainty: Theoretical reflections. *Journal of Travel Research*, *54*(3), 271-287.

Woodworth, R. M., & Mandelbaum, R. (2010). Seventy-five years of US hotel revenues, expenses, and profits. *Cornell Hospitality Quarterly*, *51*(1), 20-26.

WTTC (2024). Travel & Tourism Economic Impact Factsheet 2024. World Travel & Tourism Council.