# Crowding type and price dynamics in tourism destination choice

**Online appendix**

# Introduction

The purpose of this online appendix is to provide detailed analysis to the results obtained in the companion paper.

This document has additional Figures and propositions than the paper, therefore the number of Figures and Propositions are not the same

The appendix is organized in 4 sections. In the next section the model is presented. In section three, the static analysis of the model is made, where important preliminary results are represented. In section four, additional information on the agent based model is presented.

# The Model

The model consists of *N* tourists and *R* resorts. There are type of tourists and types of resorts. and make a non-empty partition of the set N and R respectively, and all the subsets are pairwise disjoint. As an example, a market with a demand side composed by young and old tourists, and the supply side with beach and mountain type of resorts would be described by and respectively with and .

## Tourists’ characteristics

The preferences of a tourist for a resort have an individual and a social component. On the one hand every tourist has preference for one of the types of resorts. On the other hand, tourists prefer to meet other tourists like them at the resorts, therefore the more tourists of the same type are at a given resort, the higher the preference for that resort. Thus, the preference of the tourist by the resorts can be described by the following utility function

|  |  |  |
| --- | --- | --- |
|  |  | ( 1 ) |

The function captures the preference of the tourist for the type of the resort . Thus,

where is a function representing the preferred type of resort by the consumer *i* and is a function representing the type of the resort *e*.

The second and third terms of (1) represent the preference for crowding type. Thus, is the proportion of individuals of the same type as the visitor on destination and is the proportion of individuals in destination with a type different than . Finally, , and are the parameters of individual and social preferences.

Every tourist has an exogenous income , therefore the aggregate income is . Each tourist will choose the resort that offer the greater consumer surplus within the set of available resorts in his set of information.

Each resort *j* has a fix capacity , therefore the total number of tourists that the market can receive is . It is assumed that no one resort can supply the entire demand, i.e. .

There is no fix cost and the unitary cost of serving to each visitor is . This cost structure assumes that there are not scale economies, so that the price strategy of the resorts do not consider the reduction of average costs when they increase their capacity.

Assume that all the tourists have enough income to cover at least the unitary cost of every room, for .

The resorts use price to increase their profit which is given by

|  |  |  |
| --- | --- | --- |
|  |  | ( 2 ) |

where is the number of visitors attending the resort .

## Static analysis

In this section two simplified version of the model are explored. First, the behavior of the demand is analyzed, without considering the supply side. In this case it is show that type and social preferences generates a sorting as suggested in (Kuminoff et al., 2010). Second, the strategic behavior of the resorts is introduced, assuming that visitors have preferences for the type of hotel without social preferences. This version of the model is useful for showing that this simple version has very complicated characterization of the equilibrium.

### Characterization of the demand

Assume that every resort can satisfy any demand. In this setting a tourist decides using only the utility function defined in (1) without any other constraints. For simplicity, assume that tourists comparing resorts in pairs. In this model the process of decision is characterized by the following proposition:

**Proposition 1**: Suppose that a tourist *i* is making the decision between the resorts j and k. If the tourist has the utility function for the resorts defined by (1) and he uses and to make the decision between both of them, there are four cases to consider,

Case 1: and : the tourist selects the resort k whenever

Case 2: and : the tourist selects the resort k whenever

Case 3. and : the tourist selects the resort k whenever

Case 4: and : the tourist selects the resort k whenever

for and the proportion of tourists of the same type than *i* at the resorts j and k respectively.

The four cases of the proposition can be represented in Figure 1, where the combinations of crowding difference and price difference organize the cases.

The range of variation of is between -1 and 1, and the range of variation of is between and , where is the individual income of the tourists and is the unitary cost of production of all the resorts. The area of the rectangle represented in dotted line are all possible combinations of difference between types and prices between the two resorts.

**Figure 1: Tourist decision between two resorts**

|  |
| --- |
|  |
| Note: and is the income of the tourists and the marginal cost of the resorts j and k, with |
|  |

The four cases of the proposition are represented by the three parallel lines, and in each one of the cases a tourist will prefer the resort k to the resort j in the area represented by the intersection of prices and crowding that are in the rectangle toward the North-West of the lines in each case. The slope of the four lines is determined by the intensity of the social preferences .

When the ratio between intensity of the preference for a type of hotel and the crowding preferences is higher, i.e. increases, the set of combination of price difference and crowding difference that makes the tourist to change between different types of resorts is reduced. If , or , the shifts of the lines representing cases 3 and 4 show that tourists will select only the type of hotel that they like the most, without considering the type of crowding at the resort.

In the other extreme, when the crowding preferences are strong relative to the individual preference for a type of hotel, i.e. , the four cases collapse, and therefore small variations on the crowding types will make tourists switch between resorts.

### A single type of tourist and resort, without social preferences

In this version it is assumed that visitor do not have social preferences, i.e. and . and there is only one type of tourists within , i.e. . On the supply side there is only one type of resorts, i.e. and within the unique type, all the resorts have the same potential capacity of production . Moreover, we assume that in the economy there is availability for all the tourists, i.e. and that the income of every tourist is greater than the individual cost of each firm, i.e. .

Notice that given that , the competitive equilibrium price is

|  |  |  |
| --- | --- | --- |
|  |  | ( 3 ) |

and at the equilibrium price every resort sells all its potential capacity.

In this case it can be shown (see (Heymann et al., 2014)) that the competitive outcome is not a pure strategy Nash equilibrium and no price set by all firms can be a pure-strategy, symmetric Nash equilibrium if the demand is assumed to be a unit-elastic function. The demand side of the market acts in that paper non-strategically, as a single agent with a scaled-up version of the individual demand function. This result shows that, within very simple parameters of the model, resorts have no obvious procedure to find mutually consistent optimal prices. This is the case, even with agents having full information.

# Dynamic and Learning process

Time evolves in discrete periods as and in every period tourists try to buy the services of one of the R resorts. In every period, tourists collect information to select which resort to attend, and resorts revise their decision on price. Tourists and resorts have bounded rationality and limited information; therefore, a learning mechanism must be specified for the agents.

The bounded rationality on the tourist side means that tourist does not have all the information about the resorts in the market. This means that the model specify how tourist collect information about the resorts that exist in the market, and the crowding of each resort.

On the resort side, the bounded rationality means that they do not have information about neither the price nor the occupancy of the other resorts.

## Learning of the tourist

In every period, every tourist *i* selects a resort offering the maximum surplus () within his limited set of information about the available resorts. The set of resorts available for the tourist , is denoted as with . The resorts in comes from the experience of resorts that he visited before and from some exploration to collect information about new resorts. Collecting information requires an effort, therefore only a proportion of tourist add a new resort to their set in every period. The number of resorts that can be in is equal to . The tourist has limited information when and his information is complete when .

## Learning of the resorts

Firms decide in every period the price at which they will sell the available rooms at the resort. Due to its bounded rationality managers follow an heuristic to make their decision. Based on the results obtained in Heymann et al. 2014, as consequence of exploring the decisions of subjects in experiments of a Bertrand-Edgeworth market, the heuristic adopted is,

|  |  |  |
| --- | --- | --- |
|  |  | ( 4 ) |

where is the number of rooms occupied of the resort *j* at , is the capacity constraint of the resorts and and are behavioral parameters capturing the heuristic followed by the managers to update the prices. This heuristic attempt to keep the utilization of the resorts at full capacity, using price to attract customers.

## Dynamic

The interaction between the tourist and resorts is analyzed using a computational Agent Based Model. The timing is:

1. Parameters and initial conditions are established
2. Tourists get their exogenous income
3. Resorts update their prices for the new year
4. Tourists decide the resorts to visit during the current year
5. Repeat from 2, T times.

In the following paragraph, the activities happen in each one of the steps in the baseline model will be explained in detail.

### Step 1: Parameters and initial conditions

The set of parameters that must be specified for each simulation of the model are specified in Table 1. Those values specify the characteristics of the tourists, resorts, and market.

### Step 2: Income

Every tourist at the beginning of the year, receives an exogenous income. It is assumed that tourists do not have savings coming from the previous period, and there is no possibility of borrowing. Thus, the income in every period is given by and if it is not used, the income disappears for the next period.

### Step 3: Price updating

In every period all the resorts revise their prices according to the updating rule in (4). However, there are two extreme situations that are controlled. First, a resort can never set a price below their marginal cost and second the price can never be greater than the income of the tourists. The second condition assumes that resorts have the information about the income of the tourists.

### Step 4: Tourist decision

In every period, in a random sequence, all the tourists decide which resort to visit following these two steps:

1. every single tourist with a probability search for a new resort within all the available resorts R. If he finds a new resort he add into . If the number of resorts in is already *k*, he eliminates the less visited.
2. Every tourist orders according to the surplus

|  |  |  |
| --- | --- | --- |
|  |  | ( 5 ) |

all the resorts in set . He selects the resort that has the highest surplus with availble rooms

If within the set of information there is no resorts with available rooms, tourist stays at home.

# Analysis

The parameters explored with simulation are the considered to be the most important for describing the properties of the model. The study will be made with increasing complexity.

### One type of tourist and resort, without social preferences

The parameters are specified in Table 1. Using the diagram in Figure 1, there are no case 2, 3 and 4. The line representing case 1, is horizontal and equal to the x axis. Therefore the tourists decide where to stay according to the difference of price.

The allocation of surplus in this case is always the optimal, because the tourist can only visit the most preferred, and unique, type of resort. In this version of the model, the main interest is on the price dynamic.

**Table 1: Parameters for analyzing price dynamics**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Description** | **Value** |
| N | tourists | 20 |
| y | exogenous income | 1 |
| a | individual utility parameter | 1 |
| b | Preference for type alike | 0 |
| d | Intensity of refusal to other types | 0 |
|  | inertia degree | 0.5 |
| k | memory size | 2 |
|  | type of tourists | 1 |
| R | resorts | 2 |
|  | Resorts capacity | {(11,11)} |
|  | type of resorts | 1 |
|  | positive price adjustment | 0.02 |
|  | negative price adjustment | 0.02 |
|  | the initial price of all the resorts is |  |
|  | Distribution of type of resorts | {2} |
|  | Distribution of type of tourists | {20} |
|  | Preference of tourists |  |

Figure 2 shows that the value of the behavioral parameters and determines the price dynamic, and therefore the distribution of excedents between resorts and tourists. In the figure there are three simulations representing the combination of parameters, , and . In the three cases, the utility of the tourist is the maximum, because in this situation there is only one type of resort. However, the difference is in how the surplus is distributed between tourists and resorts.

**Figure 2: Effect of the behavioral parameters on the allocation**

|  |
| --- |
| Gráfico, Gráfico de líneas  Descripción generada automáticamente |
| Note: There are three combinations of lambda values. Excedent lplus=lminus is . Excedent lplus>lminus is and Excedent lplus<lminus is |

When the average price goes up therefore the excess of tourists is almost zero. When the average price goes down to the marginal cost therefore the excedent of tourists is the highest possible. Finally, when the average price is a value greater than the marginal cost, and that value depends on the initial prices.

Given that there is excess capacity, in this case with two resorts, when a resort does not have vacancies, the other resort has available rooms. Thus, one resort will increase the price in and the other will reduce it in . If the increasing step is higher, lower or equal than the decreasing step, the average price will increase, decrease or keep the same. This sequence is repeated until the limit of the budget constraint or the unitary cost is reached in the case of unequal ’s. These results can be summarized in the following proposition:

**Proposition 2**: When there is excess of capacity, with one type of resort i.e and one type of tourist i.e. , with , and no social preferences, the price dynamic depends on the behavioral parameters and the relationship can be described in three cases:

If the surplus is assigned to the resorts

If the surplus is assigned to the tourists

if the surplus is splitted between tourists and resorts.

It is interesting to note that in the experiments developed by (Heymann et al. 2014), the adjustment of parameters based on the behavior of the subjects in laboratories indicates that the most common situation is .

### Many type of tourists and resorts, without social preferences

In the following model, different types of tourists and resorts will be integrated but still maintaining the lack of social preferences by the tourist. In this case Figure 3 represents the possible responses of the consumer to the four cases of Proposition 1.

**Figure 3: Tourist decision between two resorts**

|  |
| --- |
|  |
| Note: and is the income of the tourists and the marginal cost of the resorts j and k, with |

Given that there are no social preferences, the cases are represented by horizontal lines. Values of to the north (south) of the lines in each cases, means that the tourist will (not) change the resort j for the resort k.

The simplest case is to assume that there are two types of resorts and two types of tourists. In Table 2 are specified the parameters of the simulations to be analyzed.

**Table 2: Parameters of the base line model**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Description** | **Value** |
| N | tourists | 20 |
| y | exogenous income | 1 |
| a | individual utility parameter | 1 |
| b | Preference for type alike | 0 |
| d | Intensity of refusal to other types | 0 |
|  | inertia degree | 0.5 |
| k | memory size | 2 |
|  | type of tourists | 2 |
| R | resorts | 2 |
|  | Resorts capacity | {(11),(11)} |
| c | unitary cost | 0.5 |
|  | type of resorts | 2 |
|  | positive price adjustment | 0.02 |
|  | negative price adjustment | 0.02 |
|  | the initial price of all the resorts is |  |
|  | Distribution of type of resorts | {1,1} |
|  | Distribution of type of tourists | {10,10} |
|  | Preference of tourists |  |

The vector of resort capacity specifies that there is only one resort of type 1 and one resort of type 2, and the capacity of each one of those resorts is 11.

Table 3 is a representation of the parameters that helps to understand the distribution of types and preference parameters, , y . In the first row of the table is specified the number of resorts and in the first column the number of tourists . There are two types of resorts, and there is one of each type and , and this is specified as . There are two types of tourists, and there are 10 of each one, so that and and that is specified as . The third row of the table specifies the preference of the tourists of type 1. Thus, 10 out of the 10 tourists prefer the type of resort 1. The fourth row of the table specifies the preference of the tourists of type 2; 10 out of the 10 tourists of type 2 prefer the resort of type 2. These preferences are specified as .

**Table 3: Types and preferences parameters**

|  |  |  |  |
| --- | --- | --- | --- |
|  | |  | |
|  |  |
|  |  | 10 | 0 |
|  | 0 | 10 |

The market in this case segregates the tourists in different resorts according to their preferences by the type of resorts and prices behave according to the prediction of Proposition 2.

The analysis of the model will be based on the welfare allocation, and price behavior produced by the market. The welfare will be measured with two indicators. On the one hand the aggregate utility of the tourists and on the other hand the consumer welfare of the tourist. The aggregate utility at the end of period t is the sum of the instantaneous utility obtained by the tourist in that period.

Where is the utility obtained by the agent of type i as consequence of staying at the hotel at time t. The optimal aggregate allocation of utility at any period of time is given by

This measure is used as the benchmark of optimality. Therefore, a measure of the quality of the allocation in a period t is

This ratio can vary in the range of . When , the allocation of aggregate utility is optimal, whereas any value of represents a misallocation of utility.

The welfare of the tourists in any period t is represented by

The optimal benchmark for the welfare of the tourist is the allocation made discounting the cost of the firms. This is

Where is the unitary cost of the resort e, visited by the tourist at time t.

Therefore, the measure of allocation to be used will be,

Notice that can be any value in the range . When it represents the best allocation of welfare in the market, whereas represents that all the welfare of the market was taken by the resorts.

Stochasticity affects in two ways the results of the model. First of all, it affects the order in which tourists are called to choose the resort they will visit in each period. Second, it also affects the probability with which tourists search for new resorts from the list of available resorts in every period. The purpose of randomization of the moment of decision by tourists is to prevent any tourist from having an advantage by always deciding first, so it does not affect the results of the model. The second use of stochasticity affects the transition dynamic of the model, because it increases the exploration of the tourists. Both cases do not require to carry out studies of Monte Carlo in order to describe the final allocation of the market.

**Figure 4: Dynamic of the base line model**

|  |  |
| --- | --- |
|  |  |
| 1. Aggregate Utility and Excedent | 1. Price evolution |
| Note: The allocation of aggregate utility is measures at the left axis of the figure (a). The allocation of aggregate excedent of the tourist is shown at the right axis of the figure (a). The price evolution is shown for the two firms of the base line parameters in (b). | |

Figure 4 represents the evolution of the relative aggregate utility , the relative tourist surplus or excedent of the tourists and the price of the two resorts of the baseline model. All the plots confirm the prediction. After periods the tourists visit their prefered resorts, i.e. , and given that there is excess of capacity within every type of resorts, the exceeding is for the tourist i.e. and the prices in the market are close to the variable cost .

These results are modified if the resort's capacity is lower than market demand. In this case, , but and the prices in the market are . The results of this simulation help in two dimensions: First, it shows that just looking at the plot (a) of the figure is possible to understand the evolution of prices. Furthermore, unless there is an interest in showing special behaviors in the transition dynamics, it is possible to express the allocation of surplus made by a simulation only showing the final value of and . Second, it shows that if the preference of the tourists does not have social preferences and resorts capacity constraint is (not) enough to satisfy all the tourist that prefer them, and there is only one resort of each type, the tourist (resorts) obtain all tourists exceeding and the aggregate utility is the optimal one.

### Many type of tourists and resorts, without social preferences and with competition

Suppose that it is introduced competition within a type of resorts, according to the parameters in Table 4, that shows only the changes on to the baseline model.

**Table 4: Values of the parameters**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Description** | **Value** |
| R | resorts | 3 |
|  | Resorts capacity | {(5,6),(11)} |

In this case, even though the total capacity for the resorts of type 1 is still 11, now this capacity is divided between two resorts: one with capacity for 5, and the other for 6 tourists. In Figure 5 is a representation of the results of a simulation with two aspects which are worth pointing out. First, even when the aggregate utility is close to the maximum, the surplus or excedent of the tourists has decreased. This result is counterintuitive because if there exists excess supply, the prices should go down to the unitary cost, so that the excedent of the tourists should be the highest possible.

The difference is that now there is competition for the tourist of the type 1, and there is no tourist allocation between the two resorts that makes them believe mutually that there is an excess of supply all the time. Indeed, within each type of resorts there is a competition of the Bertrand-Edgeworth type, and this leads to the Edgeworth cycles on the segment where the two resorts are competing because the behavioral parameters are equal.

Notice that the dynamic within the type of tourists 1 and the type of tourist 2 is independent of each other. Indeed, it can be said that within the market of resorts, there are submarkets which are independent. This result is sustained on the basis of the parameters selected for the model, and they are summarized in the following proposition.

**Figure 5: Competition for one type of tourist**

|  |  |
| --- | --- |
|  |  |
| 1. Aggregate Utility and Excedent | 1. Price evolution |
| Note: The allocation of aggregate utility is measures at the left axis of the figure (a). The allocation of aggregate excedent of the tourist is shown at the right axis of the figure (a). The price evolution is shown for the two firms of the base line parameters in (b). There is no need at this point of identification of the firms. | |

**Proposition 3**: if the preference of tourists has no social considerations, i.e. ( and there is more than one type of resorts i.e. , the market is divided in submarkets or niches, where the allocation of surplus between tourists and resorts has different degrees of independence according to price variations given by the following cases:

Case 1: Complete independency: , and ,

Case 2: Partial independency: , and ,

for any pair of resorts where is the price of a resort preferred by tourist i, the price of a non-preferred resort and is the income of the tourists.

Case 1 represents a situation of complete independence where each submarket behaves as anticipated in Proposition 3 because the resorts of different types are not substitute.

In Case 2, there is some degree of substitution between the submarkets, and the allocation of surplus depends on the capacity and behavioral parameters as follows

Case 2.1: there is excess capacity in all the submarkets and or .

Case 2.2: there is excess capacity in all the submarkets and . In this case, the submarkets are interdependent and Figure 6 shows how the interdependencies work.

**Figure 6: Submarket allocation for Case 2.2 Proposition 3**

|  |  |
| --- | --- |
|  |  |
| 1. Aggregate Utility and Excedent | 1. Price evolution |
| Note: The allocation of aggregate utility is measures at the left axis of the figure (a). The allocation of aggregate excedent of the tourist is shown at the right axis of the figure (a). The price evolution is shown for the two firms of the base line parameters in (b). There is no need at this point of identification of the firms. | |

This simulation was run during T=300 periods with the following modification as compared to the base line parameters. Notice that in the submarket 1 there are two resorts, with excess of capacity. The two resorts have capacity for 11 tourists and there are only 10 tourists that prefer the type 1 resorts. In the submarket 2, there is only one resort with capacity for 11 tourists and with 10 tourists that prefer the resort of type 2. (See table 5)

**Table 5: Values of the parameters**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Description** | **Value** |
| y | Income | 2 |
| R | resorts | 3 |
|  | Resorts capacity | {(5,6),(11)} |
|  | Positive price adjustment | 0.04 |

The results represented in Figure 6 show three regimes. (i) The first regime is from the period 0 to almost the period 100. In this regime the dynamic of Proposition 3 in submarket 1 applies. In submarket 1, the price increase with Bertrand-Edgeworth cycles. In submarket 2, the price remains close to the marginal cost because it can never fulfill the capacity of the unique resort. (ii) the second regime is from almost period 100 to period 150. In this regime, the prices of submarket 1 are so high that tourists of type 1 decide to stay in the resort of type 2. This produces two effects. On the one hand, figure (b) shows that the capacity of the resort in the submarket 2 is fulfilled, and as consequence the price of the submarket 1 increases. On the other hand, figure (a) shows that there are some tourists of type 1, which are selecting the resort of type 2. This produces a decrease in the aggregate utility. The third regime (iii) is from almost period 150 onwards, where the prices in the submarket 1 cannot continue to grow because it faces the budget constraint, and that also affects the price in submarket 2. The two submarkets remains coupled, with some tourists that randomly switch from their most preferred hotel, to the most convenient one and that explains the variation of in figure (a).

### Many type of tourists and resorts, with social preferences and competition

Social preferences are represented by the preference that tourists of one type have for tourists of his same type, and the aversion for tourists who are not the same type. In order to keep the model simple, the paper focus in the case where and are the same for all the tourists.

**Table 6: Model with Social Preferences**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Description** | **Value** |
| N | tourists | 20 |
| y | exogenous income | 1 |
| a | individual utility parameter | 1 |
| b | Preference for type alike | 1 |
| d | Intensity of refusal to other types | 1 |
|  | inertia degree | 0.5 |
| k | memory size | 2 |
|  | type of tourists | 1 |
| R | resorts | 2 |
|  | Resorts capacity | {(11,11)} |
|  | type of resorts | 2 |
|  | positive price adjustment | 0.02 |
|  | negative price adjustment | 0.02 |
|  | the initial price of all the resorts is |  |
|  | Distribution of type of resorts | {1,1} |
|  | Distribution of type of tourists | {10,10} |
|  | Preference of tourists |  |

Table 6 shows the parameters for studying the allocation of surplus when tourists have preferences for crowding. Table 3 summarize the types and number of resorts and tourists and Figure 1, of Proposition 1 explains how tourists make the choice when they compare two reseorts.

The price dynamic in this setting is dominated by the excess of supply, therefore the price of the two resorts will decrease toward marginal cost. This means that the difference in price between the two firms is not important. The initial condition of the market distributes the tourists randomly between the two resorts. This means that in the initial conditions is close to zero. It is useful to have Figure 1 as a reference to explain the results. Notice that in this setting , so if the initial conditions make the market will allocate the tourist to their most individually preferred resort because is to the left of the line of Case 3, and to the right of the line of Case 4. Therefore, considering the price dynamic and the surplus allocation the distribution of welfare that this market make is and .

The dynamic becomes more interesting when there is competition in one of the submarkets. Thus, in Table 7 are specified the parameters modified compared to the parameter space of Table 6.

**Table 7: Values of the parameters**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Description** | **Value** |
| y | Income | 2 |
| R | resorts | 3 |
|  | Resorts capacity | {(5,6),(11)} |
|  | Positive price adjustment | 0.04 |

From Proposition 2 in the submarket of resorts of type 1 the price will grow and the excess of capacity in the submarket of type 2 will make price to be equal to the marginal cost.

Figure 7 shows the evolution of the market during T=1000 periods. The initial distribution of tourists in this case is that all the tourists are in the resorts where they would like to be if they would decide looking only at their individual preferences.

**Figure 7: Model with Social Preference**

|  |  |
| --- | --- |
|  |  |
| 1. Aggregate Utility and Excedent | 1. Price evolution |
| Note: The allocation of aggregate utility is measures at the left axis of the figure (a). The allocation of aggregate excedent of the tourist is shown at the right axis of the figure (a). The price evolution is shown for the two firms of the base line parameters in (b). There is no need at this point of identification of the firms. | |

In the figure it is possible to appreciate the interaction between the two submarkets. During the first 230 periods, all the tourists are in the resort where they would prefer to be, but given that the price of the submarket of type 1 is increasing, the excedent of the tourists is decreasing as well. See figure (a) and (b).

After the period 230, the price in the submarket 1 is so high that tourists of type 1 prefer to stay at the resorts of type 2. This originates an excess of demand in submarket 2 resulting in a price increase in this market. When the price difference between submarket 2 and 1 is reduced, the tourist returns to their individually preferred hotel, and the dynamics start over again.

The result is that there is a cyclical dynamic affecting the allocation of surpluses of the market, with tourists changing the type of hotel that they visit.

This dynamic is the same independently of the initial distribution of tourists. However the allocation of excedent of the tourist and utility is affected depending on the preference of the tourist.

Table 8 shows an exploration of the allocation of utility and surplus made by the market starting from different individual preferences.

**Table 8: Allocation of Utility and Excedent according to Individual Preferences**

|  |  |  |
| --- | --- | --- |
| **Individual Preferences of Tourists** | **Utility** | **Excedent** |
| {(10,0); (0,10)} | 0.84 (0.004) | 0.25 (0.002) |
| {(8,2); (2,8)} | 0.82 (0.0002) | 0 (0) |
| {(5,5); (5,5)} | 0.82 (0.0001) | 0 (0) |
| {(2,8); (8,2)} | 0.84 (0.0001) | 0 (0) |
| {(0,10); (10,0)} | 0.85 (0.006) | 0.26 (0.002) |

In the first column is represented the distribution of preference of tourists. The second column represents the average utility allocation made during the last 50 periods of a simulation during T=500 periods. Formally, . The third column represents the average excedent of the tourists obtained during the last 50 periods. Formally . In each cell, Monte Carlo simulations for 300 repetitions were made.

In the first row, the first distribution is the case where the 10 tourists of type 1 have the individual preference for the resorts of type 1, and the 10 tourists of type 2 has the preference for resorts of type 2. The second column of the first row shows that the utility reaches 84% of the best utility allocation, and within parenthesis is the variance across the 300 repetitions. The third column shows that the excedent of the tourist is 25% out of the best possible excedent that the tourist could get. This low excedent means that the prices in the two submarkets grow above the maximum utility level of the tourists.

# References

Abrate, G., & Viglia, G. (2016). Strategic and tactical price decisions in hotel revenue management. *Tourism Management*, 55, 123-132.

Alvarez, E., & Brida, J. G. (2019a). An Agent-Based Model of Tourism Destinations Choice. *International Journal of Tourism Research* 21(2): 145–55.

Alvarez, E., & Brida, J. G. (2019b). What about the others? Consensus and equilibria in the presence of self-interest and conformity in social groups. *Physica A: Statistical Mechanics and its Applications*, *518*, 285-298.

Amelung, B., Student, J., Nicholls, S., Lamers, M., Baggio, R., Boavida-Portugal, I., & Balbi, S. (2016). The value of agent-based modelling for assessing tourism–environment interactions in the Anthropocene. *Current Opinion in Environmental Sustainability*, 23, 46-53.

Arenoe, B., van der Rest, J. P. I., & Kattuman, P. (2015). Game theoretic pricing models in hotel revenue management: An equilibrium choice-based conjoint analysis approach. *Tourism Management*, 51, 96-102.

Baggio, R. (2008). Symptoms of complexity in a tourism system. *Tourism Analysis,* 13(1), 1-20.

Brida, J. G., Faias, M., Pinto, A., & Such, M. J. (2010). Strategic choice in tourism with differentiated crowding types. *Economics Bulletin, 30*(2), 1509–1515.

Brida, J.G., Faias, M., Pinto, A. and Such, M.J. (2011). A Tourist’s Choice Model. Chapter 10 (pp. 159-167) in the book *Dynamics, Games and Science II*. DYNA 2008, in Honor of MaurícioPeixoto and David Rand, University of Minho, Braga, Portugal, September 8-12, 2008. Series: Springer Proceedings in Mathematics, Vol. 1. Peixoto, Maurício Matos; Pinto, Alberto Adrego; Rand, David A. (Eds.) 1st Edition, 809 p., Hardcover ISBN: 978-3-642-11455-6.

Butler, R. W. (1980). The concept of a tourist area cycle of evolution: Implications for management of resources. *The Canadian Geographer/Le Géographe Canadien, 24*(1), 5–12.

Cartwright, E., & Wooders, M. (2001). On the theory of equalizing differences; increasing abundances of types of workers may increase their earnings. *Economics Bulletin*, 4(4), 1–10.

Conley, J. P., & Wooders, M. (1996). Taste‐homogeneity of optimal jurisdictions in a Tiebout economy with crowding types and endogenous educational investment choices. *Ricerche Economiche*, 50(4), 367–387.

Conley, J. P., & Wooders, M. H. (1998). Anonymous Lindahl pricing in a Tiebout economy with crowding types. *Canadian Journal of Economics*, 31(4), 952–974.

Claver-Cortés, E., Molina-Azorín, J. F., & Pereira-Moliner, J. (2007). Competitiveness in Mass Tourism. *Annals of Tourism Research* 34(3): 727–45.

Cui, Y. G., Kim, J., Choi, C., Lee, S. J., & Marshall, R. (2020). The influence of preciseness of price information on the travel option choice. Tourism Management, 79, 104012.

Diamantopoulos, A. (1991). Pricing: theory and evidence e a literature review. In M. J. Baker (Ed.), Perspectives on Marketing Management. Chicester: John Wiley and Sons.

Epstein, J. M., & Axtell, R. (1996). Growing artificial societies: social science from the bottom up. Brookings Institution Press.

Fodness, D. (2016). The problematic nature of sustainable tourism: Some implications for planners and managers. Current Issues in Tourism, 20(16), 1671-1683.

Guo, X., Ling, L., Dong, Y., & Lian, L. (2013). Cooperation contract in tourism supply chains: the optimal pricing strategy of hotels for cooperative third party strategic websites. Annals of Tourism Research, 41(2), 20-41.

Gursoy, D., Chen, J. S., & Chi, C. G. (2014). Theoretical examination of destination loyalty formation. International Journal of Contemporary Hospitality Management 26(5), 809–827.

Harper, D. A., & Lewis, P. (2012). New perspectives on emergence in economics. Journal of Economic Behavior and Organization, 82(2), 329-337.

Heymann, D., E. Kawamura, R. Perazzo, & M. G. Zimmermann (2014). Behavioral Heuristics and Market Patterns in a Bertrand-Edgeworth Game. Journal of Economic Behavior and Organization 105: 124–39.

Johnson, P., Nicholls, S., Student, J., Amelung, B., Baggio, R., Balbi, S., & Steiger, R. (2017). Easing the adoption of agent‐based modelling (ABM) in tourism research. *Current Issues in Tourism*, 20(8), 801–808.

Keane, M. J. (1997). Quality and pricing in tourism destinations. *Annals of Tourism Research*, 24(1), 117-130.

Kets, W. (2012). Learning with Fixed Rules: The Minority Game. *Journal of Economic Surveys* 26(5): 865–78.

Kim, S., Slutsky, S. M., & Thapa, B. (2020). Optimal Information-Sharing Behaviors among Hotels: Game-Theoretical Approach. Journal of Hospitality & Tourism Research, 1096348020936358.

Kuminoff, Nicolai V, V Kerry Smith, and Christopher Timmins (2010). The New Economics of Equilibrium Sorting and Its Transformational Role for Policy Evaluation. *Journal of Economic Literature* 51(4): 105. <http://www.nber.org/papers/w16349>.

Macal, C. M. (2016). Everything you need to know about agent-based modelling and simulation. *Journal of Simulation*, 10(2), 144-156.

Mao, I. Y., and Zhang, H. Q. Structural relationships among destination preference, satisfaction and loyalty in Chinese tourists to Australia*. International Journal of Tourism Research* 16.2 (2014): 201-208.

Martin, C. (1997). Price formation in an open economy: theory and evidence for the United Kingdom, 1951–1991. *The Economic Journal*, 107(444), 1391-1404.

Maskin, B Y E., & Jean Tirole, J. (1988). A Theory of Dynamic Oligopoly, II : Price Competition , Kinked Demand Curves , and Edgeworth Cycles. Econometrica 56(3): 571–99.

Mauri, A. G., Sainaghi, R., & Viglia, G. (2019). The use of differential pricing in tourism and hospitality. In Strategic perspectives in destination marketing (pp. 113-142). IGI Global.

Nicholls, S., Amelung, B., & Student, J. (2016). Agent‐based modeling: A powerful tool for tourism researchers. Journal of Travel Research, 56(1), 3–15.

Sasidevan, V., & Dhar, D. (2014). Strategy switches and co-action equilibria in a minority game. Physica A: Statistical Mechanics and its Applications, 402, 306-317.

Schulze, J., Müller, B., Groeneveld, J., & Grimm, V. (2017). Agent-based modelling of social-ecological systems: achievements, challenges, and a way forward. Journal of Artificial Societies and Social Simulation, 20(2).

Sun, C. J. (2017). Dynamic price dispersion in Bertrand–Edgeworth competition. International Journal of Game Theory, 46(1), 235-261.

Viglia, G., & Dolnicar, S. (2020). A review of experiments in tourism and hospitality. Annals of Tourism Research, 80, 102858.

Yang, S., Huang, G. Q., Song, H., & Liang, L. (2008). A game-theoretic approach to choice of profit and revenue maximization strategies in tourism supply chains for package holidays. Journal of China Tourism Research, 4(1), 45-60.

Zhao, Z., Chen, M. H., Su, C. H. J., & Tian, L. (2020). Asymmetric price responses to hotel competition caused by heterogeneous customers’ willingness to pay. International Journal of Hospitality Management, 90, 102409.