Differentiation in the tourist sector: an evolutionary analysis

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Abstract

In the debate on the sustainability of a mass tourism development strategy in the medium and long run of a given destination, it has been widely defended the convenience of shifting the pattern of specialization towards higher quality standards. However, little and limited theoretical analysis exists to support this idea. This paper proposes an alternative approach through an evolutionary agent based model technique. Departing from different initial configurations in the distribution of hotel qualities and varying levels of saturation of the destiny, different equilibrium configurations can be obtained. It is found that, in general, high and low quality segments coexist, and that the level of saturation of a given destination crucially determines the weight of the different quality segments. High quality expands as do tourism activities of a particular destination but only until a maximum level beyond which the destination degrades dramatically.
JEL Codes: C63, D43, L13, L83.

Introduction

A great deal of classical literature of tourism economy provides arguments to the debate about the sustainability of the mature tourist destinations. Most of them, point out the convenience of shifting the pattern of specialization towards a higher quality standard

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(Butler, 1980; Butler, 1997; Cooper, 1997). An argument supporting this view relates the number of arrivals to the level of congestion, the use and abuse of natural resources, and also the pattern of specialization. It is argued that a mass tourism development strategy usually means low quality services and, as a consequence, the need of maintaining low prices and costs, consequently depending on a large number of visitors. At the same time, a high quality tourism development strategy requires competition based on differentiation and innovation, higher prices and a lower number of tourists. Aguiló, Alegre and Sard (2005) argue, among others, that the high quality tourism development strategy offers a larger potential for sustaining growth in the long run.

While the previous topic has been widely discussed in the tourism literature, little examples of theoretical work exist, and they mostly use a partial analysis framework (see, for example, Garcia and Tugores, 2006). However, one of the shortcomings of a purely microeconomic approach to the analysis of the above problem is the fact that models yield no analytical solutions as more elements are included in the analysis. The inclusion of dynamics through various periods in the decision-making process and the inclusion of the spatial component might be two crucial elements in analyzing the specialization strategy in the tourism sector. However, the inclusion of such elements in a vertical differentiation model of imperfect competition with a large number of establishments prevents an analytical closed form result.

To overcome these common limitations of traditional economic models while maintaining a reasonable enough theoretical framework, economists have recently begun to employ other approaches. In particular, evolutionary approaches have been developed, many times based on adaptive learning optimisation mechanisms (Sargent, 1993). The most popular of these is probably the genetic algorithms (GA).

With evolutionary approaches, and when the comparison is possible, emerging equilibria are many times close enough to their counterparts in standard analytical analysis. Furthermore, this technique has some advantages that need to be remarked. First, it might more accurately resemble actual economic decision making of agents, compared to more traditional optimisation methods, and they are particularly convenient when choices occur in a decentralized way. Second, GAs have the capacity to solve highly dimensional optimisation problems without (necessarily) closed-form solutions in an efficient, reliable way. Finally, GAs could also be used to decide between alternative solutions, in case of traditional models that feature multiple equilibria.

The adaptation theory behind genetic algorithms was proposed initially by Holland (1975), although the systematisation of its methodological elements is due to Goldberg (1989). Genetic algorithms have been used in different areas of specialization of the economic literature: public economics, allocation of resources, environmental decisions, etc. However, research in industrial economics and, particularly, in tourism economics has so far made relatively little use of GAs. Few contributions could be founded related to the tourism industry: the paper of Hurley et al. (1998), with specific reference to the tourism marketing, and the papers of Hernández-López (2004, 2007) and Chen and Wang (2007), devoted to tourism demand forecasting.

Genetic algorithms mimic some of the processes of natural evolution and selection. In nature each species needs to adapt to a complicated and changing environment in order to maximize the likelihood of its survival. The knowledge that each species gains is encoded in its chromosomes, which undergo transformations when reproduction occurs. Over time, these changes to the chromosomes give rise to the propagation of individuals and species that are more likely to survive, according to a performance function, and so have a greater chance of passing on their improved characteristics to future generations. Of course, not all plausible changes are beneficial, but those which are not tend to die out as the success rate of the affected individuals worsens.

The basic idea of genetic algorithms when applied to an industry is the same (Yildizoglu, 2002). Firms proceed in a way in which adopted new strategies are necessarily based on past experience. Firms combine known decision rules to reach better ones in order to maximize their profits and, in the medium and long run, also in order to survive, of course, taking into account the changing environment in which they work. GA allows for the implementation of such a learning process through evolutionary mechanisms: from a population of actual decision rules, the selection keeps the best ones.

There are several reasons for emphasizing the dynamic evolution of an economy specialized in tourist activities, such as the hotel services sector. Fist, because the genetic algorithm describes the learning and evolution process undergone by the hotels, in which profits are determined. Hotels must decide their competition strategy, either based on price competition or rather based on quality differentiation. Of course one strategy decision could be changed in the future after a learning process. And second, because it takes into account the environment in which hotels take their competition decisions. The spatial proximity of hotels (firms) might play a major role in competition, especially when hotels compete for a local resource. It can generate negative externalities in the form of congestion but, more directly, it makes prices to go down as the number of direct competitors increases. And finally, the introduction of spatial aspects admits the study of the relationship between the tourism industry and the stock of natural resources that involves their location.

The present paper is the first step in the application of genetic algorithms to the analysis of vertical differentiation in the tourism industry. Our artificial agents are firms devoted to the provision of tourist services. Hotels with different quality level coexist at the initial phase. The average level of profits obtained by hotels diminish as more economic activity in the sector takes place, and is related as well to the pattern of specialization. It will be assumed that the ultimate objective of hotels is to maximize profits, and that they adjust their strategy choice in the short run by imitating (some of) the characteristics of their most successful neighbour competitors, with the aim of increasing their profits.

The paper organizes as follows. The following section deals with the description of the methodology used and the description of the market framework in which hotels with different categories compete. Special emphasis is placed on the economic explanations that drive the model parametrization. Section 3 shows the results obtained, making particular reference to the way in which the tourism destination level of saturation and the starting hotel structure affect the final hotel distribution in terms of quality differentiation and profit achievement. Section 4 outlines the main results when performing sensitivity with respect to the parameters' values, and section 5 summarizes the main conclusions of the paper. Finally, the appendix provides some more detailed tables of results.

The model: an evolutionary differentiation analysis

The market conditions

The tourism industry is many times said to follow a monopolistic competition structure (Fish, (1982), among others), in the sense that many suppliers are present, and that each of them offer a slightly different product, partially substitutable. In our analysis, the tourism industry is assumed to be represented by two types of agents, or hotels, vertically differentiated. These agents will be modelled as artificial agents. Two distinct quality levels exist, high and low (denoted by H and L, respectively), and each hotel is initially endowed with a particular exogenous quality. In subsequent periods, hotels can choose to be either in the high or the low quality segments, evolving over time according to certain rules, explained below. Belonging to one or another segment has consequences in terms of revenues and costs.

Each hotel is assumed to offer 1 unit of tourism service. Operating costs are different and, following Porter (1981), higher for larger qualities. Thus, $C_H > C_L$, and both are considered as constant.

Global Effects Scenario

In the simplest framework, the revenues obtained by firms depend on the aggregate supply. Prices are the same for all firms in the same quality segment, and are given by the following inverse demand functions:

$$p_H = A_H - \alpha_H m_H - \alpha_L m_L$$
$$p_L = A_L - \beta_H m_H - \beta_L m_L .$$

The constants A_H and A_L denote the maximum willingness to pay to start the consumption of 1 unit of high and low tourism service, respectively. Variables m_H and m_L represent the total supply of high and low quality units, in our setting equal to the number of hotels in the high and the low quality segment. The parameters α_H and β_H

indicate how an extra high quality hotel contributes to the decrease of the prices in the high and the low quality segments. Likewise, α_L and β_L measure the negative impact on prices of a unit increase in the low quality supply. As long as these parameters are positive, cross effects occur between different quality segments, and a certain degree of substitutability is assumed.

Some further restrictions are imposed on the values these parameters can take. First, it is logically assumed that $A_H > A_L$, since people would show a preference towards quality, other things being equal[1]. Second, inequalities $\alpha_H > \alpha_L$ and $\beta_H < \beta_L$ should apply, since a direct competitor exerts a larger negative impact on price that an imperfectly substitutable one. If lower qualities imply less differentiated and more standardized goods, then it can be safely assumed that $\beta_L > \alpha_H$, thus indicating that an increase in the quantity supplied has a more acute impact on low quality prices[2]. Finally, and following a similar line of reasoning, cross-price elasticity should be smaller with more differentiated products[3], and then $\alpha_L < \beta_H$. Summarizing, the values of the parameters should reflect the following inequalities:

$$\beta_L > \alpha_H > \beta_H > \alpha_L.$$

The resulting profits for firms belonging to each segment can be written as:

$$\begin{aligned} \Pi_H &= A_H - \alpha_H m_H - \alpha_L m_L - C_H \\ \Pi_L &= A_L - \beta_H m_H - \beta_L m_L - C_L. \end{aligned} \qquad (1)$$

The spatial structure

In this paper hotels enjoy a particular location in a lattice of side *n*. As a result our lattice has a total of n^2 available spaces, resembling a square. Each location can be occupied by a high quality hotel, a low quality one, or could be unoccupied. Given any particular initial configuration of the lattice, prices and profits can be calculated for any hotel according to its differentiation conditions.

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1 See Shaked and Sutton (1982).

2 Following Chamberlin (1933), more differentiation implies a lower price elasticity of demand. And Capó, J. et al. (2007) show that the hotel category is clearly related with the number of services and the differentiation of the product provided by those hotels, in the sense that more stars implies a more differentiated tourism product.

3 See Triffin (1940).

It is assumed that hotels can adopt the strategies of those other agents considered as neighbours. One straightforward way of defining a neighbourhood is by means of a torus. A torus is a two dimensional lattice whose corners are pasted together to ensure that all cells are connected, so that there are no edge effects. In this case, an agent's neighbours are, for example, those to the west, east, north and south, and thus a particular agent can have up to 4 neighbours as a maximum. For example, the neighbours of the hotel located in row 2 and column 10, $\{2,10\}$, would be those located in $\{2,9\}$ $\{2,1\}$, $\{1,10\}$ and $\{3,10\}$. If any of these particular locations happened to be empty, then the number of neighbours would be less than 4.

Local Effects Scenario

The fact that tourism establishments have a spatial dimension calls for the consideration of the competitors' location when calculating profits. It seems reasonable to consider that a close competitor more intensely degrades prices than another located further apart. The corresponding profit functions could be rewritten as follows:

$$\Pi_H^{\{i,j\}} = \left[A_H - \alpha_H (m_H - m_H(i,j)) - \alpha_L (m_L - m_L(i,j)) - \phi_H m_H(i,j) - \phi_L m_L(i,j)\right] - C_H$$
$$\Pi_L^{\{i,j\}} = \left[A_L - \beta_H (m_H - m_H(i,j)) - \beta_L (m_L - m_L(i,j)) - \delta_H m_H(i,j) - \delta_L m_L(i,j)\right] - C_L.$$

In the above expressions, the superscript $\{i,j\}$ refers to the hotel located in row i and column j in the grid. Let $m_H(i,j)$ and $m_L(i,j)$ denote the number of hotels in the high and low quality segments, respectively, surrounding that particular hotel. The formulas express that the negative impact on price of close competitors differs, and for this reason different parameters have been included. As long as local competition is more aggressive, the inequalities $\phi_H > \alpha_H$, $\phi_L > \alpha_L$, $\delta_H > \beta_H$ and $\delta_L > \beta_L$ hold.

Given the particular neighbourhood of a hotel, it can now happen that firms belonging to the same category attain a different level of profits because of the local competition conditions they are faced with. This latter instance is not possible under the global effects scenario.

Replicator dynamics

An element of an evolutionary analysis is the replicator dynamics. This describes when, how and why agents might change strategies. For instance, in Sethi and Somanathan (1996), where an evolutionary common-pool resource game is analyzed, agents are assumed to be able to observe their own profits and the average profits in the population, before guiding their decisions on change of strategies. We instead make the assumption that agents are only able to observe the payoffs of agents in their neighbourhood, including themselves. This rule permits the consideration of bounded rationality in the decision making process of firms, in the sense that hotels do not possess all of the information but only that which occurs close enough. At the same time, decisions can be understood to be taken on a short-run basis.

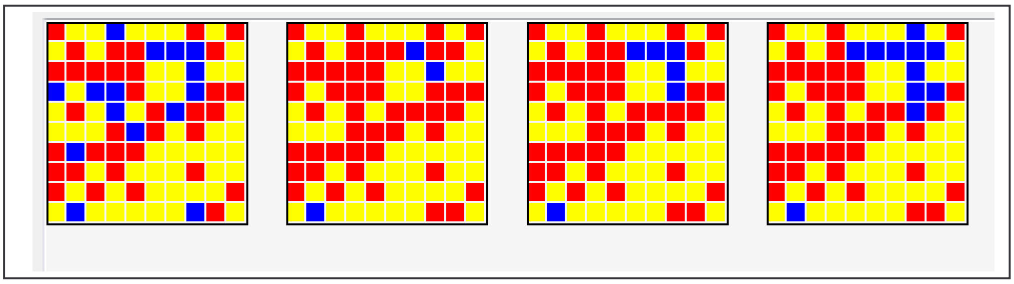
After observing profits, hotels decide on whether to keep or to change their quality supply. Different situations can take place. If the own strategy yields the largest profit in the neighbourhood, it is kept; if a larger profit can be achieved either by changing or by keeping the strategy, there is a 0.5 probability of change; and finally, a change occurs when the alternative strategy outperforms the own. Changes are however restricted when the shift goes from the low to the high quality segment. Such upgrade is costly, as new investments or some other adaptation would take place. This cost is denoted by $C_{UPGRADE}$.

Differentiation over time

The dynamic structure of the evolutionary analysis goes as follows. First, an initial population of hotels is created. The total number of firms might be any number below, n^2 distributed between the high and low quality segments. Different percentages of occupation of the lattice will be considered, to capture whether competition is fierce or not. Varying differentiation distributions will be considered, as well, depending on the presence of high and low quality hotels in the initial setting. In the first period, the particular location of hotels over the grid randomly takes places.

Profits for each particular hotel can be computed, depending on whether global or local effects are considered, and for particular values of the parameters. Hotels decide to keep or change their strategy according to the replicator dynamics explained above. After all changes have occurred, the second generation of hotels is created, and the same steps are followed. Convergence to a particular distribution of hotels in the lattice is achieved when no change occurs from one generation to the next. This final stable generation summarizes the equilibrium outcome of the evolutionary analysis. An illustration of a particular round in which the hotels' generation evolve from a randomly drawn initial distribution appears in Box 1.

Box 1.



In the picture, unoccupied spaces are represented with the yellow colour, high quality hotels are depicted in red, and blue represent the low quality ones. As the box shows, in the initial generation there is a 50% occupation of the lattice, and for occupied spaces, 35 cells correspond to high quality hotels and 15 to low. It takes four generations to attain a convergence equilibrium, in which the final number of high and low quality hotels is 39 and 11, respectively.

In order to obtain somehow more general results from the proposed evolutionary analysis, each exercise is repeated a number of times, and the average outcome results are then computed. In particular, simulations of 500 rounds of the hotels' differentiation evolution process are carried out for varying initial conditions. These include varying degrees of occupation of the lattice (ranging from 100 to 10 per cent) and varying distributions of hotels between the high and low quality segments, among other.

Values of parameters

Results of the simulations performed will be summarized in the following section. A summary of the values of the parameters employed to carry out the computation of profits is provided in Table 1.

Table 1. Values of parameters for the numerical computations ($n = 10$)

	Demand functions					*Costs*	
HIGH	$A_H = 34$	$\alpha_H = 0.5$	$\alpha_L = 0.1$	$\phi_H = 2\alpha_H$	$\phi_L = 2\alpha_L$	$C_H = 4$	
LOW	$A_H = 30$	$\beta_H = 0.2$	$\beta_L = 1$	$\delta_H = 2\beta_H$	$\delta_L = 2\beta_L$	$C_H = 2$	$C_{UPGRADE} = 2$

The dimension of the lattice is $n = 10$. The values of the parameters included in the inverse demand functions are in line with the theoretical considerations discussed above. Close competitors duplicate the negative impact of another hotel on prices, as compared to non-neighbours. With respect to costs, the chosen values reflect the relative difference between high and low, as estimated by a Balearic Hotel Survey (2008). As an aside, let us add that the values of the parameters have been chosen so that profits erode as more competition exists, and in particular, they become null for intermediate values of occupation of the lattice. In particular, without local effects, and when all hotels belong to the high quality segment, profits are zero when 60 establishments exist; when only low quality hotels exist, this number reduces to 28[4]. The evolutionary game and the simulations have been developed with the software Visual Studio.

Simulation results

The main results of the simulations that summarise the analysis of the hotel market with different vertical differentiation strategies are shown in the appendix. The main conclusion is that, in general, independently of the original differentiation structure and the level of saturation of the destination, the high and the low quality segments coexist, which clearly means that the existence of different quality hotel services is a market equilibrium. There are instances, though, in which one of the segments disappears at some particular rounds of the simulation. Of course, the degree of incidence of the high and low hotel categories depend on different elements included in the model. Here we explain and depict the most important features that are worth mentioning.

4 This hypothesis is consistent with the relationship found by Silva (2010) between the vertical differentiation and profitability of the Spanish hotel sector.

Percentage of high category hotels depending on the level of saturation, for different initial quality shares

Figure 1. % High category hotels depending on saturation. Initial distribution 20%H-80%L

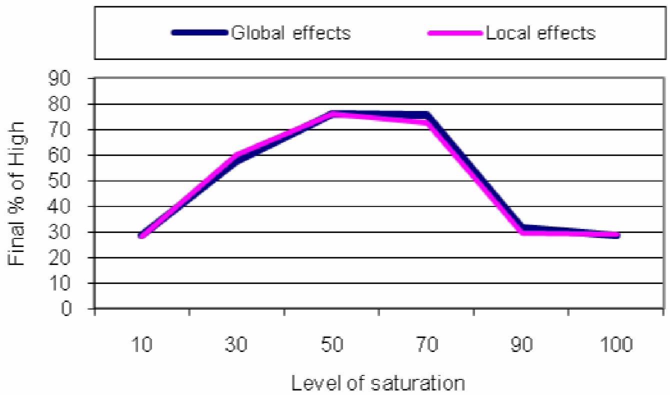


Figure 2. % High category hotels depending saturation . Initial distribution 50%H-50%L

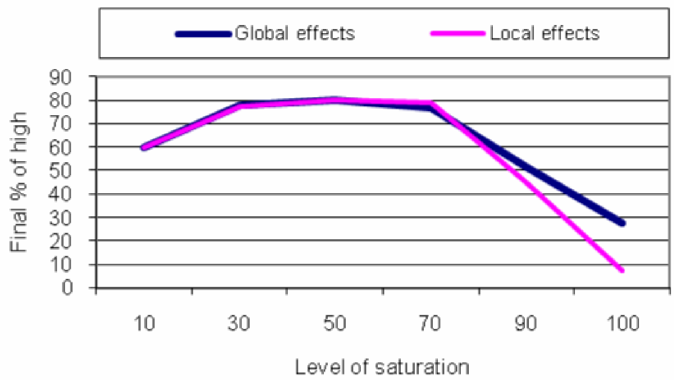
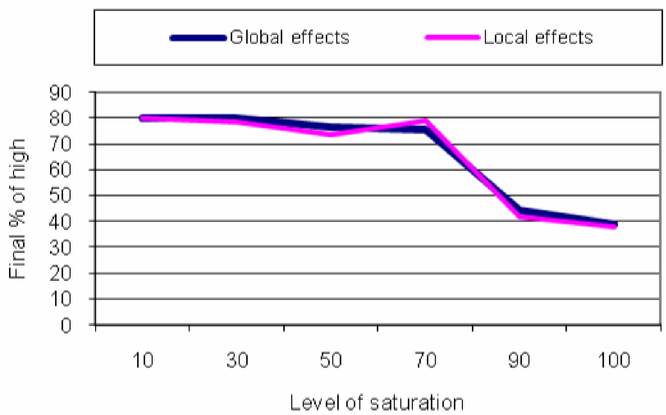


Figure 3. % High category hotels depending on saturation. Initial distribution 80%H-20%L



Level of saturation

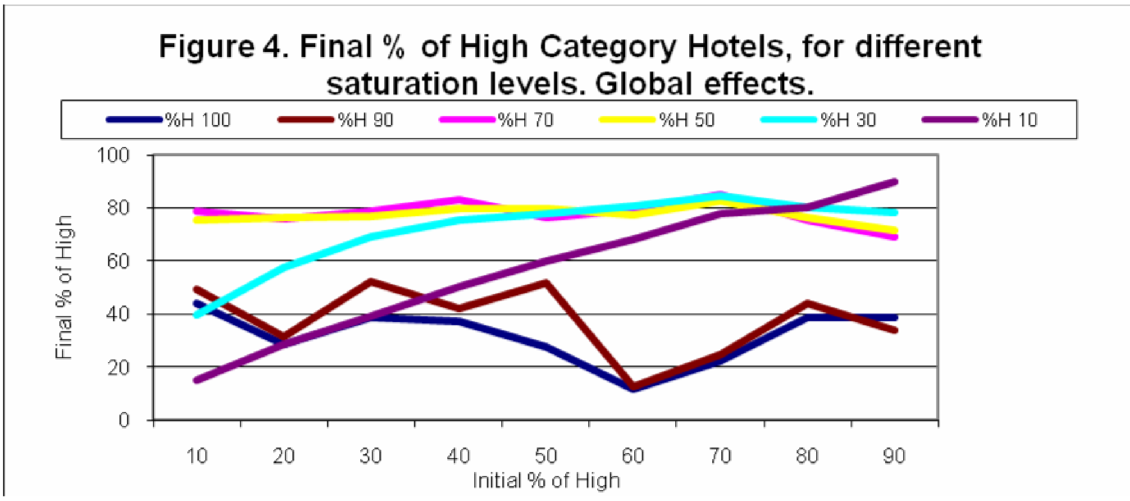
The level of saturation, understood as the share of cells of the lattice that are occupied by hotels, clearly affects the long run equilibrium differentiation strategy. The greatest the level of saturation of a given destination, the highest the bet for high quality, up to a threshold congestion point beyond which the destination "degrades" and the equilibrium quality of tourism services falls dramatically. In our model this pattern occurs, independently of the starting hotel market structure, when the level of saturation reaches more that 70% of the total lattice. That is, saturation encourages differentiation through high quality hotel services till a maximum level beyond which the hotel service is no longer worth the effort-improvement. This result is absolutely coherent with the idea of running a mature tourism destination, with a relevant level of saturation, towards the high quality differentiation strategy that has been defended in the classical tourism literature. But at the same time, it also points out that this strategy has a limit. For a large enough saturation the path towards the destination equilibrium leads to specialize in low quality hotel services.

The previous result is illustrated in figures 1 to 3 above. They plot the final equilibrium shares of high quality hotels against different saturation levels (as a percentage of the total lattice), both when considering global and local effects. Each figure corresponds to a different initial distribution between the high and low quality segments.

Initial distribution of hotel categories

Comparing figures 1, 2 and 3 it can also be concluded that different initial structures of the hotel industry lead to small differences when the saturation level is medium or high. Differences are particularly relevant, however, when the level of saturation is low. Thus, for low saturation levels, if the first generation incorporates a high weight of low-quality hotels, the final equilibrium market structure will mostly be composed of low-level hotels, while if high quality hotels are a majority at the beginning, the market equilibrium will retain a similar structure. That is, when saturation is low the baseline hotel structure greatly affects the equilibrium outcome.

Take for instance, the percentage of saturation of 10 per cent. The final share of high category considerably changes: approximately 30 per cent when the initial share is 20; it goes to about 60 per cent when starting at 50 per cent; and it ends in the range of 90 per cent when the initial share is 80. In short, the starting structure is highly relevant in those tourism destinations showing a low level of saturation. By contrast, if saturation is medium or high the starting distribution is not that determining. The equilibrium market structure is more stable.

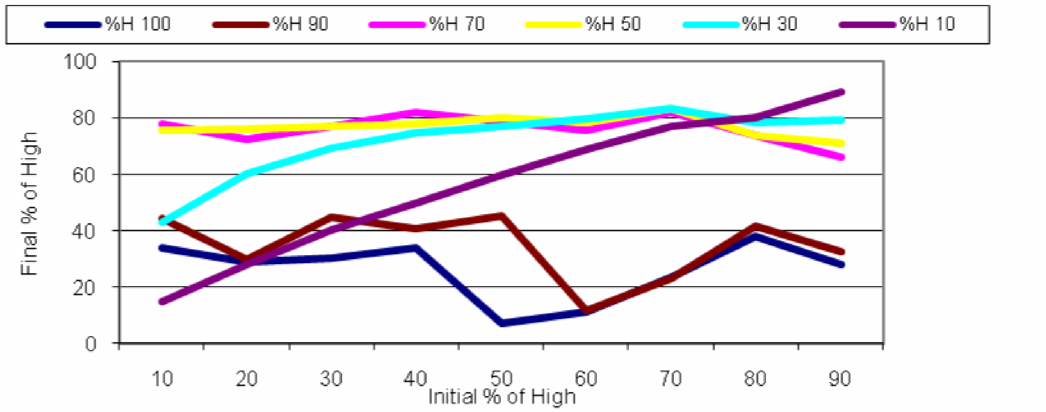


Figures 4 and 5 allow us to analyze better the effect of the initial distribution of hotel categories on the results, both with and without local effects. In those figures, each colour represents a given saturation level. When there is little activity in the industry compared to the potential (say 10 per cent), the final high quality share increases as its initial share does so, as shown by the positive slope of the purple line. Something similar happens for the 30 per cent saturation level, but only until the initial high quality is around 70 per cent. Intermediate saturation levels (50 and 70 per cent) give rise to a distribution of qualities in which the high quality segment stabilizes around 80 per cent, regardless of the initial configuration. However, larger saturation levels lead to much more erratic relationships between the initial and final high shares, and also the final percentage of high category establishments significantly decreases.

Local effects

It is shown that the inclusion of local effects slightly affects the equilibrium hotel structure. In general, there is a similar pattern but with a weight of high category hotels slightly lower in the case where local effects are included, especially for really high saturation levels Thus, if the level of congestion is 90% or 100% in a given destination, having direct competitors in the nearby hotels, creating fierce competition, makes prices fall down and, as a consequence, makes it more difficult for the differentiation in high category hotels to persist, since it requires higher prices to be profitable.

Figure 5. Final % of High Category Hotels, for different saturation levels. Local effects.



Profits

Table 2 shows the average profits by hotel and category hotel based on the tourism destination level of congestion and hotel starting structure. As leading to losses, the high levels of congestion (90% and 100%) have not been included. Of course, the comparative importance of these profits is strictly qualitative. As expected, it is found that the level of saturation adversely affects the profits for both types, high and low category hotels. It can also be observed that, broadly speaking, the starting level is relevant for profit achievement, so that, the lower the initial number of hotels in a particular category tends to be, the lower the average profits reached. This effect occurs in hotels of high and low category, and the impact is larger the lower the level of saturation of the tourism destination.

Table 2. Average profits by hotel, per category. Global effects.

%H/%L	10%-90%		30%-70%		50%-50%		70%-30%		90%-10%	
% lattice	H	L	H	L	H	L	H	L	H	L
70	1,00	1,99	0,92	2,17	1,55	0,90	-0,78	5,56	3,60	-3,21
50	9,82	8,35	9,57	8,86	9,59	8,83	8,33	11,13	9,39	9,22
30	22,19	7,62	18,79	14,42	17,64	16,72	16,76	18,34	17,47	17,06
10	28,42	19,15	27,43	21,13	26,58	22,84	25,92	24,21	25,40	25,20

With regard to differences on average profits between different hotel categories, we may note that there is no clear pattern, so that in some cases, high category hotels get better results and in some other cases, results are just the opposite. However, it can be said that, consistent with empirical evidence, in a larger number of occasions to be a high category hotel establishment is on average more profitable than being a low category hotel.

Table 3. Average profits by hotel. Global effects.

%H/%L % lattice	10%-90%	30%-70%	50%-50%	70%-30%	90%-10%
70	1,215	1,180	1,398	0,175	1,510
50	9,357	9,295	9,205	8,371	8,989
30	12,6	17,118	17,395	16,85	17,318
10	20,409	23,477	24,996	25,461	25,38

Finally, Table 3 summarizes the average profit per hotel (including both high and low category), it being clear that it is greater the lower the level of saturation. Instead, the way in which the hotel starting structure affects the average profits of the hotel industry does not follow any evident pattern.

Generations and convergence

In each round, agents were allowed to adjust their strategy for a maximum number of periods, initially established at 30. The average number of generations required to achieve convergence is always below this number, but still there are cases in which convergence is not attained. As general remarks, convergence takes place rather quickly for low and high saturation levels, and takes longer for intermediate degrees of saturation.

Table 4. Percentage of convergence, for different saturation levels. Global Effects.

	Level of saturation (in percentage)					
Initial % High	10%	30%	50%	70%	90%	100%
10%	100	100	80,6	31,6	100	100
20%	100	100	72,6	26,6	100	100
30%	100	99,8	62,4	37,2	98,6	100
40%	100	99	48,2	10,4	99,2	100
50%	100	96	43,8	28,6	100	100
60%	100	96,32	61,4	36,4	100	100
70%	100	99,6	75,4	56,4	100	100
80%	100	100	60,2	40,4	100	100
90%	100	87,2	19,2	0,8	97,2	100

Table 4 shows the percentage of rounds for which convergence is achieved, for different saturation levels and varying initial distributions. For instance, the lowest convergence rate occurs when saturation is at 70 per cent and the initial share of the high segment is at 90 per cent. The number reflects that out of the 500 rounds performed in the simulation, only 4 lead to convergence. Whenever this is the case, the percentage of high quality hotels oscillates between two values in nearly all instances. When recalculating results by forcing the end of the round at a different generation (say 29), results in general do not change much, except for particular points. Figure 6 below shows, for the 70 per cent saturation scenario, how the final presence of the high category segment would be affected.

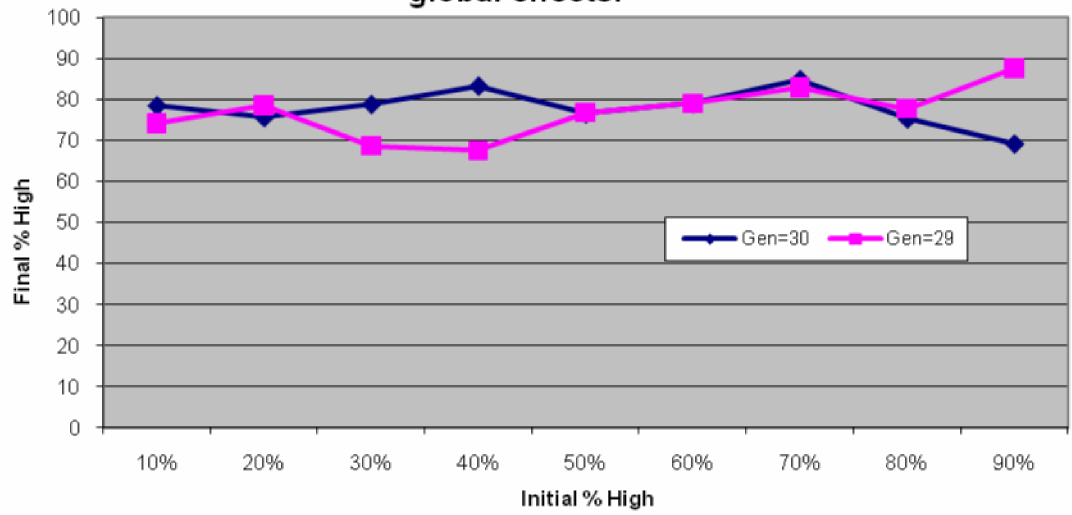


Figure 6. Final % of High Category Hotels, in terms of maximum number of generations. Saturation of 70%, global effects.

When considering local effects, the number of generations needed to converge in most cases increases. Numbers rather close to 30 are found with local effects and a level of saturation of 70 per cent, this suggesting again that in many instances equilibrium is not achieved. Although, again, in most of the cases, the percentage of high quality hotels oscillates between two values and recalculating results by forcing the end of the round at a different generation, in general, do not change much the results.

Sensitivity analysis

This section provides the results of a sensitivity analysis performed with respect to the parameter values so far used, in order to gain some insight on the influence of each on the simulation results suggested above. The analysis is carried out by changing the values of one parameter at a time, keeping the remaining ones at the levels exposed in table 1 above. In particular, we have considered alternative values for the upgrade cost faced by low quality hotels, and for all the parameters included in the inversed demand functions, ultimately affecting the payoffs that drive strategy changes. In all instances, the conditions summarized in $\beta_L > \alpha_H > \beta_H > \alpha_L$ have been respected.

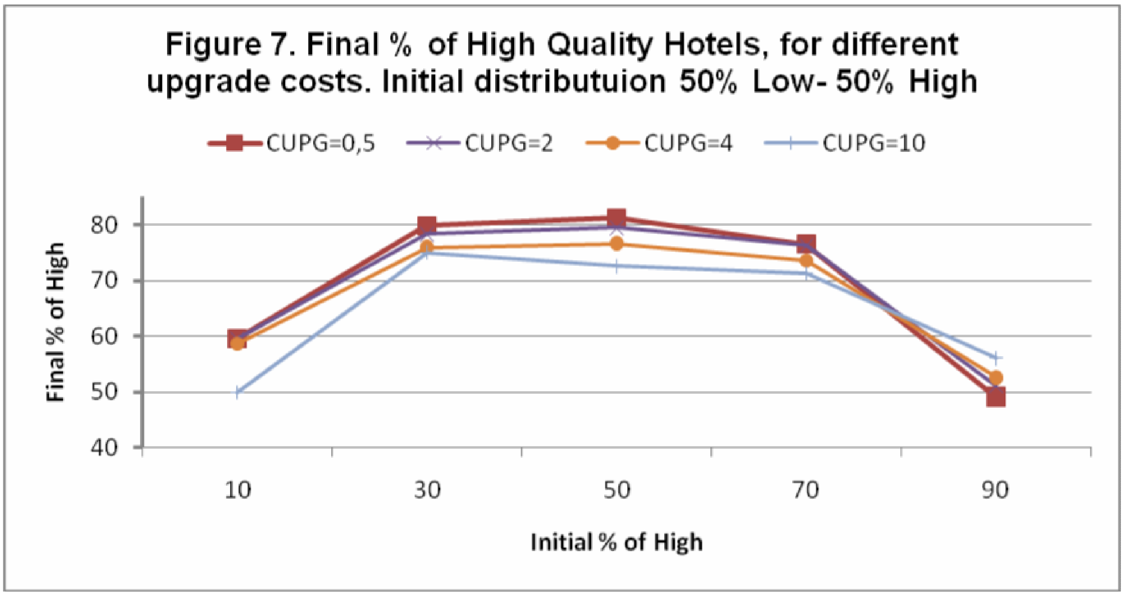
The main conclusions of the sensitivity analysis support the main results with respect to the role of saturation levels and the initial distributions of quality, that is, they are robust to the variations we have performed. Nevertheless, quantitative variations take place depending on the particular chosen values. We now comment the most outstanding outcomes.

Cost of upgrade

When looking at the influence of the cost of upgrade, it can be found that the equilibrium share of the high quality segment decreases with this cost. This is a reasonable outcome, because a higher cost precludes upgrading the strategy in some cases, since it does not result profitable enough. Likewise, convergence takes place more easily, because few changes occur.

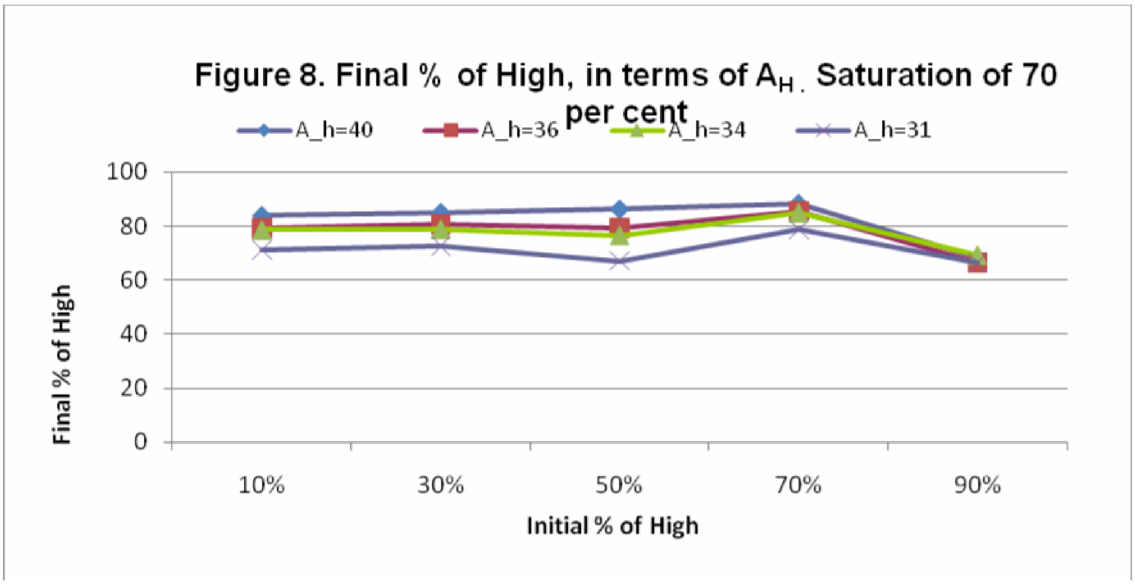
The results of the simulations with different upgrade costs appear in figure 7 for the case in which the initial distribution is equally divided between the high and low quality segments. It can be observed that curves representing higher upgrade costs shift downwards, except for large high saturation levels.

With respect to convergence shares, increasing the cost of upgrade facilitates convergence. Higher upgrade costs might make the change of strategy no longer worthy, if the expected increase in profits is not sufficiently high.

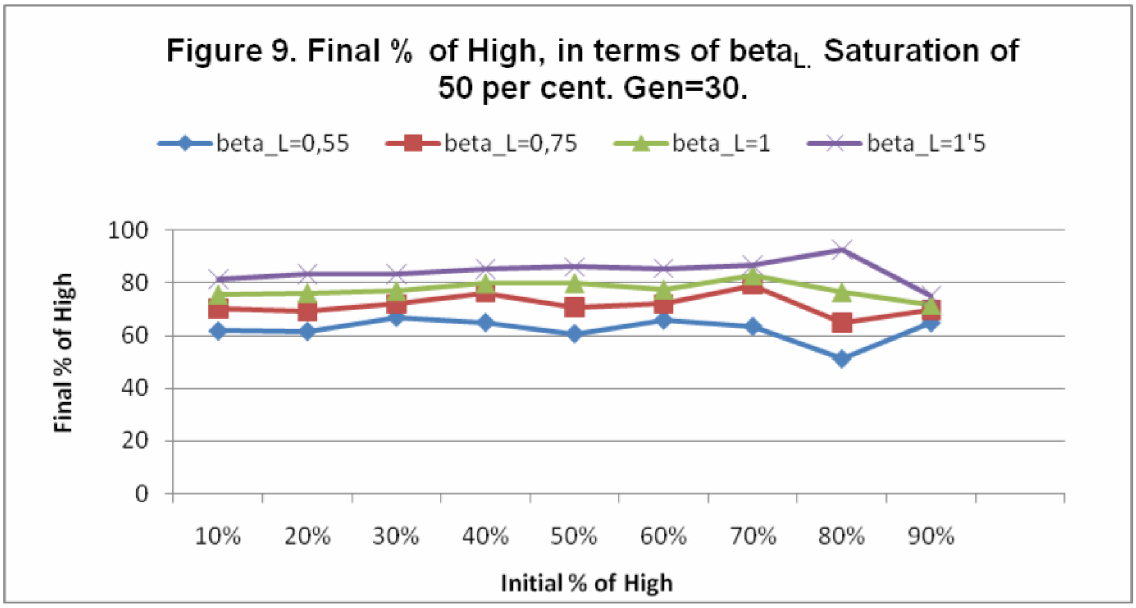


Inverse demand parameters

Parameters A_H and A_L represent the intercept in the price axis for the high and low quality segments, respectively. According to the results of the sensitivity analysis, the value choice of A_H appears to be much more crucial in quantitative terms. As it would be reasonable to expect, a higher A_H usually leads to equilibrium distributions with larger shares of the high quality segment. Impacts are the largest for saturated destinations where more competition exists. For medium and medium-low saturated destinations, the effects are of less importance, almost disappearing for the 10 per cent saturation level. The impact of A_L is the reverse, higher values of this parameter resulting in a lower equilibrium percentage of high quality hotels. Quantitatively, though, the incidence of the parameter is mucho more moderate. Figure 8 plots the resulting high quality values for different A_H, for a saturation of 70 per cent.



Next, we look at the influence of the parameters measuring the impact of direct own competition. Parameter β_L denotes the negative impact each low quality hotel exerts on the low quality tourist price, and then its profitability. As β_L increases, the direct competition among low quality firms increases, and the sensitivity analysis shows this negatively affects the number of low category hotels in equilibrium. This result holds for saturation levels of 70 per cent and below, with practically null effects when saturation decreases to 10 per cent. An illustration is shown in figure 9, for a 50 per cent saturation level.

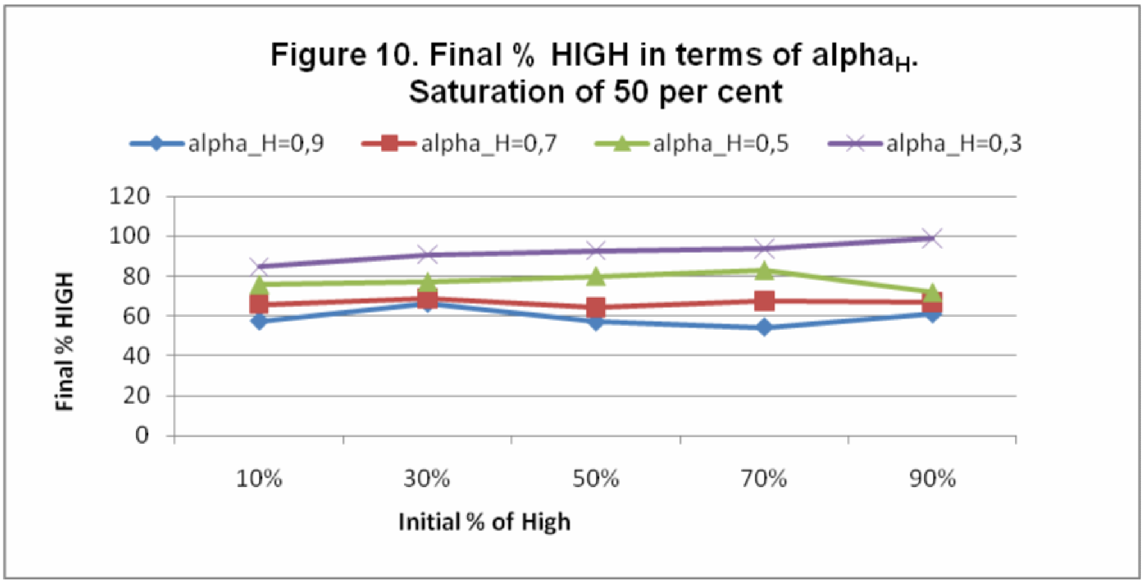


However, when it is larger (90 per cent), β_L has little impact on the equilibrium, except when the initial distribution of high quality hotels is rather small: in this instance, a larger β_L might result in a larger presence of the low category firms. This odd outcome is mitigated when accounting for the change in convergence associated to modifications of β_L, since lower values of β_L provoke smaller convergence percentages. When recalculating the shares of the high quality segment (by choosing an alternative maximum number of generations per round) the previous counterintuitive result no longer takes place.

Seen from a different perspective, when β_L is low, the saturation level does not affect much the distribution of high and low quality hotels. The largest the value of β_L, the more relevant is the saturation level for the ultimate structure of the tourism sector, especially concentrated in the high quality segment the lower the saturation level is.

Likewise, the analysis of the impact of α_H was undertaken. It would be expected that higher values of this parameter decrease the price, profit level and share in equilibrium of the high quality hotels. For medium-low saturated tourism destinations, where the high quality segment dominates, its impact is moderate. Figure 10 shows the simulation results for different values of α_H, for an intermediate saturation level. As expected, it can be seen that high quality hotels lose share in the final distribution as the negative impact of a direct competitor increases.

The sensibility of the results in quantitative terms, though, is striking for high levels of saturation: depending on the value of α_H, high quality hotels either almost disappear, or almost fully dominate. Thus, scenarios in which low quality hotels totally dominate the lattice have been encountered for high values of α_H, when high saturation (90 per cent) is combined with low starting shares of the high quality segment. These other scenarios are included in the appendix.



One way to interpret the aforementioned outcome is to account for the role of differentiation inside the high quality tourism sector. Thus, if the high quality service becomes standardized, with little specific features that make it different it in the eyes of consumers, this leaves less market power to hotels, high quality prices will be more vulnerable to competition, and this might ultimately lead to an almost disappearance of the segment, unable to compete against the low quality one in already mature destinations. In other words, upgrading might make sense in some contexts, but as long as it is accompanied by service differentiation *inside* the high quality segment itself.

Finally, simulations have been repeated for different values of α_L and β_H, that capture cross effects. With respect to the first, simulations indicated that the parameter either did not influence the results to a significant extent, or it did so in the expected way, a smaller α_L stimulating the high quality segment in the presence of many low firms. With respect to β_H, measuring the penalty of an extra high quality hotel on the low quality price, it is obtained that when this penalty increases, this encourages the high quality segment, except when the low category dominates (in highly saturated destinations and low starting shares of the high quality segment).

Conclusions

In this paper we have represented the market for hotel services with the characteristics of a monopolistic competition model, with (potentially) a large number of suppliers offering partially substitutable goods. Instead of using the standard microeconomics framework, an agent-based model in which hotels are regarded as artificial agents that evolve over time has been developed. This setting presents advantages such as the consideration of bounded rationality in the decision making process of hotels, as well as the analysis of the transitions from the initial generation to the equilibrium. An added advantage consists in the consideration of spatial as well as dynamic aspects. This paper focuses on the competition aspects of the tourism market, and leaves for further research equally important issues related to tourism activities such as environmental externalities.

Departing from different initial configurations in the distribution of hotel qualities and several levels of saturation of the destiny, different equilibrium configurations can be expected. It is found that, in general, high and low quality segments coexist after adjustment takes place, and that the level of saturation of a given destination crucially determines the weight of the different quality segments: high category increases its share as more developed is a particular destination, but only until a certain level beyond which the destination degrades dramatically, in the sense that low quality hotels gain importance.

At the same time, the initial distribution of qualities helps explain the final equilibrium pattern. In many instances both segments coexist, with high enough shares of the activity. Outcomes with a very unequal distribution of qualities can occur for very low saturation levels: in those instances, few hotels are present in the lattice, the chance of local competition is less likely and so is the possibility to change the strategy. Thus, the inertia impact of the initial configuration is very evident.

For more intermediate saturation levels, the high quality segment improves with respect to the initial shares when these are below values around 40 per cent; the share does not change much when already well represented with values in the range of 40-50 per cent; and the more high quality dominates in the beginning, the more low quality hotels will expand in the equilibrium. This result suggests that, although engaging in the supply of high quality tourism services is generally more profitable, competition ultimately leaves room for lower category hotels to survive, and allows them to obtain a similar level of profits.

The sensibility analysis shed some light with respect to the role of some of the parameters used throughout the analysis. Particularly outstanding resulted the consideration of several values for α_H, becoming the parameter most clearly determining the results, even from a qualitative point of view, in highly saturated destinations. Thus, when competition among high quality hotels become very direct, in the sense that the tourism service is not differentiated and another competition quickly erodes the price, the high quality segment could even disappear, in destinations already very saturated. The remaining comparisons mostly produced the expected results.

The performance of further sensitivity analysis with respect to some of the hypotheses made throughout the implementation of the analysis is to be object of further research. This includes, for instance, the incorporation of more realistic financial constraints that somehow precludes frequent changes in the quality choice of hotels, too much driven on a short run basis. We also plan as an immediate extension to consider the stability of the equilibria by including mutation among agents' strategies. In evolutionary game theory stability of equilibria is tied to mutations, meaning that players may make mistakes in deciding on their strategy.

Although this paper has only dealt with pure competition aspects of the tourism industry, we believe that our framework is flexible enough to incorporate other relevant aspects. Among those, the consideration of the spatial aspects associated to the characteristics of the particular locations hotels are in, is a key aspect in further differentiating the tourism product, as would be to allow for externalities to occur among hotels. Other important dynamic issues such as the forecasted evolution of demand is likewise to be taken into account and incorporated into the analysis.

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Appendix

Table A1. Global Effects. Saturation of 90 per cent.

% HIGH/ agents	Initial #		HIGH				LOW			Aver. Generations
	High	Low	Final	MAX	MIN	ST DEV	Final	MAX	MIN	
10%	9	81	44,574	69	27	10,394	45,426	63	21	5,398
20%	18	72	28,226	69	18	6,269	61,774	72	21	4,62
30%	27	63	47,104	78	25	11,256	42,896	65	12	4,452
40%	36	54	38,054	78	18	10,706	51,946	72	12	5,44
50%	45	45	46,518	90	26	11,713	43,482	64	0	5,632
60%	54	36	11,368	21	3	3,302	78,632	87	69	3,124
70%	63	27	22,44	36	12	4,302	67,56	78	54	3,066
80%	72	18	39,826	52	25	4,796	50,174	65	38	3,454
90%	81	9	30,64	68	13	7,465	59,36	77	22	4,822

Table A2. Local Effects. Saturation of 90 per cent.

% HIGH/ agents	Initial #		HIGH				LOW			Aver. Generations
	High	Low	Final	MAX	MIN	ST DEV	Final	MAX	MIN	
10%	9	81	39,854	49	19	5,103	50,146	71	41	5,87
20%	18	72	26,756	48	19	4,038	63,244	71	42	4,47
30%	27	63	40,346	69	16	7,047	49,654	74	21	4,818
40%	36	54	36,698	69	19	8,893	53,302	71	21	5,136
50%	45	45	40,566	90	21	8,226	49,434	69	0	6,086
60%	54	36	10,5	24	2	3,03	79,5	88	66	3,07
70%	63	27	20,608	33	12	3,655	69,392	78	57	3,036
80%	72	18	37,48	47	27	3,751	52,52	63	43	3,408
90%	81	9	29,39	47	14	6,166	60,61	76	43	4,262

Table A3. Global Effects. Saturation of 50 per cent.

High %	Initial #		HIGH				LOW			Aver. Generations
	High	Low	Final	MAX	MIN	ST DEV	Final	MAX	MIN	
10%	5	45	37,82	43	21	2,41	12,18	29	7	10,83
20%	10	40	38,08	43	29	1,84	11,92	21	7	11,64
30%	15	35	38,47	49	33	2,03	11,53	17	1	13,13
40%	20	30	39,87	46	34	1,77	10,13	16	4	17,1
50%	25	25	39,94	46	32	2,54	10,06	18	4	18,6
60%	30	20	38,75	50	30	3,09	11,25	20	0	13,59
70%	35	15	41,41	50	31	4,73	8,59	19	0	10,14
80%	40	10	38,26	48	26	2,72	11,74	24	2	15,87
90%	45	5	35,85	41	30	2	14,15	20	9	23,86

Table A4. Local Effects. Saturation of 50 per cent.

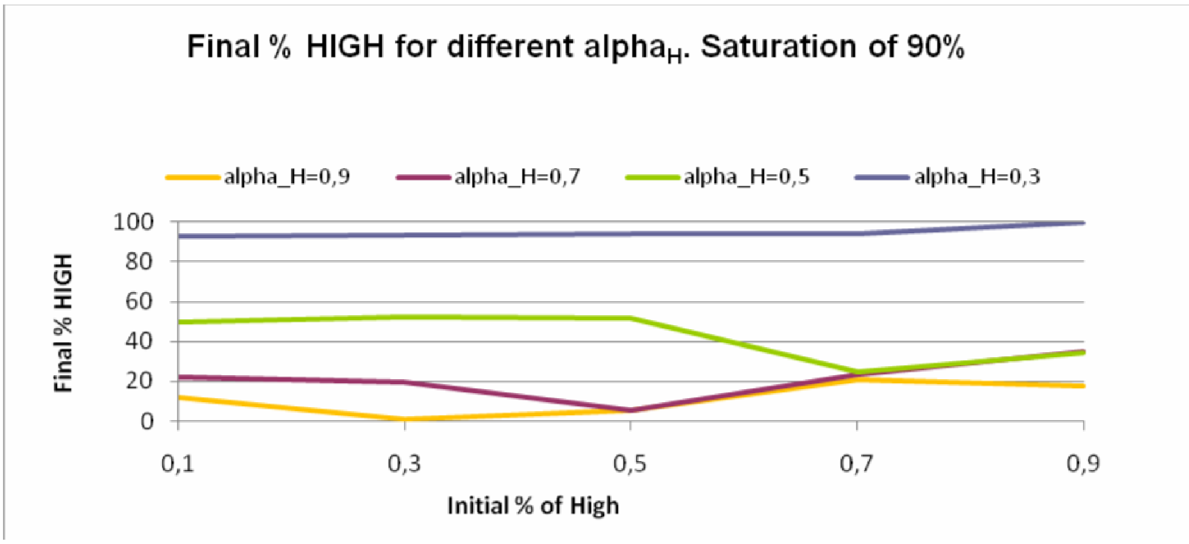
% High	Initial #		HIGH				LOW			Aver. Generations
	High	Low	Final	MAX	MIN	ST DEV	Final	MAX	MIN	
10%	5	45	37,796	43	19	2,74	12,204	31	7	13,84
20%	10	40	38,14	46	31	1,89	11,86	19	4	15,588
30%	15	35	38,622	47	30	2,001	11,378	20	3	17,54
40%	20	30	39,002	46	29	2,256	10,998	21	4	18,966
50%	25	25	40,02	49	30	2,733	9,98	20	1	23,444
60%	30	20	39,12	50	32	2,795	10,88	18	0	18,934
70%	35	15	41,708	50	29	4,868	8,292	21	0	13,828
80%	40	10	36,86	44	24	4,335	13,14	26	6	23,938
90%	45	5	35,656	43	28	2,123	14,344	22	7	27,812

Table A5. Global Effects. Saturation of 30 per cent.

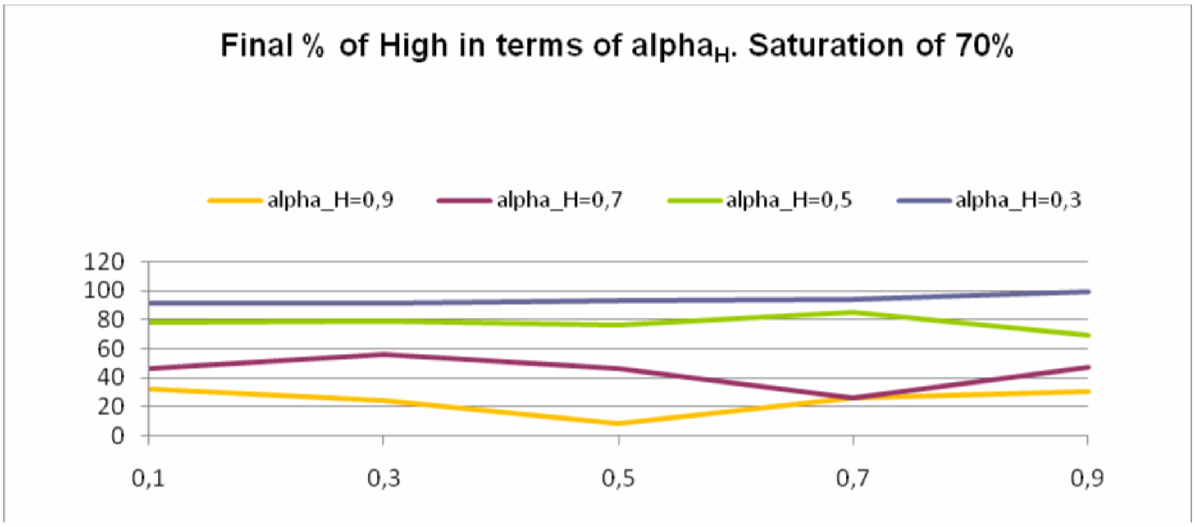
High %	Initial #		HIGH				LOW			Aver. Generations
	High	Low	Final	MAX	MIN	ST DEV	Final	MAX	MIN	
10%	3	27	11,98	25	3	4,63	18,02	27	5	4,7
20%	6	24	17,31	25	7	3,69	12,69	23	5	4,47
30%	9	21	20,78	27	12	2,63	9,22	18	3	3,91
40%	12	18	22,6	29	16	1,8	7,4	14	1	3,33
50%	15	15	23,3	27	19	1,05	6,7	11	3	3,8
60%	18	12	24,18	30	21	1,31	5,82	9	0	4,31
70%	21	9	25,43	30	21	1,92	4,57	9	0	3,35
80%	**24	6	24	24	24	0	6	6	6	1
90%	27	3	23,44	27	19	1,2	6,56	11	3	6,51

Table A6. Local Effects. Saturation of 30 per cent.

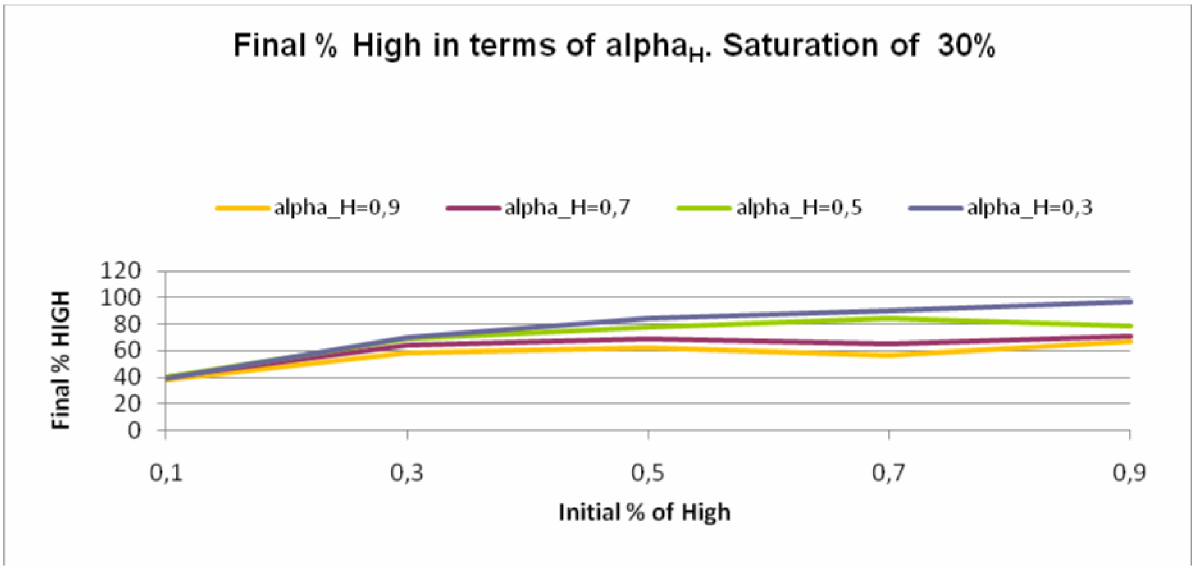
High %	Initial #		HIGH				LOW			Aver. Generations
	High	Low	Final	MAX	MIN	ST DEV	Final	MAX	MIN	
10%	3	27	12,93	24	3	5,02	17,07	27	6	5,256
20%	6	24	18,06	25	6	3,878	11,94	24	5	4,83
30%	9	21	20,786	26	12	2,697	9,214	18	4	4,906
40%	12	18	22,438	28	16	1,94	7,562	14	2	4,694
50%	15	15	23,178	26	19	1,078	6,822	11	4	6,558
60%	18	12	23,88	28	20	1,011	6,12	10	2	9,812
70%	21	9	25	30	22	1,587	5	8	0	6,666
80%	24	6	23,536	29	19	1,184	6,464	11	1	12,21
90%	27	3	23,754	27	20	1,294	6,246	10	3	11,444



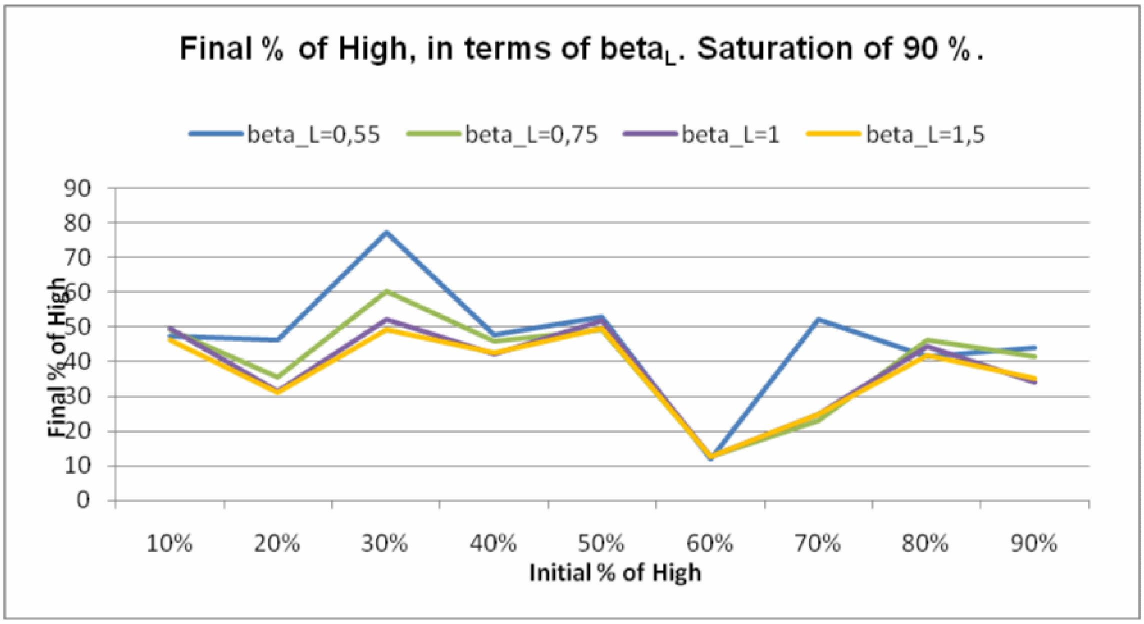
Final % HIGH for different alpha$_H$. Saturation of 90%
alpha_H=0,9
alpha_H=0,7
alpha_H=0,5
alpha_H=0,3
100
80
60
40
20
0
Final % HIGH
0,1
0,3
0,5
0,7
0,9
Initial % of High

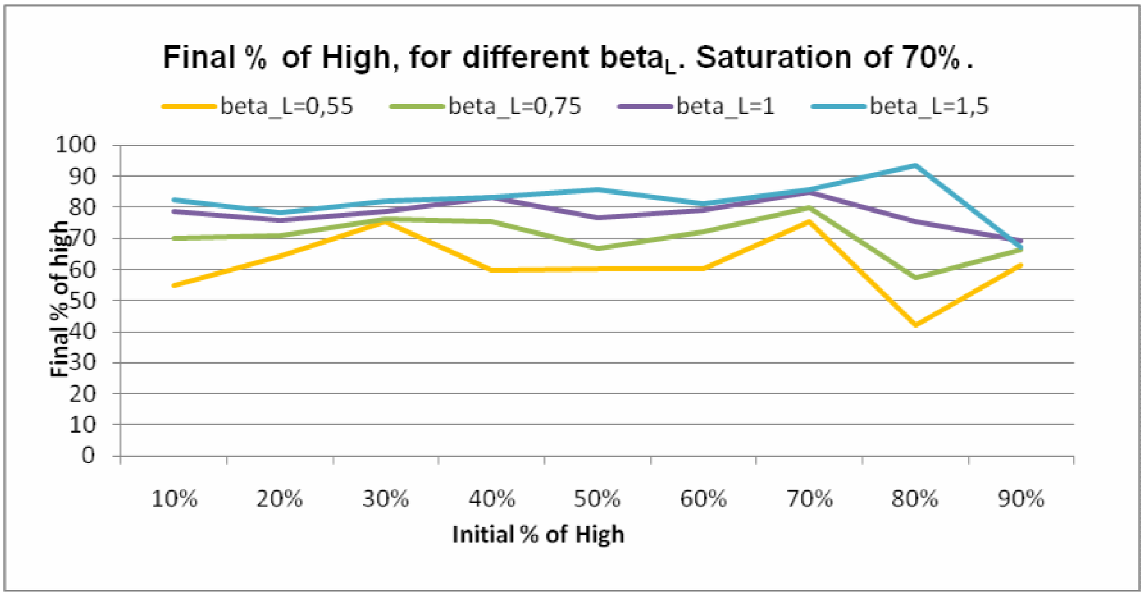


Final % of High in terms of alpha$_H$. Saturation of 70%
alpha_H=0,9
alpha_H=0,7
alpha_H=0,5
alpha_H=0,3
120
100
80
60
40
20
0
0,1
0,3
0,5
0,7
0,9



Final % High in terms of alpha$_H$. Saturation of 30%
alpha_H=0,9
alpha_H=0,7
alpha_H=0,5
alpha_H=0,3
120
100
80
60
40
20
0
Final % HIGH
0,1
0,3
0,5
0,7
0,9
Initial % of High


Final % of High, in terms of betaL. Saturation of 90 %.
beta_L=0,55
beta_L=0,75
beta_L=1
beta_L=1,5
Final % of High
Initial % of High
0
10
20
30
40
50
60
70
80
90
10%
20%
30%
40%
50%
60%
70%
80%
90%


Final % of High, for different betaL. Saturation of 70%.
beta_L=0,55
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beta_L=1
beta_L=1,5
Final % of high
Initial % of High
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10
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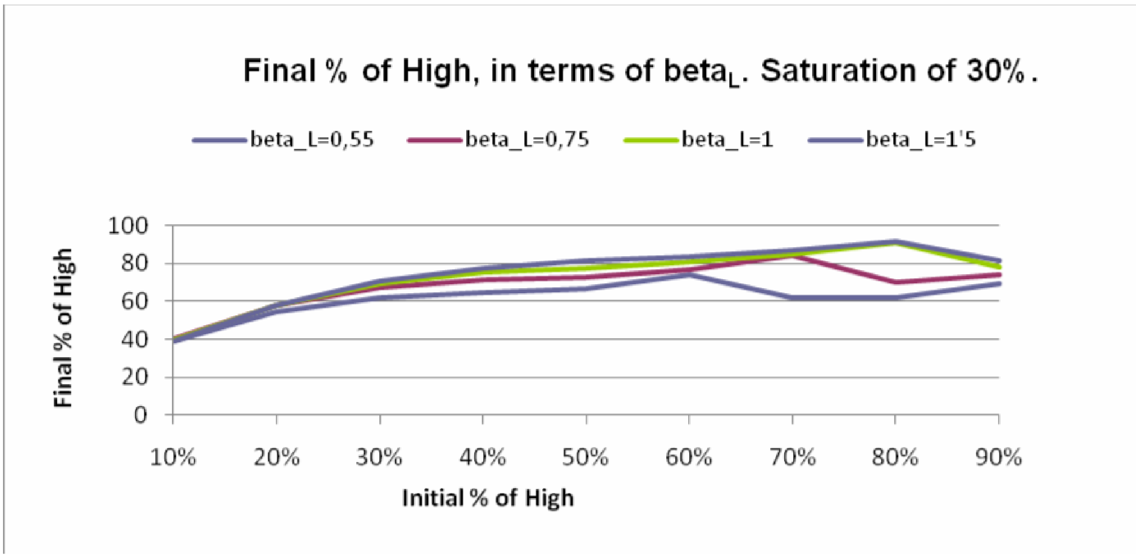
40%
50%
60%
70%
80%
90%


Final % of High, in terms of betaL. Saturation of 30%.
beta_L=0,55
beta_L=0,75
beta_L=1
beta_L=1'5
Final % of High
Initial % of High
0
20
40
60
80
100
10%
20%
30%
40%
50%
60%
70%
80%
90%