An R&D-based endogenous growth model of international tourism[1]

Isabel P. Albaladejo[2]

María Pilar Martínez-García[3]

[2]Departamento de Métodos Cuantitativos para la Economía. Universidad de Murcia. isalba@um.es.

[3]Departamento de Métodos Cuantitativos para la Economía. Universidad de Murcia. pilarmg@um.es.

An R&D-based endogenous growth model of international tourism

Abstract: According to Tourism Area Life Cycle (TALC) model by Butler (1980) the evolution of a touristic destination folows a S-shaped curve which is upper-bounded by its carrying capacity, usually assumed as fixed constant. This forecast prevents a tourism-based economy from maintaining positive growth rates in the long-run. However, infrastructures, transportation networks, accommodation facilities and the variety of attractions can be broadened to increase the tourism carrying capacity. In this paper innovation is the motor of the carrying capacity growth. The model follows the R&D-based endogenous growth models tradition and allows the long-run sustainability of economic growth in a tourism specialized economy. Along a balanced growth path, the income from tourism grows at the same rate as the innovation, and the carrying capacity will grow as the rate of innovation surpasses the foreign economic growth rate. The long term growth of the economy depends on the real exchange rate.

Introduction

Innovation is considered the main source of development and economic growth of countries (Schumpeter, 1934) and economic growth theory has recognized its importance. Since the 1980's, R&D-based growth models claim that human inventiveness prevents economic stagnation and keeps improving the standard of livings in societies. Seminal contributions to this literature include Romer (1990), Grossman and Helpman (1991) and Aghion and Howit (1992). However, the innovation literature has, until recently, mainly been concerned with innovation in manufacturing industries and patentable products. Academics have not paid much attention to innovation in service industries, where new ideas are usually related to immaterial products (Hjalager, 2010).

One example is tourism. For decades tourism has experienced continued development and has become one of the major players in international commerce (UNWTO, www2.unwto.org). This growth has gone hand in hand with an increasing diversification in the tourism supply (Butler, 2011). Traditionally, tourism destinations were identified with a sole and specific original attraction. Spain and the Mediterranean destinations were usually associated with seaside tourism, Egypt with cultural tourism, Israel with religious tourism, and so on. Nowadays, however, small-scale tourism resources are being activated in these destinations and new products and services are appearing in connection with gastronomy, sports and the environment, for example (Hjalager, 2002). Moreover, new combinations of existing products are being put forward and some infrastructure are being redefined, in response to environmental regulations

and the new needs and wishes of the tourists (Stamboulius and Skayaunis, 2003; Victorino et al., 2005). Additionally, other ways of accessing the products and services offered by the destination are being developed. All new attractions and facilities complement and boost the tourist appeal, since visitors can enjoy several experiences simultaneously (González and Bello, 2002) and, at the same time, ameliorate the congestion of the destination since more tourists can be absorbed in the same physical space (Aguiló, Alegre and Sard, 2005).

Congestion is a key element in the tourism area life cycle model (TALC) according to Butler (1980). This model predicts a decline in the rate of tourism arrivals as the number of visitors increases. According to the TALC model, destinations experience various stages over time, reaching a final stage where it has two options, decline or rejuvenation. The diversification and the wide range in supplied attractions prevent the decline and allow the rejuvenation of traditional destinations. But it is not free, it means devoting efforts to innovate: innovations in the process (supply), facilities, products, and the improvement of information technology (Camisón and Monfort-Mir, 2012).

To the best of our knowledge, models connecting innovation and tourism growth have not been developed. In this paper we provide a formal life cycle model for tourist destinations where innovation boosts of tourism rejuvenation. We use the R&D-based growth models in economic growth theory (Romer, 1990) to explain the innovation process and connect it with tourism performance. The result is an endogenous growth model of tourism where the microdecissions of economic agents (domestic consumers, producer firms, enterprising firms and tourists) drive economic and tourism development.

It is notable that, not only saving/investment decisions of domestic agents (as is in economic growth models), but also tourist's decisions, have an impact on long-run growth.

Our model belongs to the tourism-led-growth models literature developed by Hazari and Sgro (1995, 2004(ch.12)), Chao et al. (2005), Nowak et al. (2007) and Schubert and Brida (2011), among others. However, contrary to the mainstream, in this paper, tourists' arrivals is viewed as an endogenous process. Several studies in micro-economic analysis lead to the belief that the ability of a country to attract tourists depends on its characteristics as a tourist destination (facilities, diversification of leisure activities, quality of hotels and services, environmental endowment and quality, cultural heritage, political stability, among others).[4] Some of these elements have an endogenous dimension (diversification, quality, security) and can be improved through investment. Therefore, the saving/investment behavior of domestic agents affects the tourist attraction power of the economy and hence the long-term economic growth rate. Recently, Albaladejo and Martínez-García (2013) assume that tourists arrive at a rate which depends on the quality of the tourist services, which can be endogenously improved by the country. Albaladejo, González-Martínez and Martínez-García (2014) also propose that tourism arrivals and the quality of tourism services can be endogenously enhanced. Nevertheless, these works do not take into account congestion and the TALC model. In this paper the TALC hypothesis is at the core of our analysis and human inventiveness and R&D investment prevent the rate of tourism arrivals from declining.

---

[4]See, for example, Seddighi and Theocharous (2002), Alegre and Pou (2006), Gokovali et al. (2007) and Eugenio-Martín et al. (2008).

The following section presents a TALC model where the tourism carrying capacity is not a fixed number, but can evolve over time. Innovation in tourism services will be the motor of growth for the carrying capacity. In section 3 the tourist' preferences are modeled and the demand function for tourist services is obtained. Both the tourist services demand function and the flow of visitors arriving according to the TALC model are incorporated into a R&D-based growth model *á la Romer* in section 4. The long-run growth rate is obtained and a comparative static analysis is carried out. Section 5 concludes.

The tourism carrying capacity

Tourism area life cycle model (Butler, 1980) is one of the most accepted models in tourism literature. Since 1980 many authors have tested the validity and usefulness of the TALC model in a variety of destinations (Lagiewski, 2006) and a considerable number of studies found that the TALC model works well in describing the process of development of tourist destinations (Butler, 2009 and 2011). This process has six key phases: exploration, involvement, development, consolidation, stagnation, and a post-stagnation stage where the destination has two options, decline or rejuvenation (Lundtorp and Wanhill, 2001; Cole, 2009; Butler, 2009 and 2011). Each stage is characterized by several factors such as the number and type of attractions and facilities, the number of tourists or residents' attitudes towards tourism. Butler presented this life cycle as an S-shaped curve representing the arrivals of tourists until stagnation stage. The upper limit of the S-shaped curve is achieved as levels of carrying capacity of destination are reached. The implicit assumption in previousmodels is that the market equilibriumpositions we observe do

trace out the path of demand, meaning that supply is flexible enough to adjust to demand.

Lundtorp and Wanhill (2001, 2006) showed that the TALC model might be satisfactorily approximated assuming that the number of tourists arriving in the country, T, follows the pattern of a logistic growth model, that is[5]

$$\dot{T} = \sigma T \left(1 - \frac{T}{CC}\right) \tag{1}$$

where σ, assumed to be positive, is the intrinsic rate of tourism growth and CC is a measure of the carrying capacity in the destination and $\dot{T}$ denotes the time derivative of variable T. We omit time subscripts in equation (1) and in the subsequent analysis whenever no ambiguity results.

There are a lot of definitions about carrying capacity within the context of tourism. In its most traditional sense, it is understood as the maximum number of tourists or tourist use that can be accommodated within a specific geographic destination (O'Reilly, 1986). This capacity has been identified in terms of limits of environmental, social, economical or physical factors (Butler, 1980; Saveriades, 2000; Cole, 2009; Diedrich and García-Buades, 2009). The environmental factor has been widely used in tourism studies due to the concern for the negative impacts of tourism. Recently, Lozano *et al* (2008), using an environmental growth model for an economy specializing in tourism, show that its evolution does not contradict the evolution derived by the TALC model.

The first tourism destinations used and developed their natural and cultural resources as attractions for visitors (Saveriades, 2000). The modern destinations are more sophisticated and complex products (Butler, 2011). New tourism goods and services that

---

[5] The differential logistic equation was first proposed by Verhuslst in 1838 as a population model faced with resource constraints. This equation is easily solved as is seen in Clark (1932).

overlap original attractions (specially beaches or cultural heritage) emerge in the traditional destinations and new destinations arise with technological attractions such as theme parks, massive luxurious hotels, for example. Moreover, the destinations are characterized by a high level of dynamism (Butler, 2011), their attractions and facilities vary or change quite quickly over time.

Although the micro-foundations of the life-cycle predicted by TALC model are demand-oriented (Plog, 1974), appropriate policy measures may not only sustain tourism flows over time but also rejuvenate resorts initiating a *new life-cycle*(Papatheodorou, 2004).The goods and services offered by the destination (accommodation, transport, shopping, attractions, events) can define and switch the maximum number of tourists that could be accommodated by a destination. The wider and more varied number of services and attractions the more number of tourists can be received simultaneously in the same geographical space and they can enjoy several goods and services simultaneously (Aguiló, Alegre and Sard, 2005). Furthermore, if the goods and attractions offered by destination vary or change or if the quality of their infrastructures and facilities increase, the limits of capacity of the destination could be modified. Then, the tourism supply of a destination is a key significant factor in delimiting the number of tourists that can be absorbed.

The tourism services requirements of the individuals that arrive at the destination can also affect the carrying capacity. The higher per capita consumed services or goods (longer stays, more meals in restaurants, for example) the fewer the number of tourists can be attended to the destination. In this paper, the tourism carrying capacity is defined as the ratio between the tourism services supply and the per capita tourism consumption,

that is

$$CC = \frac{Y}{c_T},$$ (2)

where Y is the supply of tourism services and c_T is the individual consumption.

An equivalent definition for the carrying capacity has been used in human population growth models, where the logistic function was first used. In 1925 Albrecht Penck formulated the carrying capacity as a measure of the population that could be fed with the existing resources. This measure, which has been widely used, was calculated as the ratio between the food supply and the individual food requirements (see Cohen (1995) and references therein).

Traditionally, tourism carrying capacity has been considered as a rigid and static value. However, several authors argue that it can evolve with time (Saveriades, 2000; Cole, 2011). The definition given in (2) allows the carrying capacity to evolve with time due to changes in the tourism services supply (Y) and/or in the individual tourism services requirement (c_T). Changes in the preferences of tourists or changes in their budget could determine the evolution of c_T, as is shown in the following section. On the other hand, the tourism services supply Y can be enlarged by devoting efforts to innovate, as is shown in section 4.

Note that equation (1) follows the logistic growth pattern (sinusoidal shape) only if the carrying capacity point (*CC*) is fixed. Conversely, if *CC* grows, as we propose in this paper, the number of tourist could be continuously increasing.

The behavior of tourists

As understood in Eugenio-Martín (2003), tourists face a multi-stage decision

problem in which the decisions about the destination and budget are taken at different stages. Following this idea, we shall start assuming that the decision upon the destination is somehow taken previously. Once this decision has been taken and our country is the chosen destination, tourists must decide the budget for the vacation, denoted by variable b, which will somehow determine their tourism consumption.

Tourism is not an everyday consumption good, but just some days a year, usually concentrated in the holidays season. Therefore, decision about tourism budgets should optimize the interanual utility of a tourist, taking into account the everyday consumption that will be lost. At each instant of time (a year) a tourist must decide upon the quantity of tourism services (nights in hotel, excursions, meals, visits to amusement parks, etc.) to be consumed abroad, c_T, and the quantity of goods consumed in her own country (domestic consumption), c_T^d. Her interanual utility depends on both quantities, that is,

$$U = U(c_T, c_T^d)$$

Where $U(.,.)$ must satisfy the following property

$$U(0, c_T^d) > 0 \ \ for \ all \ \ c_T^d > 0. \tag{3}$$

Property (3) means that c_T is not necessary for welfare. If $c_T = 0$, there is no travel and the whole income is spent on domestic consumption.[6] Following Deaton and Muellbuer (1980 a,b) and Lanza *et al.* (2003), we assume that tourists' international preferences can be represented by a utility function displaying a constant elasticity of substitution (CES), that is

$$U(c_T, c_T^d) = \left[\xi c_T^{-\delta} + (1 - \xi)\left(c_T^d\right)^{-\delta} \right]^{-1/\delta} \tag{4}$$

---

[6]Note that a Cobb-Douglas utility function is not accurate in representing the behavior of a tourist.

where $0 < \xi < 1$ and $\delta > -1$.

A representative tourist must solve the following static optimization problem

$$\max_{c_T, c_T^d} U(c_T, c_T^d) \tag{5}$$

$$s.t. \quad p^T c_T = b \tag{6}$$

$$p^d c_T^d = \mathcal{R} - b \tag{7}$$

where $\mathcal{R}$ is the tourist's annual income, b is the budget for tourism and p^d is the price of domestic consumption goods. Solving (5)-(7), the relative demand as a function of the prices can be obtained, that is,

$$\frac{c_T}{c_T^d} = \left(\frac{1-\xi}{\xi} \right)^{-\phi} p^{-\phi}, \tag{8}$$

where $\phi = 1/(1+\delta)$ is the elasticity of substitution and p is the ratio of prices $\frac{p^T}{p^d}$. The shadow price of the tourism budget (the shadow price of b) is

$$\frac{dU^*}{db} = \frac{\partial U}{\partial c_T} \left(\frac{b}{p^T}, \frac{\mathcal{R}-b}{p^d} \right) \frac{1}{p^T}. \tag{9}$$

The rent not spent on tourism, $\mathcal{R} - b$, will be spent on inboard consumption, c_T^d. Its value (in terms of utility) is the shadow price of $\mathcal{R} - b$:

$$\frac{dU^*}{d(\mathcal{R}-b)} = \frac{\partial U}{\partial c_T^d} \left(\frac{b}{p^T}, \frac{\mathcal{R}-b}{p^d} \right) \frac{1}{p^d}. \tag{10}$$

The tourist will chose the level of b that satisfies that (9) and (10) are equal, that is[7]

$$\frac{\partial U}{\partial c_T} \left(\frac{b}{p^T}, \frac{\mathcal{R}-b}{p^d} \right) \frac{1}{p^T} = \frac{\partial U}{\partial c_T^d} \left(\frac{b}{p^T}, \frac{\mathcal{R}-b}{p^d} \right) \frac{1}{p^d}. \tag{11}$$

Therefore, the utility of a tourist is maximized when the budget is allocated so that the marginal utility per unit of money spent is equal for domestic consumption and for

---

[7]Note that the maximization of $U[b/p^T, (\mathcal{R} - b)/p^d]$ with respect to b gives the same result.

tourism consumption. If this equality did not hold, the consumer could increase her utility by cutting spending on the good with lower marginal utility per unit of money and increase spending on the other good.

The following proposition, using (11), obtains the optimal budget for a representative tourist with a CES utility function.

Proposition 1 *If a CES function represents the tourists preferences (see equation (4)), then the tourism budget is proportional to the tourist's annual income $\mathcal{R}$ and inversely related to the ratio of prices p, according to the following equation*

$$b = \frac{\mathcal{R}}{\left(\frac{1-\xi}{\xi}\right)^{\phi} p^{\phi-1}+1} \qquad (12)$$

where ϕ is the constant elasticity substitution between tourism consumption, c_T, and domestic consumption, c_T^d.

Expression (12) leads to different special cases. The ratio of prices p will have a positive or a negative effect on the budget depending on the value of ϕ. Recently, Lanza *et al.* (2003), using data series referring to 13 European countries from 1975 to 1992, conclude that the elasticity of substitution is below one. This means that p has a positive effect on the tourism expenditure. Note that in the extreme case ($\phi \rightarrow 1$), when the CES function converges to a Cobb-Douglas, the ratio of prices p will not have an impact on the tourism budget, which is not realistic. This supports our assumption of a CES utility function.

Moreover, equation (12) establishes a relation between p and the marginal propensity to tourism consumption $t = b/\mathcal{R}$. That is,

$$p^{1-\phi} = \left(\frac{1-\xi}{\xi}\right)^{\phi} \frac{t}{1-t},$$

(13)

being t a parameter which usually depends on the idiosyncrasy of the visitors. If ϕ is lower than 1, this is a positive relation: If the tourist agrees to pay a higher price it would be since she has a higher marginal propensity to tourism consumption.

We have started this section taken from granted that the decision of visiting our country had been taken previously, and our country was the chosen destination. We ask now, who are those tourists who had decided to come to our country?, where are they from?.

To characterize our country's tourists we assume that those destinations with higher price are the ones which bring the tourists more utility (other things equal). It is not a strong assumption given that higher price is usually directly related with higher quality (Keane, 1997; Alegre and Juaneda, 2006; Alen et al., 2007). Under this asumption, the following proposition establishes a characterization:

Proposition 2 *If a CES function represents the tourists preferences (equation (4)), then those tourists visiting our country are characterized by a marginal propensity to tourism consumption t which satisfies that*

$$\frac{t}{1-t} = \left(\frac{\xi}{1-\xi}\right)^{\phi} p^{1-\phi}.$$

(14)

Proof. The real exchange rate p between our country and the potential visitors' country is known. Those individuals with a low marginal propensity to tourism consumption t such that

$$\frac{t}{1-t} < \left(\frac{\xi}{1-\xi}\right)^{\phi} p^{1-\phi}$$

would choose another destination with a lower p.

Otherwise, the individuals with a high marginal propensity to tourism consumption such that

$$\frac{t}{1-t} > \left(\frac{\xi}{1-\xi}\right)^{\phi} p^{1-\phi}$$

would choose another destination, one with a higher price, since as we are assuming, it will bring him a higher utility. ▪

The supply of tourism services and market equilibrium

The R&D-based endogenous growth model of tourism we propose relies on innovation to increase the carrying capacity and avoid a decrease in the rate of tourism arrivals as this number increases. The following equations summarize the main features of the productive sector of the economy:

$$Y = AL^{1-\alpha} \sum_{j=1}^{N} X_j^{\alpha} \qquad 0 < \alpha < 1, \tag{15}$$

$$Y = cL + c_T T + \eta \dot{N} \tag{16}$$

$$X_j = X = L \left(\frac{\alpha^2 A}{p_K}\right)^{1/(1-\alpha)} \qquad \text{for all } j = 1,..,N. \tag{17}$$

where Y is final output (a composite good that, for the sake of simplicity, is used either as tourism services and for domestic consumption and investment). This production function characterizes technological change as increasing variety, in the tradition of Dixit and Stiglitz (1977) and Ethier (1982). Production of this good needs labor L and intermediate inputs X_j, $j = 1,...,N$. Full employment of inputs and population is

assumed. Moreover, population L is constant.[8]The number N is the available variety of intermediate inputs, which, in the context of a tourism specialized country, will be understood as the available variety of tourism services in relation to transport, accommodation, catering, and other activities, like recreation, cultural or sport activities, among others. The final output Y is a bundle of different tourist services. Equation (16) expresses that the gross domestic product, Y, must be allocated to consumption of residents and tourists, $cL + c_T T$, and to the creation of new varieties $\dot{N}$, each of which costs η units of Y. Letter X denotes the same quantity produced of each intermediate good, resulting from the profit maximizing behavior of output producers and monopolistic entrepreneurship. Variable p_K is the rental rate of a unit of capital.

In equations (15)-(17), we are considering an R&D-based growth model *á la* Romer (1990) in an open economy whose traded good is tourism in exchange of foreign capital. The price of the domestic output is chosen as the numeraire. Consequently, the ratio of prices p is also the real exchange rate. Since R&D-based growth models are well established in the literature, the micro-foundations are given in the Appendix.

Here, we briefly comment that equations (15)-(17) emerge from a three-sector economy. The final-output sector produces the consumption good (for investment and residents/tourists consumption) using labor and a set of non-durable intermediate goods. In the intermediate-goods sector, monopoly firms transform foreign imported capital K into non-durable intermediate goods using new invented designs. Intermediate good producers are monopolists and each of them sets the same price and sells the same

---

[8]A constant population size in a compulsory assumption in R&D-based endogenous growth models because they predict scale effects.

quantity of its product X.

Domestic consumers accumulate assets in the form of property rights on new intermediate firms (ηN in units of Y) or on imported foreign capital (K/p in units of Y). We assume that both types of assets are perfect substitutes, so they must yield the same return, that is,

$$r = p_K \cdot p - \frac{\dot{p}}{p} - \delta, \tag{18}$$

where r is the rate of return on intermediate firms, p_K is the price paid by intermediate producers for one unit of household's foreign capital K, $\dot{p}/p$ is the depreciation rate of the value of foreign capital due to increases in the real exchange rate and $\delta \geq 0$ is the rate of capital depreciation.

In its simplest form, the R&D-based endogenous growth model assumes that one unit of capital can be effortlessly transformed into a single unit of intermediate input according to a one-to-one production technology (see Appendix). Thus, the assumption of full employment of capital implies that

$$K = \sum_{j=1}^{N} X_j = NX \tag{19}$$

which yields that the production function for the final-goods sector can be expressed as

$$Y = AK^\alpha (LN)^{1-\alpha}, \tag{20}$$

which means that technological innovation is neutral (Harrod neutral). In other words, the relative input shares, $(K \cdot Y_K)/(L \cdot Y_L)$, remain unchanged for a given capital-output ratio.

It is well known that the optimal behavior of all different agents in this decentralized economy with imperfect competition in the intermediate-goods sector

obeys to two rules:

The rate of return on assets is lower than the social rate of return: This is due to the existence of imperfect competition. Monopolistic producers of intermediate goods know the demand function and charge a price over the marginal cost or competitive price. The rate of return is calculated in the Appendix, and takes the following form:

$$r = \frac{1}{\eta}\alpha(1-\alpha)\frac{Y}{N}. \qquad (21)$$

That is,

$$r = \frac{1}{\eta}LA^{1/(1-\alpha)}\left(\frac{1-\alpha}{\alpha}\right)\alpha^{2/(1-\alpha)}(p_K)^{-\alpha/(1-\alpha)}, \qquad (22)$$

where (15) and (17) have been used.

The Ramsey rule: the relation between the rate of return on assets, r, and the rate of time preference, ρ, determines whether households choose a growing pattern of consumption over time, a constant one or a falling one. A lesser willingness to substitute present for future consumption implies smaller responsiveness of the growth rate of consumption to the gap between r and ρ, that is,

$$\gamma_c = \frac{1}{\sigma}(r - \rho), \qquad (23)$$

with σ being the inverse of the elasticity of the intertemporal substitution of consumption. As it has been proved in the Appendix, this expression stems from farsighted consumers who can invest on assets and have a utility function with a constant elasticity of intertemporal substitution.

Here, and henceforth, γ_x denotes the growth rate of variable x.

After describing the model, we focus on equilibrium solutions. In a perfect-foresight equilibrium, all agents take as given the time paths of variables that they do not control: consumers take the time paths of wages and rate of return as given; intermediate-goods producers take price of capital and the demand for intermediate goods as given; and so forth. In equilibrium, markets clear and supply equals demand for all relevant quantities.

Moreover, we focus on those equilibria where international trade is balanced. Our model represents an open economy which exports tourism services (domestic output) in exchange for foreign capital. International trade is balanced if the following equality holds

$$pc_T T = iL \tag{24}$$

where i is per capita imports of foreign capital. Note that, foreign capital accumulation is driven by domestic household investment minus physical depreciation, that is,

$$\dot{K} = iL - \delta K. \tag{25}$$

Long-run balanced growth path

As has been known since Kaldor (1963), there are some empirical regularities on long-run growth rates of countries. In the long run, per capita output and physical capital grow over time, the rate of return on assets remains constant and the ratio of physical capital to final output is nearly constant. With this inspiration, economic growth theory uses the concept of *balanced growth path*, defined as the equilibrium where variables are constant or grow at constant rates.

The following propositions characterize a balanced growth path and identify the innovation as the motor of tourism growth.

Proposition 3 *Along a balanced growth path, the rate of return r remains constant and output production Y, capital K and the number of intermediates N grow at the same constant rate, say γ^*.*

Proof. From (23) the growth rate of consumption is constant if and only if the rate of return on assets, r, remains constant. Then, from (21), final output Y and the number of new intermediates N grow at a common rate. Taking this into account in (20) and knowing that L is constant, it is obtained that capital grows at the same rate. ▪

Proposition 4 *Along a balanced growth path, the real exchange rate p must be constant.*

Proof. By definition, along a balanced growth path r and $\dot{p}/p$ must be constant. Then, since δ is constant, from (18), $p_K p$ must be constant, that is

$$\gamma_{p_K} + \gamma_p = 0.$$

Then, from (17),

$$\gamma_X = \frac{1}{1-\alpha}\gamma_p,$$

and from (19)

$$\gamma_K = \gamma_N + \frac{1}{1-\alpha}\gamma_p$$

which is compatible with the result in the previous proposition if and only if $\gamma_p = 0$. ▪

As a direct consequence from the previous propositions, it is obtained that per capita domestic consumption grows, along a balanced growth path, at the same rate γ^* as output and innovation.

Proposition 5 *Along a balanced growth path, per capita domestic consumption c grows at the rate γ^**

Proof. Taking into account (16), (24) and (25) it is obtained that

$$\frac{Y}{N} = \frac{cL}{N} + \frac{\dot{K} - \delta K}{pN} + \eta\frac{\dot{N}}{N} = \frac{C}{N} + \left(\frac{\dot{K}}{K} - \delta\right)\frac{K}{pN} + \eta\frac{\dot{N}}{N},$$

Therefore, since the growth rates $\dot{K}/K$ and $\dot{N}/N$ must be constant on a balanced growth path, and, from the previous propositions, so must Y/N, K/N and p, the result follows. ▪

The following proposition expresses the growth rate of the economy, γ^*, as a function of the parameters of the model and of the real exchange rate.

Proposition 6 *Along a balanced growth path, the economic growth rate for our economy is given by*

$$\gamma^* = \frac{1}{\sigma}[r^* - \rho], \tag{26}$$

with r^* the unique positive solution of the equation

$$\Lambda \cdot r^{-\frac{1-\alpha}{\alpha}} = r + \delta \tag{27}$$

and Λ a positive constant given by

$$\Lambda = \left[\frac{L(1-\alpha)}{\eta\alpha}\right]^{\frac{1-\alpha}{\alpha}} A^{\frac{1}{\alpha}}\alpha^{\frac{2}{\alpha}}\left(\frac{1-\xi}{\xi}\right)^{\frac{\phi}{1-\phi}}\left(\frac{t}{1-t}\right)^{\frac{1}{1-\phi}}.$$

Proof. Equation (26) comes from (23). Moreover, taking into account that $\gamma_p = 0$ on a balanced path in (18) and the relation between p_K and r given in (22) it follows that

$$\left[\frac{L(1-\alpha)}{\eta\alpha}\right]^{\frac{1-\alpha}{\alpha}} A^{\frac{1}{\alpha}}\alpha^{\frac{2}{\alpha}}r^{-\frac{1-\alpha}{\alpha}}p = r + \delta.$$

Using the value of p given by (13), the equation (27) follows.

It is easy to probe that equation (27) has a unique positive solution. Note that the

left-hand-side of this equation is a strictly decreasing function of r such that$\lim_{r \to 0} \Lambda \cdot$

$r^{-\frac{1-\alpha}{\alpha}} = +\infty$ and $\lim_{r \to +\infty} \Lambda \cdot r^{-\frac{1-\alpha}{\alpha}} = 0$, while the right-hand-side is an increasing linear

function. There exists an unique positive value r^* where both sides coincide. ▪

In an open economy, the long-run economic growth rate depends, not only on its

own economic efficiency (cost of innovation (η), capital or labor production elasticities

(α), production technology (A)), but also on the idiosyncrasy of the visitors, that is, on

their marginal propensity to tourism consumption (t) and on the elasticity substitution

between tourism and domestic consumption (ϕ) (both parameters determine the value of

p).

The growth rate given in (26) will be positive as long as ρ is relatively low with

respect the rest of the parameters of the model. Note that, other things equal, a higher

marginal propensity to tourism consumption (t) yields to a higher real exchange rate (p),

higher interest rate (r^*) and higher growth rate (γ^*). A higher elasticity substitution

between tourism and domestic consumption (ϕ) will have also a positive impact on these

variables.

Taking above propositions into account, the following proposition shows that the

long-run evolution for the income from tourism coincides with the evolution of innovation

on a balanced growth path.

Proposition 7 *Along a balanced growth path, the income from tourism grows at*

the same growth rate than the innovations, γ^*, that is

$$\gamma_I = \gamma^*$$

where $I = c_T T$ is the income from tourism.

Proof. According to (24), income from tourism equals iL/p. Thus income from tourism drive the accumulation of foreign capital, that is, $\dot{K} = iL - \delta K = pI - \delta K$. Therefore, $\gamma_K = \gamma_{\dot{K}} = \gamma_p + \gamma_I$, since $\dot{K}/K$ is constant if and only if the first equality is satisfied. Since $\gamma_p = 0$ according to proposition 3, the result follows. ▪

We have assumed that the temporal evolution of the number of tourists is given by the differential logistic equation (1) with a time-evolving carrying capacity (2). This differential equation has two stationary equilibria: $T = 0$ and $T = CC$. The first is unstable since, given an initial condition $0 < T_0 < CC$, the number of tourists will grow, trying to reach the level CC. Similarly, if $T_0 > CC$, the number of tourists will fall trying to approach the CC level. Since we allow the carrying capacity to evolve with time (thanks to the growth of Y and affected also by the growth of c_T), awareness of possible short-run deviations, in the long-run, the growth rate of the number of tourists equals the growth rate of the carrying capacity, that is

$$\gamma_T^* = \gamma_{CC}^* = \gamma^* - \gamma_{c_T}^*, \tag{28}$$

where γ^* is the growth rate of output and innovation on a balanced growth path. The last equality means that the carrying capacity will grow as the economy grows, driven by innovative entrepreneurship, but this growth will be offset by the growth of individual tourist consumption. Longer stays, higher use of transportation, restaurants, beaches, etc. will reduce the carrying capacity. The growth of tourists' individual consumption will be connected with the growth rate of their income, $\mathcal{R}$, that of their origin country. The following proposition shows this.

Proposition 8 *Along a balanced growth path, the growth rate of the carrying*

capacity is given by

$$\gamma_{CC}^* = \gamma^* - \gamma_{\mathcal{R}},$$

where $\gamma_{\mathcal{R}}$ is the growth rate of foreigners' income (exogenously given to our economy).

Proof. From (28) and (8) we obtain that

$$\gamma_{CC}^* = \gamma^* - \gamma_{c_T^d} + \phi\gamma_p = \gamma^* - \gamma_{\mathcal{R}},$$

since $\gamma_p = 0$ according to proposition 3 and $\gamma_{c_T^d}$ is the growth rate of consumption of

tourists in their origin countries, which is exogenously given and equal to $\gamma_{\mathcal{R}}$. ▪

Consequently, while the innovation growth rate of the domestic country surpasses

the foreign growth rate, the carrying capacity will grow and also the tourist arrivals.

Otherwise, the carrying capacity will remain constant or decline, causing a reduction in the

growth rate of tourist arrivals. The lower flow of tourists arriving in our country will be

offset with a higher per capita tourism consumption, ensuring a positive domestic

economic growth.

Concluding remarks

The carrying capacity of a touristic destination can be increased by investing in

innovation. We propose a model where the R&D investment allows the sustainability of

tourism income in the long run. The long-run growth rate of the host economy depends

not only on its own economic efficiency, but also on the real exchange rate with the

country where visitors come from. Tourists with a higher marginal propensity to tourism

consumption will increase the real exchange rate and the host country long-run economic

growth rate. Tourists with a higher elasticity substitution between tourism and domestic

consumption will have also a positive impact on these variables. On a balanced growth

path, the income from tourism grows at the same rate as innovation, and the carrying capacity will grow while the rate of innovation surpasses a certain value. Specifically, while investing in tourism innovation, the rate of tourism arrivals could be increased as the number of visitors increases and the destination is set away from its stagnation stage.

Appendix: The market economy

This appendix describes the behavior of agents in each sector of the domestic economy and derives the rate of return on assets and the Ramsey rule for consumption.

Final good-sector

The final output production in this economy will be of the form (15). Since final-goods production is constant returns to scale, without loss we can consider a single price-taking firm when solving for the competitive outcome. When the price of Y is normalized to unity in every period, profit maximization,

$$\max \quad Y - wL - \sum_{j=1}^{N} p_j X_j,$$

yields the following conditional demand functions

$$(1-\alpha)\frac{Y}{L} = w, \tag{29}$$

$$A\alpha L^{1-\alpha} X_j^{\alpha-1} = p_j, \tag{30}$$

where w is the wage paid to labor in the final-good sector, and p_j is the price paid for intermediate good j.

Enterprising Firms

At a given date, there exits a number N of enterprising firms. An expansion of the number N requires purposive effort of entrepreneurs. However, the creation of a new

intermediate good j, is costly but could then be used in a nonrival way by all potential producers of good j. That is, one producer's use of the idea would not affect the output that could be generated for given inputs by other producers who use the same idea. Entrepreneurship have to be compensated in some manner, in order to motivate innovation. Patents could provide the necessary incentives to innovation. However, in service industries, like in tourism, innovation produces new ways of offering existing goods, new combinations or presentations of cultural or environmental resources, which is not easily patentable. Acknowledging this difficulty in tourism, it is also realistic to assume that, during a period of time, the creator of a new service would obtain monopoly rental. The reason is just because she has been the first one. This monopoly power will erode gradually over time as potential competitors learned about the new good and imitated it or created substitutes. However, in this period of time, monopoly rentals would provide the incentives to innovate.

For the sake of simplicity, we will consider that the creator of good j retains perpetual monopoly right over the production and sale of good X_j. This is the main stream in endogenous growth literature, although some authors are working for relaxing this assumption in order to obtain more realistic models.

If monopoly power never erodes, the present value of return from discovery the $j - th$ intermediate good is given by

$$V(t) = \int_t^{+\infty} \pi_j e^{-\tilde{r}(t,s)(s-t)} ds \tag{31}$$

where $\pi_j(s)$ is the profit flow at date s and $\tilde{r}(t,s) = [1/(s-t)] \int_t^s r(v) dv$ is the average interest rate between times t and s.

The producer's revenue at each date equals the price p_j times the amount of goods sold less production costs, given by the rental price of capital, p_K, times the quantity of used capital, K_j in the production of good j. That is

$$\pi_j = p_j X_j - p_K K_j.$$

The assumption of a one-to-one production technology in this sector together with monopoly power (producers of intermediates know the downward-sloping demand curves for their produced intermediate goods given is (30)), allows to write instantaneous benefits as:

$$\max_{p_j} \pi_j = (p_j - p_K) L \left(\frac{\alpha A}{p_j}\right)^{1/(1-\alpha)}$$

Profit maximization yields the following equations for price:

$$p_j = \frac{p_K}{\alpha} > p_K \quad \forall j. \tag{32}$$

Thus, the capital is underpaid, compared to the competitive case, in order to compensate for the investment in the R&D sector. Taking into account (32), equation (17) follows and

$$\pi_j = \pi = (1-\alpha) p_j X = (1-\alpha) \alpha \frac{Y}{N} \quad \forall j. \tag{33}$$

These equations demonstrate that each intermediate firm sets the same price and sells the same quantity of its product.

Free entry into the business of being an inventor is assumed, so that anyone can pay the $R\&D$ cost η (in units of output) to secure the net present value, $V(t)$, shown in equation (31). Therefore, on equilibria,

$$V(t) = \eta \tag{34}$$

holds for all t. If $V(t) > \eta$ an infinite amount of resources would be channeled into R&D at time t and $V(t) > \eta$ cannot hold in equilibrium. If $V(t) < \eta$, no resources would be devoted at time t to R&D, and, therefore, the number of intermediates, N, would not change over time. We focus the main discussion on equilibria with positive R&D and, hence, growing N at all points in time.

Differentiating equation (31) with respect to time t we get

$$r = \frac{\pi}{V} + \frac{\dot{V}}{V} \tag{35}$$

where π is the constant profit flow given by equation (33). Equation (35) says that the rate of return to bonds, r, equals the rate of return to investing in R&D, which is the profit rate, π/V, plus the rate of change in the value of the research firm. Since η is constant, the free entry condition implies that $\dot{V} = 0$, therefore $r = \pi/\eta$ and equation (21) is obtained.

Domestic Consumers

Capital is a necessary input for intermediate goods production. A tourism based economy is by definition an open economy so we assume that capital must be imported by trading domestic production with nonresidents, that is, tourists. Therefore, total domestic households' assets equals the market value of firms (ηN) and the value of the imported capital K. Thus per capita households' assets reads

$$assets = \eta n + \frac{k}{p} \tag{36}$$

where $n = N/L$ and $k = K/L$. The tradable good Y has been chosen as the *numeraire*, so p is the relative value of the foreign capital with respect to the domestic's output.

In addition to financial assets, households own labor. Assets deliver a rate of return and labor is a paid wage. The total income received by households is the sum of asset and labor income. Households use the income that they do not consume to accumulate more assets,[9]

$$\frac{d(assets)}{dt} = r \cdot assets + w - c \tag{37}$$

where w is the wage rate and c is per capita consumption.

Accumulation of foreign capital is the result of decision taking on investment. Thus, per capita inversion in foreign capital, i, drives per capita capital accumulation:

$$\dot{k} = i - \delta k. \tag{38}$$

Equations (36), (37) and (38) drive the expression for the evolution of the number of tourism varieties n

$$\dot{n} = rn + \frac{1}{\eta}\left[\left(r + \delta + \frac{\dot{p}}{p}\right)\frac{k}{p} + w - c - \frac{i}{p}\right]. \tag{39}$$

Multiplying by L equation (39) and taking into account (18), the number of intermediate goods evolves according to

$$\dot{N} = rN + \frac{1}{\eta}\left[p_K K + wL - cL - c_T T\right],$$

where (24) has been used. Taking into account (21), (29) and that $p_K K = \alpha^2 Y$ the equation (16) is obtained.

Following the usual convention, we shall assume that consumption and inversion decision can be characterized by a representative consumer maximizing an additively

---

separable function

$$\max_{c,i} \int_0^{+\infty} e^{-\rho t} u(c) \, dt$$

subject to the dynamic budget constraint (37) and capital accumulation law (38). Parameter $\rho > 0$ is the rate of time preference. Assuming that the utility function $u(\cdot)$ exhibits constant relative risk aversion equal to σ, we can write the first order conditions for consumer's problem as the Ramsey rule (23).

References

Aghion, P., Howit, P. (1992), 'A model of growth through creative destruction', *Econometrica*.,Vol 60, No 2, pp 323-351.

Aguiló, E., Alegre, J. Sard, M., (2005), 'The persistence of the sun and sand tourism model'. *Tourism Management*, Vol 26, No 3, pp 219-231.

Albaladejo, I.P., Martínez-García, M.P. (2013), 'An endogenous growth model of international tourism'. *Tourism Economics*, Vol 19, No 3, pp 509-529.

Albaladejo, I.P., González-Martínez, M.I., Martínez-García, M.P. (2014), 'Quality and endogenous tourism: an empirical approach', *Tourism Management*, Vol 41, pp 141-147.

Alegre, J., Juaneda, C., (2006), 'Destination loyalty: consumers' economic behaviour', *Annals of Tourism Research*, Vol 33, No 3, pp 684--706.

Alegre, J., Pou, L., (2006), 'The length of stay in the demand for tourism', *Tourism Management*, Vol 27, No 6, pp 1343-1355.

Alen, M.E., Rodriguez, L., Fraiz, J.A. (2007), 'Assessing tourist behavioral intentions through perceived service quality and customer satisfaction'. *Journal of Business Research*, Vol 60, No 2, pp 153-60.

Butler, R.W. (1980), 'The concept of a tourist area cycle of evolution: implications for management of resources', *Canadian Geographer*, Vol 24, No 1, pp 5-12.

Butler, R.W. (2009), 'Tourism in the future: Cycles, Waves or Wheels?' *Futures*, Vol 41, No 6, pp 346-352.

Butler, R.W. (2011) *Tourism area life cycle*. Goodfellow Publishers Limited, Woodeaton, Oxford.

Camisón, C. and Monfort-Mir, V. (2012), 'Measuring innovation in tourism from the Schumpeterian and the dynamic-capabilities perspectives', *Tourism Management,* Vol 33, No 4, pp 776-789.

Chao, C.C, Hazari, B.R., Sgro, P.M., (2005), 'Tourism and economic development in a cash-in-advance economy' *Research in International Business and Finance,* Vol 19, No 3, pp 365-373.

Clark, C. W. (1932), *Mathematical bioeconomics. The optimal management of renewable resources,* John Wiley & Sons, Inc. New York.

Cohen, J.E. (1995), 'Population Growth and Earth's Human Carrying Capacity', *Science* Vol 269, No 5222, pp 341-346.

Cole, S. (2009), 'A logistic tourism model: Resort Cycles, Globalization and Chaos', *Annals of Tourism Research*, Vol 36, No 4, pp 689-714.

Cole, S. (2011), 'Synergy and congestion in the tourist destination life cycle', *Tourism Management*, Vol 33, No 5, pp 1128-1140.

Deaton, A. Muelbauer, J., (1980a), *Economics and consumer behaviour,* Cambridge: Cambridge University Press.

Deaton, A. Muelbauer, J. (1980b), 'An almost ideal demand system', *American Economic Review*, Vol 70, No 3, pp 312-326.

Diedrich, A., García-Buades, E. (2009), 'Local perceptions of tourism as indicators of destination decline', *Tourism Management*, Vol 30, No 4, pp 512-521.

Dixit, A.K., Stiglitz J.E. (1977), 'Monopolistic competition and Optimal Product Diversity', *American Economic Revi*ew, Vol 67, No 3, pp 297-308.

Ethier, W.J. (1982), 'National and International returns to scale in modern theory of international trade', *American Economic Review*, Vol 72, No 3, pp 389-405.

Eugenio-Martín, J. L. (2003), 'Modelling determinants of tourism demand as a five-stage process: A discrete choice methodological approach', *Tourism and Hospitality research*, Vol 4, No 4, pp 341-354.

Eugenio-Martín, J.L., Martín-Morales, N., Sinclair, M.T., (2008), 'The role of economic development in tourism demand', *Tourism Economics,* Vol 14, No 4, pp 673-690.

Gokovali, U., Bahar, O., Kozak, M. (2007), 'Determinants of length of stay: A practical use of survival analysis', *Tourism Management*, Vol 28, No 3, pp 736-746.

González, A. M. and Bello, L. (2002), 'The Construct " Lifestyle" in Market Segmentation the Behavior of Tourist Consumers' *European Journal of Marketing*, Vol 36, No 1/2, pp 51-85.

Grossman, G.M. Helpman, E. (1991), *Innovation and growth in the global economy*, Cambridge, MA: MIT Press.

Hazari, B.R., Sgro, P.M. (1995), 'Tourism and growth in a dynamic model of trade', *Journal of international trade and economic development* Vol 4, No 2, pp 243-252.

Hazari, B. R., Sgro, P.M. (2004), *Tourism, Trade and National Welfare. Contributions to Economic Analysis,* Elsevier, Amsterdam.

Hjalager, A.M. (2002), 'Repairing innovation defectiveness in tourism', *Tourism Management* Vol 23, No 3, pp 465-474.

Hjalager. A.M. (2010) A review of innovation research in tourism. *Tourism Management* Vol 31, No 1, pp 1-12.

Keane, M.J., (1997), 'Quality and pricing in tourism destinations', *Annals of Tourism Research*, Vol 24, No 1, pp 117-130.

Kaldor, N. (1963), *Capital accumulation and economic growth*, In Lutz, F.A. and Hague, D.C. eds., Proceedings of a conference held by the international economics association. London:Macmillan.

Lagiewski, R. (2006), *The Application of the TALC Model: A Literature Survey,* In The Tourism Area Life Cycle: Conceptual and Theoretical Issues (Vol. 1), R. Butler, ed. Channelview Publications,Clevedon.

Lanza, A., Temple, P., Urga, G., (2003), 'The implications of tourism specialization in the long run: an econometric analysis for 13 OECD economies', *Tourism Management*, Vol 24, No 3, pp 315-321.

Lozano, J., Gómez, C. M., Rey-Maquieira, J. (2008), "The TALC hypothesis and economic growth theory', *Tourism Economics,* Vol 14, No 4, pp 727-749.

Lundtorp, S., and Wanhill, S. (2001), 'The resort life cycle theory. Generating processes and estimation', *Annals of Tourism Research*, Vol 28, No 4, pp 947-964.

Lundtorp, S., and Wanhill, S. (2006), *Time path analysis and TALC stage demarcation,* In

The Tourism Area Life Cycle: Conceptual and Theoretical Issues (Vol. 2), R. Butler, Channelview Publications, Clevedon.

Nowak, J.J., Sahli, M., Cortés-Jiménez, I. (2007), 'Tourism, capital imports and economic growth: theory and evidence for Spain', *Tourism Economics,* Vol 13, No 4, pp 515-536.

O'Reilly, A. M. (1986), 'Tourism carrying capacity: concepts and issues', *Tourism Management*, Vol 7, No 3, pp 154-167.

Papatheodorou, A. (2004), 'Exploring the evolution of tourism resorts', *Annals of Tourism Research*, Vol 31, No 1, pp 219-237.

Plog, S. (1974), 'Why Destination Areas Rise and Fall in Popularity', *Cornell Hotel, Restaurant and Administration Quarterly*, Vol 14, No 4, pp 55-58.

Romer, P.M. (1990), 'Endogenous technical change', *Journal of Political Economy*, Vol 98, No 5, pp 71-102.

Saveriades, A. (2000), 'Establishing the social tourism carrying capacity for the tourist resorts of the east coast of the Republic of Cyprus', *Tourism Management,* Vol 21, No 2, pp 147-156.

Schubert, S. F., & Brida, J. G. (2011), 'The impacts of international tourism demand on economic growth of small economies dependent on tourism', *Tourism Management*, Vol 32, No 2, pp 377-385.

Schumpeter, J.A. (1934), *The theory of economic development,* Oxford University press: London.

Seddighi, H.R., Theocharous, A.L. (2002), 'A model of tourism destination choice: a theoretical and empirical analysis', *Tourism Management,* Vol 23, No 5, pp 475-487.

Tang, C.F. and Tan, E.C. (2013), 'How stable is the tourism-led growth hypothesis in Malaysia? Evidence from disaggregated tourism markets', *Tourism Management*, Vol 37, pp 52-57.

Victorino, L., Verma, R., Plaschka, G. and Dev, C. (2005), 'Service innovation and customer choices in the hospitality industry', *Managing Service Quality,* Vol 15, No 6, pp 555-576.