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Bruno Marques

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TOURISME-TRANSPORT : CAPACITY COORDINATION

Bruno MARQUES, Docteur en Sciences Economiques,

Professeur Associé à l'Université des Antilles (UA).

TRANSPORT-TOURISM: CAPACITY COORDINATION

Bruno Marques

French University of the Caribbean and Guyana (UAG), Center in Economics, Management,

Modeling, and Applied Computing (CEREGMIA) – b.marques@orange.fr

Two major findings emerge from the theoretical analysis of Transport-Tourism link via a game theory type model of capacity coordination. Firstly the model explains the optimal capacities ratio of Transport and Tourism by the quotient of the ratio of tourism type (ratio of the length of stay in the destination and of transport duration) divided by the installation costs ratio (of transport and tourism).The corollary of this first finding gives the second outcome: The optimal transport and Tourism profit ratio is the product of the ratio of the type of tourism by the index of overcapacity conditions (a non linear combination of installation costs, and durations). From these results, it follows an interpretive grid that allows, according to tourism types, firstly to identify the optimal overcapacities by the difference between installation costs; and secondly the equilibrium ratio of profits according to the overcapacity direction and the tourism types.

Keywords: coordination, capacity, profit, tourism type, installation costs.

1. Introduction

The link between Tourism and Transport is a major issue of the tourism economics of a destination. According to the definition of tourism adopted by the United Nations Statistics Commission, WTO, OECD, Eurostat (2001), tourism is intrinsically linked to traveling and transport as well. Asserting that there is no tourism without transport is not unfounded; for the intensive and/or extensive development of tourism requires the existence of transport capacities preceding or accompanying it. The dynamics of Transport and Tourism and the issue of potential overcapacity are at the heart of the analysis of Transport-Tourism link, which can be expressed as follows: Should Transport capacities precede or follow those of tourist reception, to cause tourism development?

The advent and development of Internet profoundly changed the nature of the Transport-Tourism link and suggests to re-examine the study of its dynamics. Disintermediation and new pricing practices initiated by the Internet impacted doubly the link between Transport and Tourism.

Internet primarily affected the coordination of the three private tourism agents: Transport, Tourism Characteristic Industries [producing "tourism characteristic products and services" as defined by the WTO(1999)] and Intermediaries Branches [Tour Operators (TO) and travel agents (AV)]. As documented by Duncan (2009) and Buhalis and Zoge (2007), internet reduced the role of intermediaries in the organization of tourism. Before the advent of internet, the intermediaries aggregated or in the words of Klein and Orsborn (2009) coordinated transport services with tourism characteristic products (accommodation and other leisure activities, attractions ...). More than an interface between supply and demand, intermediaries were the coordinating tool of private productions, regulating capacities and quantities and price. Through the direct access to demand (clients), it provides to transport and tourism characteristic industries, internet restricts or annihilates the coordinating (aggregation) role of intermediaries. Therefore direct prices interactions began to govern coordination between market agents. By adopting the categorization Orsborn and Klein (2009), the link between transport and tourism previously a coordination / aggregation organized by intermediaries became, with the advent of Internet, a mutual coordination ruled by the interactions between tourism players.

The increased uses of Yield and/or Revenue Management [Cf. Deksnyte and Lydeka (2012), Bitran and Caldentey (2003), Chiang and Chen (2007)] by the transport and tourism characteristic branches is the second Internet byproduct. Such pricing behavior based on price discrimination, customer segmentation, real-time knowledge of available capabilities are only possible through the Information and Communication Technology, of which internet is quintessential. Sahut (2009) details the impact of Internet on the expansion of dynamic pricing in tourism. This pricing method is based on the disintermediation effects of Internet, which promoted the development of transport lowcost.

Disintermediation and its byproduct new pricing methods re-question the link between transport and tourism because it eases entries/exits of firms on the tourism market and consequently influences capacities and tourism development. Recent works [Wachsman (2006), Candela et al. (2008), Alvarez-Albelo and Hernandez-Martin (2009) and Andergassen et al. (2013)] justified the favorable role of intermediaries relative to price, welfare and profit. These works do not include capacity constraints intrinsically linked to tourist visits and transportation. Yet the dynamics of transport and tourism capacities shapes the tourism development of destinations. Analyzing structural trends in air transport via the concept of connectivity, UNWTO (2012) highlights the importance of capacity dynamics, evoking latent imbalances between transport and tourism offerings. Lowering entry barriers allowed by Internet and new pricing methods necessarily influence the adjustment dynamics between transport and tourism capacities and thus the tourism development of destinations.

The paper proposes a theoretical analysis of the Transport-Tourism link based on the question: What determines the equilibrium ratio between transport capacity and tourist receiving capacity? Using the methodological framework of the non-cooperative mutual coordination, it proposes a "scheme of intelligibility" of the Transport-Tourism relationship through their relative capacity. It highlights the parameters of the dynamics of tourism development initiated by the interactions between transport capacities and tourist receiving capacities. The analysis provides an explanation framework for overcapacity situations and for the distribution of profits (tourism rent) between the carriers and tourism characteristic industries.

The first section of the paper argues the prism of the capacity coordination as the suitable methodological framework for the study and modeling of the Transport-Tourism link. The second part presents a game theory type model of Transport-Tourism capacity coordination to answer the question. Concluding remarks complete the paper.

2. Transport-Tourism: a capacity coordination problem

According to Klein and Orsborn (2009), as a methodological approach, implemented by the game theory, mutual coordination analyzes economic phenomena as the result of interactions between systemically dependent actors: firms, individuals, sectors ... Consequentely the coordination is apprehended as the mechanical adjustment of interacting systemically linked agents, producing the state of the system at a given moment. Coordination does not necessarily mean cooperation which require a will, whereas the former is a process explanatory.

The literature of the last ten years dedicated to the study of Transport-Tourism link is mainly based upon the methodological approach of mutual coordination. Macintosh et al. (1995) define tourism (including transport) as a system to coordinate. Andergassen et al. (2013) round off this research field and acknowledge the need to analyze the tourism through the prism of coordination. According to these authors, the concept of Tourist Destination and the definition of the tourism product as a complementary bundle of goods necessarily entail the study of tourism as a coordination problem; because the complex lattice of products and services to tourists generates inter-branch interactions bounding the tourism system and its performances [Candela et Figini (2008, 2010)]. The specific study of the link between Transport and Tourism also uses the coordination approach. Prideaux (2000) and Lumsdon and Page (2004) conclude that transport and tourism are structurally dependent, in an "asymmetric" relationship; demand and revenue of the latter being fixed by the former, via infrastructure and the decisions of carriers. Beyond the search for a unidirectional causality, Gay (2006) indicates that the links between tourism and transport are "cumulative" and that there is a need to avoid the "mediological trap... that would make tourism and tourists determined by the medium, namely the transportation modes ". The concepts of Tourist Transport and of Supply Chain [Page (2009)] recognize inherently the systemic dimension of Transport-Tourism relation and thus justifies the coordination methodological approach. For Lohmann and Duval (2011), the Transport Tourism relationship is "symbiotic" and is a "co-dependency".

Keeping with the literature cited above, the paper adopts the mutual intersectoral coordination as the methodological framework for the theoretical analysis of the Transport-

Tourism relationship. Consequently the Tourist Destination[1] is a system of two players: the Transport branch and the Tourism industry[2], conceived as the aggregation of tourism characteristic branches (accommodation and other leisure activities, attractions ...). The branches interact through their price behavior and the capacity implementation of firms. With fixed capacities, price interactions decide the short run arrivals in the destination. The dynamic adjustment of transport and tourism capacities sets the long-term tourism development (arrival trend, production and capacity). Insufficient transportation capacity hinders the development of tourism by limiting arrivals. Conversely scarce tourism capacity do not encourage adding transport capacity. The adjustment of capacities depends on interactive sector strategies or on the coordination of transport and tourism operators. The paper considers capacity coordination, the suitable methodological framework to study of Tourism-Transport link, and consequently adopts the long run perspective. Thus it aims to identify the determinants for optimal capacity that arise from interactions between the two sectoral operators of the destination and as such its long-term tourist arrivals.

Like transportation, whose capacity is measured by offered seats, tourism characteristic activities instantly have a limited receiving capacity; equivalent to the maximum number of visitors during a given period. For tourism characteristic activities, the notion of receiving capacity is equally suitable for a firm or a sector; and can be extended to physical or sustainable capacity of the destination. It allows to consider hosting capabilities of hotels or the maximum receiving capacity of an area measured by the number of physically afforded excursionists, as well as the concept of carrying capacity [Cf.Sayre (2008)]. Thus, the notion of capacity used by the paper provides an interpretive spectrum large enough to be applied for the study of links between transport and accommodation or the relationship between transport and a recreation park.

The analysis of direct sectoral interactions with the methodological framework of non cooperative mutual coordination allows to consider the shrinking role of intermediaries, generated by internet. In addition, the prism of transport and tourism capacities of the paper proposes a new approach compared with recent works emphasizing the interactions of price and production and justifying the role of intermediaries [Cf. Wachsman (2006), Candela et al. (2008), Alvarez-Albelo and Hernandez-Martin (2009) and Andergassen et al. (2013)].

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[1] A country, a sub-region, a city, or a specific space.
[2] branch, sector and industry are equivalent in the paper.

The following section provides a model of mutual intersectoral coordination Transport-Tourism via the interactions of transport and tourism capacities.

3. A coordination model of transport and tourism capacities

The model of mutual intersectoral coordination of Transport and tourism capacities is conducted via a two step non-cooperative game, with simultaneous choice of the players. The search of the Nash equilibrium in perfect sub-games provides the optimal ratio for the two strategic variables of the destination system: price and capacities. The following paragraphs describe the description the game: players, their behavior and its resolution mode.

§ **The players** are the two sectors Transport and Tourism (aggregation of tourism-characteristic branches). At the sectoral level the two branches can be considered as two monopolistic firms, supplying transport capacities and tourism capacities during a given period. These capacities result from single or repeated use of the production factor combination in a given period. In fact, the sectors-firms offer a capacity utilization of transport capacity (T_1) and of Tourism capacity (T_2, which is the aggregation of all the capacities of firms producing characteristics tourism goods). In the modeling, the index 1 indicates the transport industry and 2, the tourism industry.

§ **The behavior of sector-firms** follows a dual perspective. Firstly, each sector-firm decides the capacity allocated to the destination and secondly they set their prices in order to ensure the highest load factor. The first step materializes the long-run behavior of the players and the second its short-term dimension. The dual perspective behavior requires a two steps model.

The first step determines the optimum capacity through the potential-profit maximizing behavior of each sector-firm, since each sector-firm do not know ex ante the level of demand, dependent on price alone. The form of the sector profit function is:

$$\pi_i = p_i T_i - c_i T_i \qquad (1) \ i = 1,2$$

p_i are the sale prices of each unit of capacity. T_i are transport and tourism capacities. Variable marginal costs associated with demand (number of tourist) are assumed negligible. The capacity installation costs ($c_i T_i$) consists of the remuneration of production factors (capital and labor) and other fixed charges linked to installation, in case of repeated use of physical capital. They are postulated linearly dependent on the offered capacity (T_i and so to

physical capital and the intensity of its use) due to the complementary of production factors. This assumption is also underpinned by the normative ratios of the number of employees to the total capacity (seats or rooms) as a quantitative or qualitative index by transport companies and hotel. Constant returns in transport activities for unique routes and with stable technology [Cf. Oum and Zhang (1997), Hensher and Button (2008, pp. 391-392) and De Palma et al. (2013, pp. 286-287)] led to consider fixed the installation marginal cost in the Transport branch(c_1). Notwithstanding the diversity of the tourism branch, returns to scale are also postulated constant, hence the fixity of its marginal installation cost (c_2).

The second step of the game produces the optimum price of the capacity unit by postulating that the sectors-firms minimize their revenue loss (P) at fixed capacity. P is the difference between the maximum revenue $(p_i T_i)$ and actual sales: the product price (p_i) by tourist arrivals: $F = a - bp_1 - p_2$. The formalization of this behavior is: $[Min\ P = p_i T_i - p_i(a - bp_1 - p_2)]$. The arrivals equation (F, the number of arrivals) combines empirical tourism demand modeling with tourist's rational behavior, as presented by appendix 1. b and d are the respective weight of Transport and Tourism, considered complementary goods or durations in the representative tourist's utility function. The revenue loss minimization behavior leads in the equilibrium to a price equation that respects dynamic pricing principles (Revenue and Yield Management) mentioned in the introduction. Appendix 1 explains the two latter points.

§ The resolution of the game: Dynamic adjustment, relative optimal capacities and profits. The resolution of the game is reversely performed. Firstly the Nash equilibrium in price of step 2 is solved; out of which comes the Nash equilibrium in capacity of step 1.

Step 2: The loss minimization by each sector-firm provides the reaction system functions below:

$$\begin{cases} p_1 = \dfrac{1}{2b}(a - dp_2 - T_1) \\ \\ p_2 = \dfrac{1}{2d}(a - bp_1 - T_2) \end{cases}$$

that generates the equilibrium price p_1^* and p_2^*. The price of each sector-firm is negatively related to the capacity of the same branch, and positively to those of the other branch.

$$p_1^* = \frac{1}{3b}(a + T_2 - 2T_1) \qquad\qquad (2-1)$$

$$p_2^* = \frac{1}{3d}(a + T_1 - 2T_2) \qquad\qquad (2-2)$$

The overall equilibrium price of the tourist trip is: $\bar{p} = p_1^* + p_2^* = \frac{(d-2b)T_2+(b-2d)T_1+a^2db}{3bd}$.
The non-cooperative coordination framework $\left(\text{where } \frac{dT_2}{dT_1} \text{ and } \frac{dT_1}{dT_2} = 0\right)$ allows to identify when freedom of entry in the transport market or the tourism market induces a decrease of the equilibrium price of travel ($\bar{p}$), through the partial derivatives of $\bar{p}$. All thing being equal, in the case of Tourist-Tourism (Cf. Appendix 1) an increase of transport capacity always decreases price of the trip (and only if transport duration exceeds 2 times the duration of the excursion for Excursionnist-Tourism: $\frac{b}{d} \in \,]1,2[$). Symmetrically, in the case of Excursionist-Tourism (Cf. Appendix 1) an increase of tourism capacity always decreases price of the trip (and only in case of short stay, when transport lasts less than 2 times the stay for Tourist-Tourism).

Figure 1 summarizes the effect of capacity changes on the equilibrium price of the journey, which can be stated as follows: the simultaneous increase of transport and tourism capacities generates a decrease of price of the trip if:

- **Transport and Tourism are considered as goods in the utility function($b = d = 1$)**
- **Transport and Tourism have the same duration ($b = d$).**
- **Tourist-tourism is a short stay and the transport lasts less than two times the duration of the excursion$\left(\frac{1}{2} < \frac{b}{d} < 2\right)$.**

Figure 1: Effects of capacity changes on the equilibrium price of the journey

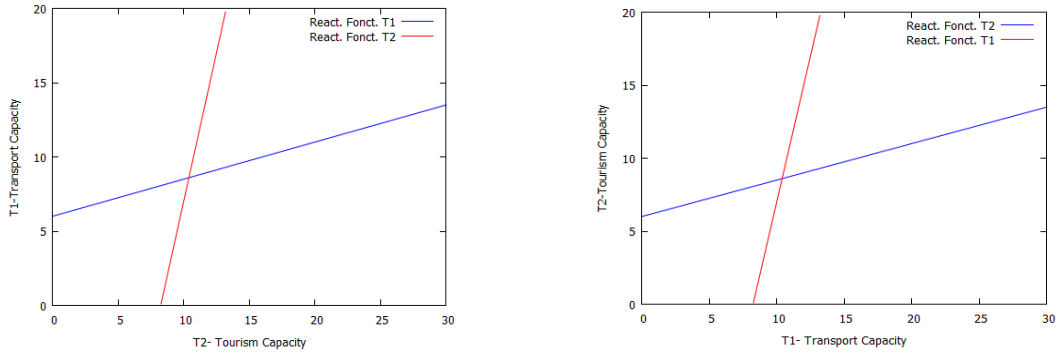|		b/d		
0	1/2		2	
	$d\bar{p}/dT_1 < 0$			$d\bar{p}/dT_1 > 0$
$d\bar{p}/dT_2 > 0$		$d\bar{p}/dT_2 < 0$		
	$d\bar{p}/dT_1, d\bar{p}/dT_2 < 0$			

Step 1: using the optimal prices of step 2 above for maximizing the potential profit of each sector-firm gives the system of reaction functions below:

$$
\begin{cases}
T_1 = \dfrac{1}{4}(a - 3bc_1 + T_2) \\[2mm]
T_2 = \dfrac{1}{4}(a - 3dc_2 + T_1)
\end{cases}
$$

The positive partial derivatives $\left(\dfrac{\partial T_1}{dT_2} \text{ et } \dfrac{\partial T_2}{dT_1}\right)$ confirms the complementarity of Transport and Tourism. The reaction functions system describes the dynamics of tourism development through the capacities dynamics, illustrated in Figure 2 with given parameters [Cf. Varian (1991, p. 287) for a dynamic reading of the reaction functions system for duopolistic markets]. Three main features stem out of the transitional dynamics of Transport-Tourism capacities:

- It is triggered by pre-existing capacities of tourism or transport, as both capacities do not start on the y-axis ($T_2=0$ in equation T_1 and $T_1=0$ in equation T_2). As noted in the left figure, an initial transport capacity linked with resident's journey is necessary to start off the installation of tourist capacities and to launch the dynamic Transport - Tourism. Conversely (right figure) an initial capacity tourism indicating pre-existing internal tourism (as defined by WTO) triggers the installation of transport capacity thus increasing tourism capacity;

- It is based solely on the observation sector-firms capacities as the partial derivatives are not weighted by the parameters (including installation costs). Thus only imperfect information can hamper Transport-Tourism dynamics. Consequently the model highlights Information as a privileged field for public policy;

- It starts with a development phase (positive increase of T_1 and T_2) generating a stable equilibrium capacity [because the slopes are different. Cf. Varian (1991, p. 287)], which if exceeded induce adjustments to lower capacity. Thus the reaction functions system pinpoints transitional overcapacity situations.

Figure 2 : Reaction fonctions in Transport / Tourisme

Solving the reaction system gives the equilibrium capacities below, which are negatively dependent of sector installation costs:

$$T_1^* = \frac{1}{15}(5a - 3dc_2 - 12bc_1) \qquad (3-1)$$

$$T_2^* = \frac{1}{15}(5a - 3bc_1 - 12dc_2) \qquad (3-2)$$

These equilibrium capacities determine the occurrence of structural overcapacities. The optimal ratio of Transport and tourism capacities $(T_1^* - T_2^*)$ depends on the ratio $\frac{d}{b}/\frac{c_1}{c_2}$. The overcapacity of transport $(T_1^* > T_2^*)$ occurs when $\frac{d}{b} > \frac{c_1}{c_2}$. and tourism overcapacity $(T_1^* < T_2^*)$ when $\frac{d}{b} < \frac{c_1}{c_2}$. The asymmetry between the type of tourism (the relative time in transport and in the destination) and installation costs regulates the optimum lag of transport and tourism capacities.

The model allows to express the following rule, summarizes in Table 1: the optimal Transport and Tourism capacities ratio depends on the quotient of the tourism type ratio (ratio of the stay time in the destination and of transport duration) divided by the installation costs ratio (of transport and tourism).

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Table 1: Determinants of the optimal transport-tourism ratio capacities

	$b = d$	$b \neq d$
$c_2 \gtrless c_1$	$T^*_{transport} \gtrless T^*_{Tourism}$	
$\left(\dfrac{d}{b}\right) \gtrless \left(\dfrac{c_1}{c_2}\right)$		$T^*_{transport} \gtrless T^*_{Tourism}$

This rule induces logical necessities from which comes a reading grid of relative overcapacity (see Table 2) according to the type of tourism.

Thus when the tourism and transport are considered goods (b = d = 1), the comparative ratio of installation costs is a good predictor for the relative overcapacity. The relative superiority of tourism installation cost leads to overcapacity of transport and vice versa. This also applies when transport and tourism are assessed as durations, and are similar (b = d).

However, according to the tourism type, installation costs ratio alone does not allow for a symmetrical prediction of overcapacity; while generating corollaries in terms of price.

In Tourist-tourism situations $\left(\frac{d}{b} > 1\right)$, the superiority of Tourism installation costs $(c_2 > c_1)$ leads necessarily to the overcapacity of transport $(T^*_{transp} > T^*_{Tour})$. The reverse is not proved: $c_1 > c_2$ leaves an uncertainty, which does not allow to conclude about the direction of overcapacity $\left(\frac{d}{b} > \frac{c_1}{c_2} > 1 \text{ ou } \frac{c_1}{c_2} > \frac{d}{b} > 1\right)$.

Similarly in the case of excursionist tourism $\left(\frac{d}{b} < 1\right)$, the previous inference applies in reverse: the superiority of the transport installation costs $(c_2 < c_1)$ necessarily induces tourism overcapacity $(T^*_{transp} < T^*_{Tour})$; the reverse is not proven because $c_2 > c_1$ does not necessarily imply $T^*_{transp} > T^*_{Tour}$.

In tourist- tourism situations $\left(\frac{d}{b} > 1\right)$, the tourism overcapacity $(T^*_{transp} < T^*_{Tour})$ goes with the relative superiority of transport price ($p^*_1 > p^*_2$). On the contrary in excursionist tourism situations $\left(\frac{d}{b} < 1\right)$, the relative overcapacity of transport is concomitant with the relative superiority of tourism prices.

Table 2: Interpretive Grid of overcapacity depending on tourism situations

Tourism type / Parameter	$c_2 > c_1$	$c_2 < c_1$	$T^*_{transp} < T^*_{Tour}$	$T^*_{transp} > T^*_{Tour}$
Transport-Tourisme: Goods (b=d=1)	$T^*_{trans} > T^*_{Tour}$	$T^*_{transp} < T^*_{Tour}$		
Touris-Tourism $\left(\frac{d}{b} > 1\right)$	$T^*_{transp} > T^*_{Tour}$		$p_1^* > p_2^*$	
Excursionist-Tourism $\left(\frac{d}{b} < 1\right)$		$T^*_{tranp} < T^*_{Touris}$		$p_1^* < p_2^*$

Proofs supporting the table are in Appendix 2.

The transitional dynamic of step 1, the general rule and the reading grid of table 2 provide an interpretive scheme for imbalances between air transport and tourism capacities revealed by UNWTO (2012). More broadly the model allows the two following inferences:

- Public policies to rebalance excess capacity depends not only on installation costs but also on demand policies: d and b reflecting the nature of tourist clienteles; b for remoteness and d for the length of stay. The effectiveness of the policy is determined by the equation governing the direction of overcapacity: $T^*_{trans} - T^*_{Tour} = (dc_2 - bc_1)\frac{3}{5}$,

- Through the lowering of installation costs it can induce and/or the shift of clientele it can foster by dynamic pricing, Internet necessarily changes the optimum capacities of transport and tourism and hence the link between the two branches

Equilibrium prices and capacities provides the relative ratio of actual profits of each branch: $\frac{\pi_1^*}{\pi_2^*} = \frac{d}{b}\beta$. As explained by appendix 3, β is a non linear combination of installation costs, and durations, and as such can be read as an index of overcapacity because: $\beta \lesseqgtr 1 \Rightarrow T^*_{trans} \gtreqless T^*_{Tour}$.   .

The capacity coordination model allows to summarize the optimal ratio of equilibrium profits $\left(\frac{\pi_1^*}{\pi_2^*} = \frac{d}{b}\beta\right)$ as the product of the tourism type ratio $\left(\frac{d}{b}\right)$ by the index of overcapacity condition.

The interpretive grid for equilibrium ratio of the two sector-firms' profits $\left(\frac{\pi_1^*}{\pi_2^*}\right)$, summarized by table 3, is structured by tourism types and relative overcapacity.

- When transport and tourism are considered goods or when their durations are the same [d=b (=1)], the overcapacity of a sector induces its relative inferiority of profit. Profits are equal if the capacities are identical,

- In the situation of Tourist-Tourism (d > b), Transport-sector profit is relatively higher in case of equal capacity ($T^*_{trans} = T^*_{Tour}$), in case of relative Tourism overcapacity ($T^*_{trans} < T^*_{Tour}$), and if the transport overcapacity is below the maximum arrivals weighted by the inverse of the tourism type ratio $\left[(T^*_{trans} - T^*_{Tour}) < a\left(1 - \frac{b}{a}\right)6.23^{-1}\right]$. Tourism profits are relatively higher only if Transport overcapacity exceeds the previously mentioned threshold,

- In the situation of Excursionist-Tourism (d <b), tourism profit is relatively higher in case of equal capacity ($T^*_{trans} = T^*_{Tour}$), in case of transport overcapacity, and if Tourism overcapacity is above the maximum arrivals weighted by the inverse of the tourism type ratio $\left[(T^*_{Tour} - T^*_{trans}) > a\left(\frac{b}{d} - 1\right)6.23^{-1}\right]$. Transport profits are relatively higher if the tourism overcapacity is below the previously mentioned threshold.

According to Table 3, overcapacity is broadly a good predictor of sector profit ratio and consequently the distribution of tourism income distribution.

Table 3: Relative Profit ratio acording to tourism type and overcapacity index

Tourism Type de tourism / Overcapacity Parameter	$\beta = 1$ $\Rightarrow T_{trans}^* = T_{Tour}^*$	$\beta > 1 \Rightarrow T_{trans}^* < T_{Tour}^*$	$\beta < 1 \Rightarrow T_{trans}^* > T_{Tour}^*$
Transport-Tourism : Goods (b=d=1 ou b=d)	$\pi_1^* = \pi_2^*$	$\pi_1^* > \pi_2^*$	$\pi_1^* < \pi_2^*$
Tourist-Tourism $\left(\frac{d}{b} > 1\right)$	$\pi_1^* > \pi_2^*$	$\pi_1^* > \pi_2^*$ (1)	$(T_{trans}^* - T_{Tour}^*) < a\left(1 - \frac{b}{d}\right)6.23^{-1} \Rightarrow \pi_1^* > \pi_2^*$ $(T_{trans}^* - T_{Tour}^*) \geq a\left(1 - \frac{b}{d}\right)6.23^{-1} \Rightarrow \pi_1^* < \pi_2^*$
Excursionst-Tourism $\left(\frac{d}{b} < 1\right)$	$\pi_1^* < \pi_2^*$	$(T_{trans}^* - T_{Tour}^*) \geq a\left(1 - \frac{b}{d}\right)6.23^{-1} \Rightarrow \pi_1^* > \pi_2^*$ $(T_{trans}^* - T_{Tour}^*) < a\left(1 - \frac{b}{d}\right)6.23^{-1} \Rightarrow \pi_1^* < \pi_2^*$	$\pi_1^* < \pi_2^*$ (2)

Proofs supporting the table are in Appendix 2.

Table 3 provides an "intelligibility scheme" to actual situations.

Tourist-Tourism with tourism overcapacity [(1) in Table 3] corresponds to the situation described by UNWTO (2012), where air transportation seats are below accommodation capacity. In this situation, the model interprets policies aiming to increase transport capacity as a profit rebalancing directed to the tourism sector since $\pi_{transp}^* > \pi_{Tour}^*$ and not necessarily as a tourism development strategy.

The model explains cruiselines' fee on shore excursions during the stopovers [Cf. Petit-Charles and Marques (2012)]. This percentage of the shore excursion price is a share of the profit kept by the carrier, in order to rebalance the profit ratio in favor of tourism sector, in a situation of excursionist-tourism (d / b <1) and relative transport overcapacity ([(2) in Table 2]. Indeed in the Caribbean islands, the capacity of cruise megaships often exceeds the capacity of ground attractions. Without the rebalancing, cruiselines stopovers are less numerous in the destination [Cf. Little Charles and Marques (2012)]. Thus the cruiselines' fee appears as a cooperation device, fully understandable in the frame of the model.

4. Concluding Remarks

Two major findings emerged from the theoretical analysis of transport-tourism link via a game theory type model of capacity coordination. These findings provide the expression and the determinants of Transport and Tourism optimal relative capacities and profits. Firstly the model explains the optimal capacities ratio of Transport and Tourism by the quotient of the ratio of tourism type (ratio of the length of stay in the destination and of transport duration) divided by the installation costs ratio (of transport and tourism). The second outcome of the paper shows the equilibrium profit ratio as the product of the tourism type ratio by the index of overcapacity conditions (a non linear combination of installation costs, and durations).

From these overall rules, it follows an interpretive grid that identifies:

- The optimum capacities ratio by the gap between the installation costs ratio and the tourism type ratio,

- The equilibrium profits ratio according to the direction of relative overcapacity and the tourism type ratio.

Finally, through the model, the paper provides different ratios for empirical tests to assess the link between capacity and profits of Transport and Tourism.

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Appendix 1: Arrivals equation and Revenue loss minimization

b and d parameters in the arrivals equation. The meaning of b and d in the arrivals function is based on the complementarity of transport and tourism in the utility function of the representative visitor and hence on his/her optimization behavior.

The visitor buys a right to use a unit of Transport and Tourism capacity which can be considered a good (calibrated in its duration and in its composition) or a variable duration. Given the sequential nature of the acquisition of transport and tourism services, the model assumes they are perfect complement during the journey. In order to rationally allocate goods or duration of transport and tourism, the representative visitor maximizes a utility function of the form $Min\ (bX_1, dX_2)$, under the budget constraint $m = p_1 X_1 + p_2 X_2$, with X_1, the good or transport time (the right to use one unit of capacity), X_2, the right to use the tourism unit capacity (good or duration), with p_1, p_2, their respective prices. as regards to the utility function, the proportions of X_1 and X_2 are fixed and determined by b and d according to the equation: $bX_1 = dX_2$. Hence b and d are the respective weights of Transport and Tourism. If utility is measured by the number of services then b = d = 1, since the travel requires one transport service and one tourism service (considered the aggregation of all rights of use of tourism characteristic goods, consumed during the stay). If time is the utility unit (transport hours and nights of the stay) b and d are the weighting parameters of transportation duration and stay in the destination. Thus, considering transport technology (able to connect all places within 24 hours) when $d \leq b$, (length of stay in the destination lower than or equal to the transport duration) the model considers the journey as an excursion trip, and the visitor like an "excursionist" according to UNWTO(2002) categories. Consequently in the frame of the model d > b refers to longer stays (and to some extent to more distant destinations) and to visitors categorized as "tourists" by UNWTO (2002). Within these broad limits defining the two major tourism categories (excursion and long stay), the various values for d / b signalize the variety of tourist types. In order to ease interpretations and to adopt broad categories, when $d \leq b$, the model categorizes tourism activities as **Excursionist-Tourism** and if d > b, as **Tourist-Tourism**.

In equilibrium X_i demand function is: $= \frac{m}{bp_1 + dp_2}$, from which it comes $bp_1 + dp_2 = \frac{m}{X_i}$. m is the journey budget.

Following the papers of Sinclair and Stabler (1997) and Lim (2006) on empirical tourism demand modeling, it is possible to model linearly arrivals as: $F = a - \frac{m}{X_2}$; negatively linked with the journey budget (m) and positively with the specific demand of the destination : X_2 (calibrated service or duration). Combining this empirical arrivals equation with the previous demand function of the representative visitor, gives the arrival equation of the model: $F = a - bp_1 - p_2$. In this perspective b and d come from the utility function and are the weights of the two goods or durations. They also materialize the sensitivity of arrivals to prices and to passenger types and to varieties of trips and visitors.

Minimizing Revenue losses and dynamic pricing. The first order condition for static minimization of Revenue losses $[Min\ P = p_i T_i - p_i(a - bp_1 - p_2)]$ is $T_i - (a - bp_1 - p_2) = -bp_i$[3]. Reading dynamically this result (projecting it in the moment) and allows T_i to be an instantaneously available capacity (total capacity less total sales), it comes $T_{it} - (a - bp_{1t} - p_{2t}) = -bp_{it}$ which is equivalent to $T_{it} - F_t = -bp_{it}$. And the remaining capacity instantly () evolves inversely to price. In other words the lower the remaining capacity and the higher the instantaneous price; which illustrates a basic principle of the Revenue / Yield management: either a price which increases in time with the filling. As a result, moderate assumptions of minimizing Revenue loss lead to dynamic pricing, reproducing the behavior of firms initiated by internet.

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[3] With $\frac{\partial^2 P}{\partial P_i^2}$=-2b < 0 the extremum is a minimum.

Appendix 2: Interpretive grid of relative overcapacity

The equilibrium capacities are:

$$T_1^* = \frac{1}{15}(5a - 3dc_2 - 12bc_1)$$

$$T_2^* = \frac{1}{15}(5a - 3bc_1 - 12dc_2)$$

They allow the calculus of equilibrium prices:

$$p_1^* = \frac{1}{3b}(a + T_2^* - 2T_1^*) = \frac{1}{45b}(10a - 6dc_2 + 21bc_1)$$

$$p_2^* = \frac{1}{3d}(a + T_1^* - 2T_2^*) = \frac{1}{45d}(10a - 6bc_1 + 21dc_2)$$

From T_1^* et T_2^* , it comes:

$$\boxed{dc_2 \lesseqgtr bc_1 \Leftrightarrow \frac{d}{b} \lesseqgtr \frac{c_1}{c_2} \Rightarrow T_1^* \lesseqgtr T_2^* \qquad (1)}$$

p_1^* et p_2^*, give $\frac{p_1^*}{p_2^*} = \frac{d}{b} \frac{(10a - 6dc_2 + 21bc_1)}{(10a - 6bc_1 + 21dc_2)} = \frac{d}{b}\alpha$ with $\alpha = \frac{(10a - 6dc_2 + 21bc_1)}{(10a - 6bc_1 + 21dc_2)}$. The ratio $\frac{p_1^*}{p_2^*}$ dépend primarily on $\frac{d}{b}$ and secondly positively or negatively of α. Then

$$\boxed{\frac{c_1}{c_2} \lesseqgtr \frac{d}{b} \Rightarrow \alpha \lesseqgtr 1 \qquad (2)}$$

The implications of the interpretive grid (Table 2) derive from (1) and / or (2)

- Given (1), if $b = d$ or $b = d = 1$ then $c_2 \lesseqgtr c_1 \Rightarrow T_{trans}^* \lesseqgtr T_{Tour}^*$; in the first line of Table 2.

- Given (1), si $b \neq d$ and if $\frac{d}{b} > 1$ then $> c_1 \Rightarrow \frac{d}{b} > \frac{c_1}{c_2}$ hence necesserarily $T_1^* > T_2^*$; (a) in table 2.

- Given (1) and (2), if $b \neq d$ and if $\frac{d}{b} < \frac{c_1}{c_2} \Rightarrow T_1^* < T_2^*$ and $\alpha > 1$, equivalent to $p_1^* > p_2^*$ because $\frac{d}{b} > 1$, hence $\frac{d}{b}\alpha > 1$; (b) in table 2.

- Given (1), if $b \neq d, \frac{d}{b} < 1$ *then* $c_1 > c_2 \Rightarrow \frac{d}{b} < \frac{c_1}{c_2} \Rightarrow T_1^* < T_2^*$; (c) in table 2.

- Given (1) and (2), if $\neq d$ *and if* $\frac{d}{b} > \frac{c_1}{c_2} \Rightarrow T_1^* > T_2^*$ *and* $\alpha < 1,$ *equivalent to* $p_1^* > p_2^*$ *because* $\frac{d}{b} < 1$, hence $\frac{d}{b}\alpha < 1$; (d) in table 2.

Table 2: Interpretive grid of relative overcapacity according to tourism type

Tourism Type / Parameters	$c_2 > c_1$	$c_2 < c_1$	$T_{transp}^* < T_{Tour}^*$	$T_{transp}^* > T_{Tour}^*$
Tourism-Transport : Goods	$T_{trans}^* > T_{Tour}^*$	$T_{transp}^* < T_{Tour}^*$		
Tourist Tourism $\left(\frac{d}{b} > 1\right)$	$T_{transp}^* > T_{Tour}^*$ (a)		$p_1^* > p_2^*$ (b)	
Excursionist Tourism $\left(\frac{d}{b} < 1\right)$		$T_{tranp}^* < T_{Touris}^*$ (c)		$p_1^* < p_2^*$ (d)

Appendix 3: Profits and equilibrium profits ratio.

Equilibrium Profits

The equilibrium prices and capacities from appendix 2 allow the calculus of actual equilibrium profit.

$$\pi_1^* = p_1^*(a - bp_1^* - dp_2^*) - c_1 T_1^*$$
$$= \frac{1}{405b}\left(18c_2^2 d^2 + (36bc_1 - 60a)c_2 d + 261b^2 c_1^2 - 60abc_1 + 50a^2\right)$$

$$\pi_2^* = p_2^*(a - bp_1^* - dp_2^*) - c_2 T_2^*$$
$$= \frac{1}{405d}\left(261c_2^2 d^2 + (36bc_1 - 60a)c_2 d + 18b^2 c_1^2 - 60abc_1 + 50a^2\right)$$

hence the equilibrium profits ratio : $\dfrac{\pi_1^*}{\pi_2^*} = \dfrac{d}{b}\dfrac{\left(18c_2^2 d^2 + (36bc_1 - 60a)c_2 d + 261b^2 c_1^2 - 60abc_1 + 50a^2\right)}{\left(261c_2^2 d^2 + (36bc_1 - 60a)c_2 d + 18b^2 c_1^2 - 60abc_1 + 50a^2\right)}$,

equivalent to $\dfrac{d}{b}\beta$ with $\beta = \dfrac{\left(18c_2^2 d^2 + (36bc_1 - 60a)c_2 d + 261b^2 c_1^2 - 60abc_1 + 50a^2\right)}{\left(261c_2^2 d^2 + (36bc_1 - 60a)c_2 d + 18b^2 c_1^2 - 60abc_1 + 50a^2\right)}$, whose acceptable values, which ensure the positivity of the parameters induce : $\beta \lesseqgtr 1$ si $\dfrac{c_1}{c2} \gtreqless \dfrac{d}{b}$. β reveals excess capacity situations and increase or decrease $\dfrac{d}{b}$, which can be considered as the primary or basic value of the profit ratio.

Equilibrium profit ratio

Le classement des deux composantes du ratio $\dfrac{\pi_1^*}{\pi_2^*}, \dfrac{d}{b}$ et β, selon leur valeur seuil permet une lecture simplifiée des rapports de profit effectif d'équilibre, que synthétise le tableau 3 :

Ranking the two components of the profit ratio $\left(\dfrac{\pi_1^*}{\pi_2^*}, \dfrac{d}{b} \text{ et } \beta\right)$, according to their threshold values allows a simplified reading of the sectoral distribution of profit, as summarized by Table 3

- (1) $\dfrac{d}{b} = 1, \beta = 1 \Longrightarrow \dfrac{d}{b}\beta = 1 \Longrightarrow \pi_1^* = \pi_2^*$

- (2) $\dfrac{d}{b} = 1, \beta > 1 \Longrightarrow \dfrac{d}{b}\beta > 1 \Longrightarrow \pi_1^* > \pi_2^*$

- (3) $\dfrac{d}{b} = 1, \beta < 1 \Longrightarrow \dfrac{d}{b}\beta < 1 \Longrightarrow \pi_1^* < \pi_2^*$

- (4) $\dfrac{d}{b} > 1, \beta = 1 \Longrightarrow \dfrac{d}{b}\beta > 1 \Longrightarrow \pi_1^* > \pi_2^*$

- (5) $\dfrac{d}{b} > 1, \beta > 1 \Longrightarrow \dfrac{d}{b}\beta > 1 \Longrightarrow \pi_1^* > \pi_2^*$

- (6-1) − (6-2) $\frac{d}{b} > 1$ and considering the linear approximation of $\beta(c_1)$ in the in the

  vicinity of $\frac{d}{b}c_2$, it comes $\frac{d}{b}\beta = \frac{d}{b}\left[1 + \left(c_1 - \frac{d}{b}c_2\right)\frac{486bdc_2}{315c_2^2d^2 - 120adc_2 + 50a^2}\right]$ hence :

$$\frac{d}{b}\beta > 1, \text{equivalent to } \pi_1^* > \pi_2^* \Rightarrow 1 + \left(c_1 - \frac{d}{b}c_2\right)\frac{486bdc_2}{315c_2^2d^2 - 120adc_2 + 50a^2} > \frac{b}{d}$$

$$\Rightarrow \frac{1}{b}(bc_1 - dc_2)\frac{486bdc_2}{315c_2^2d^2 - 120adc_2 + 50a^2} > \frac{b-d}{d}$$

$$\Rightarrow \frac{15}{9b}[-(T_1^* - T_2^*)]\frac{486bdc_2}{315c_2^2d^2 - 120adc_2 + 50a^2} > \frac{-(d-b)}{d}$$

$$\Rightarrow \theta < \frac{1}{54d^2c_2}(21c_2^2d^2 - 8adc_2 + 50a^2), \text{with } \theta = \frac{T_1^* - T_2^*}{d-b}$$

$$\Rightarrow 0 < 21c_2^2d^2 - (8a + 54\theta d)dc_2 + 3.3a^2$$

Hence with $A(c_2) = 21c_2^2d^2 - (8a + 54\theta d)dc_2 + 3.3a^2$, it comes $A(c_2) > 0$

$$\Rightarrow \forall c_2 \text{ si } (8a + 54\theta d)d^2 - 4 \times 21d^2 \times 3.3a^2 < 0 \Rightarrow \theta < \frac{a}{d}\frac{1}{6.23}$$

$$\Leftrightarrow T_1^* - T_2^* < a\left(1 - \frac{b}{d}\right)\frac{1}{6.23}.$$

Thus if $T_1^* - T_2^* < a\left(1 - \frac{b}{d}\right)\frac{1}{6.23}$ then $\pi_1^* > \pi_2^*$ (6-1)

and if $T_1^* - T_2^* \geq a\left(1 - \frac{b}{d}\right)\frac{1}{6.23}$ then $\pi_1^* < \pi_2^*$ (6-2)

- (7) $\frac{d}{b} < 1, \beta = 1 \Rightarrow \frac{d}{b}\beta < 1 \Rightarrow \pi_1^* < \pi_2^*$

- (8-1) − (8-2) are are obtained with the same method (6-1) − (6-2)

- (9) $\frac{d}{b} < 1, \beta < 1 \Rightarrow \frac{d}{b}\beta < 1 \Rightarrow \pi_1^* < \pi_2^*$

Table 3: Interpretive grid of profits ratio according to tourism types

Type de tourisme / Paramètres	$\beta = 1$ $\Rightarrow T^*_{trans} = T^*_{Tour}$	$\beta > 1 \Rightarrow T^*_{trans} < T^*_{Tour}$	$\beta < 1 \Rightarrow T^*_{trans} > T^*_{Tour}$
Tourisme-Transport : Biens (b=d=1 ou b=d)	$\pi^*_1 = \pi^*_2$ **(1)**	$\pi^*_1 > \pi^*_2$ **(2)**	$\pi^*_1 < \pi^*_2$ **(3)**
Tourisme de Séjour Long $\left(\frac{d}{b} > 1\right)$	$\pi^*_1 > \pi^*_2$**(4)**	$\pi^*_1 > \pi^*_2$ **(5)**	**(6-1)** $(T^*_{trans} - T^*_{Tour}) < a\left(1 - \frac{b}{d}\right)6.23^{-1} \Rightarrow \pi^*_1 > \pi^*_2$ **(6-2)** $(T^*_{trans} - T^*_{Tour}) \geq a\left(1 - \frac{b}{d}\right)6.23^{-1} \Rightarrow \pi^*_1 < \pi^*_2$
Tourisme d'Excursion $\left(\frac{d}{b} < 1\right)$	$\pi^*_1 < \pi^*_2$**(7)**	**(8-1)** $(T^*_{trans} - T^*_{Tour}) \geq a\left(1 - \frac{b}{d}\right)6.23^{-1} \Rightarrow \pi^*_1 > \pi^*_2$ **(8-2)** $(T^*_{trans} - T^*_{Tour}) < a\left(1 - \frac{b}{d}\right)6.23^{-1} \Rightarrow \pi^*_1 < \pi^*_2$	$\pi^*_1 < \pi^*_2$ **(9)**