Coordinating a tourism supply chain using cooperative advertising under various channel power structures

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Abstract
We analyze a tourism supply chain containing a theme park, local hotels, and multiple travel agents using a game theoretic approach in three scenarios: Nash equilibrium, Stackelberg equilibrium, and full cooperation. We find that a vertical cooperative advertising strategy is particularly effective in increasing customer demand.

Keywords: Supply chain management, Tourism, Cooperative advertising

Introduction
Package holidays are becoming increasingly popular in many countries (Yang et al. 2009). Travel agents and related companies form a tourism supply chain (TSC) by bundling multiple tourism features into such packages. A typical TSC involves the suppliers and retailers of all tourism goods, services, and tourists to whom the services are delivered. Downstream players include travel agents and tour operators that provide products and services to tourists. Midstream enterprises provide tourist facilities such as hotels, restaurants, transportation, and shopping facilities. Upstream members provide materials to the midstream enterprises and also include customer destinations such as theme parks (Huang, et al. 2012).

Integration of tourism distribution channels can increase profits for members of the TSC (Ford et al. 2012), which shows the importance of tourism supply chain management (TSCM) (Song et al. 2013). TSCM, which can be defined as the management of tourism supply chain operations with the objective of satisfying tourists’ demands and companies economic goals (Zhang et al. 2009), is an emerging field that has been receiving great attention. However, research in this area has only just begun.

Achieving coordination among the stakeholders is among the most efficient ways to manage any supply chain. Our study aims to coordinate the TSC using cooperative advertising. Marketing efforts are critical in the tourism industry. Many times, travel agents fail to promote destinations properly (Zhang and Murphy 2009). For instance, due to high printing
costs, travel agents tend to keep the destination booklets for their own reference instead of sending them home with tourists. Potential tourist demand consequently suffers. As a result, destinations should be involved with marketing efforts for package holidays. Although popular destinations such as theme parks (e.g. Disneyland, Universal Studios) have their own brand identity, local advertisement with travel agents is important for maintaining that identity. Such local advertisements can be implemented by distributing handouts, sending emails, promoting in newspapers and on TV, and so on.

Previous studies have examined cooperative advertising in manufacturing supply chains (e.g. SeyedEsfahani et al. 2011). Most of these focus on a manufacturer-retailer system involving two or three stakeholders (e.g. Wang et al. 2011). However, research on cooperative advertising in TSCs has been quite limited. Due to the importance of the tourism industry and its unique characteristics, exploring cooperative advertising in TSCs is worthy of careful study.

Our paper examines cooperative advertising among theme parks and travel agents under three different channel power arrangements: (1) the theme park and the set of travel agents have the same decision power; (2) the theme park has greater decision power than that of the set of travel agents; and (3) full cooperation among the theme park and the travel agents. We raise two research questions: (1) If the theme park can share some local advertisement costs with the travel agents, will the travel agents be more motivated to increase their local advertising efforts?, and (2) What factors can drive the theme park to share a larger proportion of local advertising costs with the travel agents?

Overall, this paper contributes to the extant literature in the following ways. First, the models in this study extend the number of retailers (travel agents in our example) to \( n \) instead of only 1 or 2 as seen in most of the current cooperative advertising literature. Second, another supply chain level (containing the hotels) is added in our model. Third, this is one of the first papers to explore cooperative advertising using a game theoretic approach in the TSC.

**Literature Review**

TSCM is a burgeoning field drawing more and more research attention. Most of the papers in TSCM are either empirical or qualitative, and only a few publications take a modeling approach (Pairach and Michael 2009). For example, Huang et al. (2012) present a comparative study that explores the influence of the tour operator on tourists’ demand. They utilize game theory because it is a useful way to analyze conflicting circumstances involving many stakeholders. Yang et al. (2009) also use a game theoretic approach to find the significant factors influencing the profits of stakeholders in a TSC. SeyedEsfahani et al. (2011) use game theory to examine the equilibriums in four games under various decision power scenarios for one manufacturer and one retailer. We extend their analysis to incorporate multiple retailers (travel agents) and to include information about the hotels. We explore how to use corporate advertising to coordinate a TSC under three channel power arrangements.
Models
Table 1 provides the notation used in this paper.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Notation</th>
<th>Meaning</th>
<th>Notation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>α</td>
<td>The primary demand of each agent</td>
<td>$q_1^j$</td>
<td>Demand of holiday package for travel agent $j$</td>
<td></td>
</tr>
<tr>
<td>β</td>
<td>Store-level factors of each agent that influence consumers’ sensitivity to price</td>
<td>$q_2^i$</td>
<td>Demand of rooms for accommodation provider $i$</td>
<td></td>
</tr>
<tr>
<td>r</td>
<td>Competitive factors that influence consumers’ sensitivity to price</td>
<td>$p_2$</td>
<td>Retail price of rooms for each accommodation provider</td>
<td></td>
</tr>
<tr>
<td>h</td>
<td>Positive constants reflecting the efficacy of local advertising in generating sales</td>
<td>$Q$</td>
<td>Quantity of arrivals at the theme park</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>Ticket price of the theme park</td>
<td>$c$</td>
<td>Operational cost for the theme park</td>
<td></td>
</tr>
<tr>
<td>$\pi_1^j / \pi_2 / \pi_3$</td>
<td>Profit for travel agent $j$ / accommodation provider $i$ / theme park</td>
<td>$k_3$</td>
<td>Positive constants reflecting the efficacy of brand advertising in generating sales</td>
<td></td>
</tr>
<tr>
<td>$c_1^j / c_2^i$</td>
<td>Cost for travel agent $j$ / accommodation provider $i$</td>
<td>$A$</td>
<td>Brand advertising costs for theme park</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Decision Variables</th>
<th>Notation</th>
<th>Meaning</th>
<th>Notation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p_1^j$</td>
<td>Retail price of holiday package from travel agent $j$</td>
<td>$t$</td>
<td>Local advertisement cost-sharing proportion from the theme park</td>
<td></td>
</tr>
<tr>
<td>$a_j$</td>
<td>Local advertising costs for travel agent $j$</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Our paper focuses on the typical tourism supply chain including $n$ travel agents, $m$ accommodation providers (e.g. Hotels), and one theme park as stakeholders, and we use the framework set up by Huang et al. (2010). Every holiday package includes the same theme park. For the demand of each travel agent, we employ the model $D(p_1^j (j = 1, 2, \ldots n), a_j) = g(p_1^j (j = 1, 2, \ldots n))h(a_j)$, where $g(p_1^j (j = 1, 2, \ldots n)) = (\alpha - \beta j^1 p_1^j + \sum_{i=1, i\neq j}^{n} r_i p_1^i)$ is the impact of retail price on demand and $h(a_j) = h_j(h_j \sqrt{a_j} + k_3 \sqrt{A})$ is the sales response function. This model has been used in some previous studies (e.g. SeyedEsfahani et al. 2011).

Assumptions
(1) As Table 1 presents, travel agents differ by (1) holiday package price offered to the
tourists (decision variable), (2) local advertising efforts (decision variable), and (3) cost (exogenous). For simplification, we assume that the demand function parameters facing each retailer are the same and that the hotels charge the same room rate.

(2) Based on special characteristics of the TSC, we consider the price of the theme park as an exogenous variable. Also, we consider the brand effect (for global advertising) of the theme park as an exogenous variable because it has been developed for years and considered to be relatively constant nowadays. Based on the above assumptions, we generate the following functions:

\[ q^j_1 = (\alpha - \beta p_1^j + \sum_{i=1,i\neq j}^n rp_1^i)(h\sqrt{a_j} + k\sqrt{A}) \]  
(1)

\[ \pi^j_1 = q^j_1(p_1^j - p - p_2 - c_1^j) - (1 - t)a_j \]  
(2)

\[ \pi^j_2 = q^j_2(p_2 - c_2^j), \text{ where } q^j_2 = Q/m \]  
(3)

\[ \pi_3 = Q(p - c) - \sum_{j=1}^n t a_j - A \]  
(4)

**Nash Game**

In the first model, we find the Nash equilibrium under the condition that the stakeholders make their strategies independently and simultaneously. Here, we solve the decision problems for the travel agents and theme park separately:

\[
\text{max } \pi_3(t) = Q(p - c) - \sum_{j=1}^n t a_j - A \quad \text{s.t. } 0 \leq t \leq 1
\]  
(5)

\[
\text{max } \pi^j_1(p_1^j, a_j) = (\alpha - \beta p_1^j + \sum_{i=1,i\neq j}^n rp_1^i)(h\sqrt{a_j} + k\sqrt{A})(p_1^j - p - p_2 - c_1^j) - (1 - t)a_j
\]

\[
\text{s.t. } p_1^j \geq p + p_2 + c_1^j, \quad a_j \geq 0
\]  
(6)

**Proposition 1:** The Nash game has the following unique equilibrium:

\[ t^N = 0 \]  
(7)

\[
(p_1^j)^N = \frac{\alpha + r \left( p + p_2 + \overline{c_1} \right) \beta}{2\beta - r(n-1)} + \left( p + p_2 + c_1^j \right) \beta = H + Gc_1^j
\]  
(8)

\[ a_j^N = \frac{D(c_1^j)^2 + E c_1^j + F}{4}, \]  
(9)

where \( \overline{c_1} = \frac{1}{n} \sum_{j=1}^n c_1^j \). For interpretations of other variables, please see appendix A.1.

Proof: See appendix A.2.
**Stackelberg Theme Park Game**

Next, we solve the Stackelberg equilibrium, where the theme park is assumed to be the channel leader. The theme park makes the decision first followed by travel agents who make their respective decisions based on the theme park.

**Proposition 2:** The Stackelberg game has the following unique equilibrium:

\[
t^S = \begin{cases} 
    \frac{2x(p-c)-u}{2x(p-c)+u} & \text{if } u \leq 2x(p-c)-u \\
    0 & \text{otherwise}
\end{cases}
\]

(10)

\[
(p_i^j)^S = \alpha + rm \frac{\alpha + (p + p_2 + c_i^j)\beta}{2\beta - r(n-1)} + (p + p_2 + c_i^j)\beta \\
= \frac{H + Gc_i^j}{2\beta + r}
\]

(11)

\[
a_j^S = \frac{D(c_1^j)^2 + Ec_i^j + F}{4(1-t^S)^2}
\]

(12)

where \(c_1 = \frac{1}{n}\sum_{j=1}^{n} c_i^j\). For interpretations of other variables, please see appendix A.1.

Proof: See appendix A.1.

**Proposition 3:** The holiday package price of each agent in Nash game and Stackelberg game is the same.

Proof: From the function of \(p_1^j\), we can see that \(p_1^j\) in each equilibrium does not depend on \(t\).

So \((p_1^j)^N = (p_1^j)^S\).

Proposition 4 describes the impact on the TSC if the theme park can reduce its operating cost.

**Proposition 4:** In the Stackelberg game, we have higher \(t^j, a_j^S, (q_1^j)^S, Q^S, (q_2^j)^S\), and \((\pi_2^j)^S\) if the cost \(c\) of the theme park goes down.

Proof: Knowing that \(t^S > t^N = 0\), the result follows directly from Proposition 4.

**Corollary 4.1:** \(a_j^N < a_j^S, (q_1^j)^N < (q_1^j)^S, Q^N < Q^S, (q_2^j)^N < (q_2^j)^S, (\pi_2^j)^N < (\pi_2^j)^S\).

Proof: Knowing that \(t^S > t^N = 0\), the result follows directly from Proposition 4.

**Cooperation Game**

The previous subsections discussed two non-cooperative games. However, nowadays competition exists among supply chains instead of individual companies (Cronin et al. 2011). The stakeholders in the TSC may cooperate with each other to take actions to improve profits...
for the entire chain. Next, we model the travel agents – theme park relationship as a cooperative game. All of the channel members agree to cooperate and they aim to maximize the profits for the entire TSC. To simplify this problem, we now assume that all travel agents agree to offer the same retail price \( p \) for the holiday package and provide the same local advertising efforts \( a \). In this way, the profit of the entire system is:

\[
\max \; \pi (p, a_j) = \sum_{j=1}^{n} (p - c_1^j) q_1^j - (\bar{c}_2 + c) \sum_{j=1}^{n} q_1^j - na - A \quad s.t. \; p \geq 0, \; a_j \geq 0, \tag{13}
\]

where \( q_1^j = q = (\alpha - \beta p + r(n-1)p)(h\sqrt{a} + k\sqrt{A}) \), \( \bar{c}_2 = \frac{1}{m} \sum_{i=1}^{m} c_2^i \).

Solving the above problem, we have the following proposition.

**Proposition 5:** The cooperation game has the following unique solution:

\[
p^c = \frac{\alpha + (\beta - r(n-1))(\bar{c}_1 + \bar{c}_2 + c)}{2(\beta - r(n-1))} \tag{14}
\]

\[
a^c = \frac{1}{4} \frac{h^2}{\alpha} \left( \frac{1}{2} \alpha - \frac{1}{2} (\beta - r(n-1))(\bar{c}_1 + \bar{c}_2 + c) \right)^2 \left( \frac{\alpha}{2(\beta - r(n-1))} - \frac{1}{2} (\bar{c}_1 + \bar{c}_2 + c) \right)^2 \tag{15}
\]

\[
0 \leq t^c \leq 1 \tag{16}
\]

Proof: See appendix A.4.

Proposition 6 describes the impact on the TSC if the theme park can reduce its operating cost.

**Proposition 6:** In the cooperative game, we have higher \( a^c \), \( q_1^c \), \( Q^c \), \( q_2^c \), \( \pi_2^c \) and lower \( p^c \) if the cost \( c \) of the theme park goes down.

Proof: See appendix A.5.

**Numerical Example**

In this section, we introduce a numerical example to show how the numbers change under each scenario. Our example contains \( n = 4 \) travel agents, \( m = 2 \) hotels and one theme park in the TSC. Parameter values include: \( \alpha = 800 \), \( \beta = 8 \), \( r = 2 \), \( h = 1.0 \), \( k = 1.2 \), \( p = 90 \), \( p_2 = 40 \), \( c_1^1 = 20 \), \( c_1^2 = 30 \), \( c_1^3 = 28 \), \( c_1^4 = 25 \), \( c_2^1 = 20 \), \( c_2^2 = 30 \), and \( A = 8 \times 10^7 \). The results of each scenario are listed in Table 2. The travel agents, hotels and theme park are represented by TA, HO, and TP, respectively.

The numerical results justify our theoretical results. As seen from Table 2, when \( t \) increases from 0 to 0.269, the local advertising efforts increase almost two times for each travel agent (e.g. from \( 1.638 \times 10^8 \) to \( 3.067 \times 10^8 \) for travel agent 1). The total tourists’ demand therefore increases from \( 3.519 \times 10^7 \) to \( 4.224 \times 10^7 \) and the profit increases by 8.15% for the whole TSC. Therefore, a vertical cooperative advertising strategy appears to be particularly effective in increasing customer demand.
Table 2 – Results of Numerical Example for the Three Scenarios

<table>
<thead>
<tr>
<th></th>
<th>Nash Game</th>
<th>Stackelberg Game</th>
<th>Cooperation Game</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$p_1^j$</td>
<td>$a_1^j \times 10^8$</td>
<td>$q_1^j \times 10^6$</td>
</tr>
</tbody>
</table>

Conclusions and Implications

Conclusions

Three scenarios are examined in this research: Nash equilibrium, Stackelberg equilibrium, and cooperative game equilibrium. We found a unique equilibrium for each scenario.

With regard to the first research question, the answer is yes, cooperation does increase advertising efforts by travel agents. In detail, we identified the local advertising efforts of each travel agent, the amount of tourists buying holiday packages from each travel agent (the total amount of tourists), and the profits of each hotel, which are lower in Nash game than in the Stackelberg game due to no local advertisement cost-sharing from the theme park. The more local advertisement efforts travel agents make, the more profits each hotel will gain due to the
increased demand.

With regard to the second research question, the results substantiate the operational cost of theme park as an important factor. Specifically, a reduced operational cost increases the proportion of local advertising costs shared by the theme park in the Stackelberg game. This practice strengthens the motivation for the travel agents to invest more efforts in local advertisements and thus increase tourist demand for holiday packages in both the Stackelberg game and the cooperative game.

Managerial Implications
In light of the findings in this study, we conclude that cooperate advertising could increase tourist arrivals to the theme park and thus increase demands at hotels. In this fashion, hotels could also be involved in cooperative advertising and share some local advertising costs (e.g. sharing the booklet printing cost). The TSC’s profits will be enhanced as a result. In addition, local government agents could introduce policies (such as offering a subsidy to the theme park) to stimulate the theme park to share local advertising costs for travel agents. We found the importance of cost reduction of the theme park to facilitate cooperate advertising. Therefore, the theme park could try to reduce its operational cost and thus divert more of those dollars into cooperative advertising with travel agents. Finally, from the supply chain management perspective, long-term and strategic partnerships among all of the stakeholders in the TSC could induce more efficient decisions and thus improve the performance of the entire TSC.

Implications for Future Research
Two principle implications are proposed for further research. First, this paper provides a theoretical approach to analyze the stakeholders’ respective revenues and profits from the supply chain perspective. Quantitative models, which have not been widely applied to the realm of TSCs so far, should raise more attention in future research in that they reflect the essence of stakeholder theory and predict future actions for relevant stakeholders in a mathematical way. Further quantitative research on TSCs could extend our model by adding more variables, including the hotels as decision makers, and running numerical simulations. Second, further research on TSCM could focus on empirical studies. Through interviewing the related stakeholders or other data collection, the scope of theoretical results in this study could be extended to the real world. Hence, a comparison between theoretical results using quantitative models and empirical results by data analysis will yield a tremendous contribution.

Appendix
A.1 Proof of Proposition 2

The function $\pi_1^j$ is concave w.r.t $a_j$ and $p_1^j$. The Jacobian is an increasing function w.r.t $A$. By the previous assumption, we have a big enough $A$ so that $J > 0$. By taking the FOC and some algebra, we get $p_1^j = \frac{\alpha + r_1^{\alpha}(p+p_2+c^j_1)G + (p+p_2+c^j_1)\beta}{2\beta + r} = H + Gc_1^j$, where
\[
H = \frac{\alpha + r_n \frac{\alpha + (p + p_2 + c_1)}{2 \beta - r(n-1)} + (p + p_2) \beta}{2 \beta + r},
\]
\[
G = \frac{\beta}{2 \beta + r}, \quad a_j = \left(\frac{\alpha - \beta H - \beta Gc_1^j + r B - r H - r Gc_1^j}{2(1-t)}\right)^2
\]
\[
\left(\frac{h(s - Tc_1^j)(G - 1)c_1^j + M}{2(1-t)}\right)^2 = \left(\frac{p(c_1^j)^2 + Ec_1^j + F}{2(1-t)}\right)^2
\]
where \(S = \alpha - \beta H + \frac{r B}{R} - r H; \quad T = (\beta + r) G; \quad M = H - p - p_2; \quad D = -hT(G-1); \quad E = (h(G-1)S - TMh); \quad F = hSM; \quad B = n\alpha + \beta(p + p_2 + c_1); \quad R = 2\beta - r(n-1).\) Then \(q_1^j = -\frac{ThD(c_1^j)^3}{2(1-t)} + \frac{(hSD - hTE)(c_1^j)^2}{2(1-t)} + \frac{(hSE - ThF) - k\sqrt{AT}}{2(1-t)} + \frac{hsF}{2(1-t)}.\) So \(Q = \sum_{j=1}^{n} q_1^j = \frac{x}{2(1-t)} + \Delta,\) where \(x = -ThD\theta + (hsD - ThE)\theta_2 + (hSE - ThF)\theta_3 + nhSF,\) \(\Delta = (nS - T\theta_1) k\sqrt{A},\) \(\theta_1 = \sum_{j=1}^{n} c_1^j = n c_1,\) \(\theta_2 = \sum_{j=1}^{n} c_1^j, \quad \theta_3 = \sum_{j=1}^{n} (c_1^j)^3 \quad \sum_{j=1}^{n} d_j = \sum_{j=1}^{n} (\sqrt{a_j})^2 = \frac{D^2\theta_4 + 2DE\theta_3 + (E^2 + 2DF)\theta_2 + 2EF\theta_1 + nF^2}{4(1-t)^2}.
\]
Thus, \(\pi_3 = \left(\frac{x}{2(1-t)} + \Delta\right) (p - c) - t \sum_{j=1}^{n} a_j - A = \left(\frac{x}{2(1-t)} + \Delta\right) (p - c) - \frac{tu}{4(1-t)^2} - A.
\]
When \(t = \frac{2x(p - c) - u}{2x(p - c) + u} = 1 - \frac{2u}{2x(p - c) + u},\) the maximum value of \(\pi_3\) is obtained. Since \(u > 0\) and \(x > 0, \quad t = 1 - \frac{2u}{2x(p - c) + u} < 1.\) However, \(t\) needs to be between 0 and 1. So if \(u < 2x(p - c),\) the optimal \(t = 1 - \frac{2u}{2x(p - c) + u} \). Otherwise, \(t = 0.\) After plugging in \(t\) we get \(a_j.\)

A.2 Proof of Proposition 1
The optimal value of \(t^N\) should be 0 in the view of theme park because it has a negative coefficient in the objective function (6). When \(t^N = 0,\) then follow the first several steps in A.1 and get \((p_1^j)^N\) and \(a_j^N.\)

A.3 Proof of Proposition 4
With increased \(t, \quad a_j^S\) is increased. Then with the increased \(a_j, \quad (q_1^j)^S\) is increased. Since \(Q^S = \sum_{j=1}^{n} (q_1^j)^S, \) with the increased each \((q_1^j)^S, Q^S\) is increased with increased \(a_j.\) Since \((q_1^j)^S = \frac{Q^S}{M}, \quad (q_1^j)^S\) is increased with increased \(a_j.\) Thus \((\pi_3^j)^S\) is increased with increased \(a_j.\)

A.4 Proof of Proposition 5
Any \(t (0 \leq t \leq 1)\) is optimal since it only influences the profit distribution among TAs and the TP, but doesn’t influence the profit of the whole tourism supply chain system. (14) is a concave function with respect to \(a\) and \(p\) when assuming that \(\beta - r(n - 1) > 0,\) which means the
Agent \( j \) store-level factors that influence consumers’ sensitivity to price are more influential to its demand then the total other \( (n - 1) \) agents’ competitive factors that influence consumers’ sensitivity to price. Thus, through FOC, we find that \( a = \left( \frac{(a-\beta p+r(n-1)p)h(p-c_1-c_2-c)}{2} \right)^2 \). Since 
\[
p = \frac{a+(\beta-r(n-1))(c_1+c_2+c)}{2(\beta-r(n-1))},
\]
we can get \( a \).

A.5 Proof of Proposition 6

We see that \( a^C \) increases with decreased \( c \), and \( p^C \) decreases with decreased \( c \). Since 
\[
\beta - r(n - 1) > 0,
\]
\( q^l_1 \) increases with decreased \( p^C \) and increased \( a^C \). So \( q^l_1 \) increases with decreased \( c \). With the increased each \( (q^l_1)^C, Q^C \) is increased with decreased \( c \). Since \( (q^l_2)^C = Q^C/m \), \( (q^l_2)^C \) is increased with decreased \( c \). Thus \( (\pi^l_2)^C \) is increased with decreased \( c \).

References


