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Author

Yabuta, Masahiro, Scott, Noel

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RESEARCH NOTE

DYNAMIC PROPERTY OF A TOURISM DESTINATION NETWORK

MASAHIRO YABUTA*† and NOEL SCOTT†

*Faculty of Economics, Chuo University, Japan
†School of Tourism, The University of Queensland, St Lucia, Australia

The development pattern of a tourism destination network is a factor in determining the growth of each tourism destination. This research note provides an analytical framework to investigate the dynamic properties of a tourism destination network and separately estimate the individual and destination benefits from destination network development. The method assumes network development is a dynamic process and uses estimates from expert assessors to measure the changes in network properties over time.

Key words: Networks; Destination management; Dynamic process; Linkage effect; Network effect; Fuzzy set theory

Introduction

The aim of this research note is to provide a theoretical framework for analysis of the effect of an increase in collaborative linkages between a network of operators in a destination. Here operators (nodes) are considered to be linked together through flows of customers (relationships), and to benefit from these links through the "sharing" of customer expenditure. These linkages are established and maintained by business relationships, such as exchange of information and development of collaborative projects. Such a network is dynamic, but the previous literature examining tourism networks provide only static analyses and report the structural characteristics at one point in time (Dredge, 2006; Scott, Cooper, & Baggio, 2008), a deficiency that this research note seeks to address.

The analysis of the relationships among tourism operators in a destination is developed as follows. In network terms, each operator is a node, the flow of customers between them is a link, and together these nodes and links define a network. From a business viewpoint, strengthening the link between nodes leads to increased customers or revenue, a good measure of the effectiveness of a link because it corresponds to actual business activity. Network analysis (NA) allows us to examine the structure of the network so defined and to analyze its dynamic properties. The network to be analyzed is assumed

Address correspondence to Masahiro Yabuta, Ph.D., Professor, Faculty of Economics, Chuo University, 742-1, Higashinakano, Hachioji, Tokyo, Japan. Tel: 0426743386; Fax: 0426743425; E-mail: yabuta@tamacc.chuo-u.ac.jp

to be located within a small geographical area easily accessed by tourists. Also while each business may be complex, and include various services, they are considered as one node. A three-step approach is adopted using NA methods in conjunction with some techniques for analysis of tourism chains developed by Pyo (2010). Firstly, the characteristics of a destination network are determined. Secondly, the changing pattern of internode customer flows is estimated using a fuzzy performance grading method. Finally, a quantitative measure of the benefits of network changes is determined.

Tourism Destination Network Performance

A simple example of the tourism destination network is shown in Figure 1, where a new business (node C) in a tourism destination receives referrals and customers' business from another supplier (node A). Figure 1 indicates that C may then become further linked by developing relationships with B and D. The overall structure of the network may then affect destination performance as well as the outcome attained by each node. Increased business generated by either A, B, C, or D can lead to additional business for the others in the network. These network outcomes can be evaluated on a variety of measures such as income (or revenue) or the number of tourists that use two businesses. Clearly, this information must be collected by examining a real case of network development, but in the simple example in Figure 1, the attention is only on the changing pattern of links between nodes. To make the analysis simpler, only binary values and nondirected links are used. As shown in Figure 1, the network develops due to an increase in links among B, C, and D and this changes its structure.

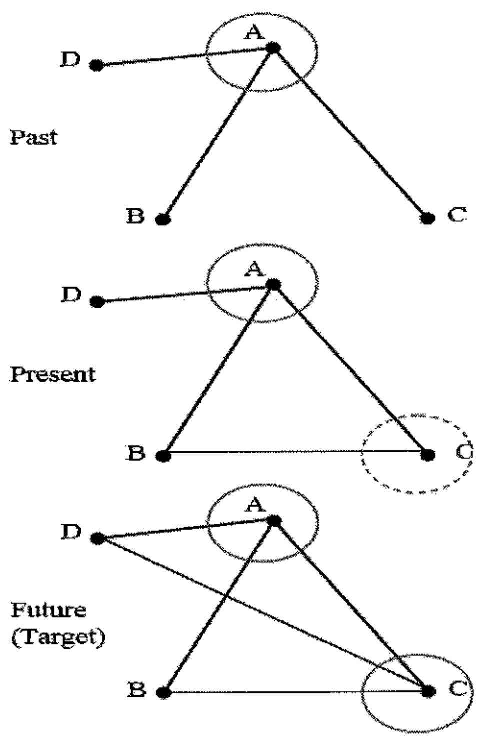

Figure 1. Development of an example tourism destination network.

Data concerning the network pattern, given as Figure 1, can be collected through the use of expert evaluators who have a professional knowledge of the destination network. To collect such data, questions should include, "(For node A) Do you think there was (is, or will be) a network relationship with other nodes?" and "If any, how effective do you think these network links worked (work, or will work)? Please estimate the overall value of the performance of your activities, by scoring from 0, when no relationship, to 100, if a perfect relationship exists." Specifically, each evaluator in the network would be asked to evaluate the importance of nodes in the network, giving each a score out of a hundred. The weighting of the performance can be calculated as a ratio of its score to total scores each time. Following the ordinary procedures of NA, the adjacency matrix, in which the ijth element becomes 1 if there is a link between nodes i and j, and otherwise 0, and the "visitor flow" matrix for the network shown in Figure 1 can be calculated.

The basic structural characteristics of a network include density and centrality. Density is calculated as the proportion of actual ties in a network relative to the maximum number of ties possible. In general, the average value of referrals among nodes increases when density increases. Centrality provides a measure of the position of a node in the network (Freeman, 1979). A number of centrality measures have been proposed; degree centrality, between centrality, closeness centrality, eigenvector centrality, and closeness centrality.

Here we employ the mathematical formula of closeness centrality, the extent to which an individual node is near other nodes, as follow:

$$Cc(i) = \frac{1}{\sum_{j=1}^{g} d(i,j)} \quad or \quad Cc^g(i) = \frac{g-1}{\sum_{j=1}^{g} d(i,j)}, \quad (1)$$

where $d(i,j)$ is the distance between node i and j, and g is the total number of nodes. As for Figure 1, $g = 4$ and i, or j, is A, B, C, or D. $C_c^g(i)$ shows a standardized closeness centrality.[1] In this regard, the centralization for closeness centrality is given by:

$$Cc = \frac{\sum_{i=1}^{g}[Cc^g(i^*) - Cc^g(i)]}{[(g-2)(g-1)]/(2g-3)}, \quad (2)$$

where $C_c^g(i^*)$ shows the maximum value of closeness centrality for all nodes in the network.

Evaluation of Outcomes

The second step of the procedure is to evaluate the performance of the tourism destination network and outcomes for each actor. Evaluators interview the manager of each node, and obtain quantitative data to determine their performance. In analyzing a whole destination, the method that Chan, Qi, Chan, Lau, and Ip (2003) use for analysis of a supply chain may be applied. Chan et al. (2003) and Font, Tapper, Schwartz, and Kornilaki (2008) provide measurement methods for cross-organizational performance that also can be applicable to NA. Researchers examining supply chain management naturally use the network perspective because they examine relationships among stakeholders, such as cooperation, competition, and channels. The measurement method for each node follows the steps below.

Step 2.1: Evaluation of the Performance by Evaluators: $e_i = (E_{i1}$;past, E_{i2};present, E_{i3};target).

Step 2.2: Calculate the performance score (PS), as defined by:

$$\mu_i = \frac{E_{i2} - E_{i1}}{E_{i3} - E_{i1}} \times 10,$$

where $\mu_i \in [0,10]$, i = A, B, C, D. Therefore, each PS shows an achievement ratio of the present performance compared to the future target.

Step 2.3: Estimate the performance grades. Evaluations may contain ambiguities or incorrect information, because each evaluator's judgment may be subjective and arbitrary. Applying fuzzy set theory to reestimate the performance scores is therefore a useful procedure to avoid these ambiguities and to reach unbiased evaluations. A typical method is to calculate the expected value of PS by using both the probability (called the

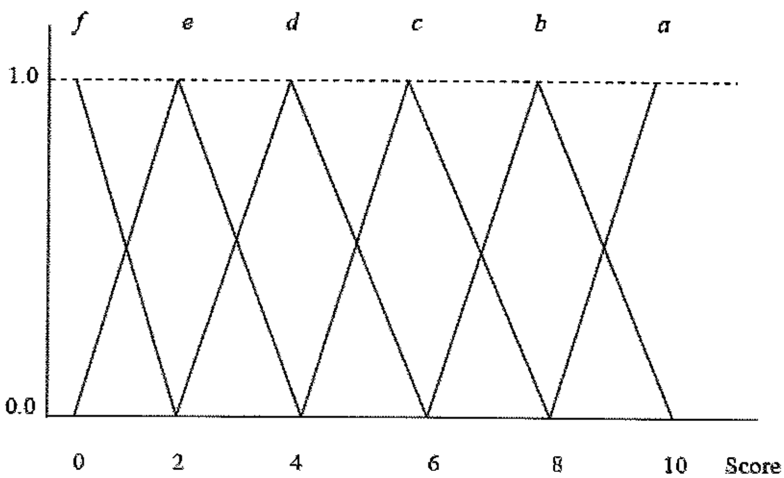

Figure 2. Triangular fuzzy grades.

degree of belongingness) and also a specified fuzzy grade (Fig. 2).

Step 2.4: To calculate the performance index (PI): Multiply a measurement result matrix given by FP_G (Fazzy performance grade matrix) with the weight vector, W^T. Then, PI is given by:

$$PI_i = \frac{s x_i}{\sum_{j=1}^{6} x_{ij}},$$

where x_{ij} [$i = 1$ (past), 2 (present), and 3 (future), $j = 1,2, \ldots, 6$] is the jth element of the ith row vector, $\mathbf{x}_i$, of $FP_G \times W^T$. Each element of vector **s** shows the scores that correspond to apexes from *a* to *f*.

After completing these calculations, the third step is to evaluate the outcome where we find the following. Firstly, PI as an aggregate measurement crucially depends on the weight vector. The difference in relative weights among actors is due to the difference in viewpoints of the importance of each node. The evaluations of nodes might change from time to time, meaning that the weight vector will vary with changing network structure. Moreover, this changing pattern of relative weights or network structure is the key to determining the PI itself. Secondly, although PI is estimated by using scores at three points in time [i.e., past, present, and future (target)], it corresponds only to performance at present because PS merely indicates a present evaluation of a target. If the target of a node is set lower to compare with another node, the PS of the node will be large. Moreover, if actors in all nodes keep the target low, then PI will become large. However, this does not necessarily imply that the performance is good. Thirdly, PS is estimated by using scores that actors grade for each period. PS indicates not an absolute score but a relative score. This procedure may be preferable when performance must be calculated with differing units.

Decomposing Network and Linkage Effects

The PI calculated above results from a mixed effect due to a node's own development and its linkages within the network. A major aim in applying NA to a tourism destination is to estimate the relationship between increasing linkages and its effect on tourism development. Here we consider the network as a type of infrastructure; developing a network directly contributes to overall destination performance, and network expansion contributes to an increase in welfare (income, employment, etc.) at each node. The following procedure quantifies the effect of a changing pattern of a network on the overall outcome in terms of income at a tourism destination.[2]

To make the analysis simple, the outcomes of the tourism sector are assumed to be measured by income, or equivalently, production. The income level is hypothetically determined by:

$$\begin{aligned} y_i &= f_i\left(n_i, \sum_{j \neq i} l_{ji} n_j, \sum_j n_j\right),\ l_{ij} \\ &= 1 \text{ when } j \text{ directly tied to } i, \text{or } l_{ij} \\ &= 0 \text{ otherwise} \end{aligned} \tag{3}$$

where y_i is income, n_i is total inputs at node i, such as employment. It is assumed that there are two layers of effects from a network; one is the direct effect, which stems from other nodes that link directly to node i, and the other is the overall externality of the network.[3] In fact, it may be difficult to estimate equation (1) within a nonlinear formation.[4] Following the Taylor expansion, the evolution of the tourism destination network can be given by a linear function:

$$\begin{aligned} \Delta y_i &= f_{i1}\Delta n_i + f_{i2}\sum_{j \neq i}(\Delta l_{ij} n_j + l_{ij}\Delta n_j) \\ &\quad + f_{i3}\sum_j(\Delta n_j) + \varepsilon_i \end{aligned} \tag{4}$$

In this equation, each partial derivative f_{i1}, f_{i2}, and f_{i3} indicates the effect of change in the size of node i itself, the change in the size of other node's and additional links with node i, and the change in the total network, on the outcome at node i, respectively. ε_i is the reminder of linear approximation, but hereafter is ignored.

Expressed as a matrix, equation (4) will become:

$$\begin{aligned} \Delta Y &= F_1\Delta N + [F_2\Delta L'N + F_2 L'\Delta N] + F_3\Delta N^0, \\ &= \{[F_1 + F_2 L']\Delta N + F_3\Delta N^0\} + F_2\Delta L'N \end{aligned} \tag{5}$$

where F_k is a diagonal matrix whose components consist of f_{ik}. L is a matrix whose elements consist of l_{ij}. ΔL is a matrix whose components are Δl_{ij}. ΔN

is a vector whose elements are an increment of capacity of each node and ΔN^0 is a vector whose elements are the sum of all node's increments of capacity. N is a vector whose elements are n_i.

The first expression on right-hand side of equation (5) indicates that an increment of output can be decomposed into three factors. The first is a direct effect due to changes in the capacity of node itself; the second is a network effect via linkage among nodes through which a changing pattern of the network can influence output; and the third is an overall effect of a network destination. The second expression in equation (5) separates the effects into two parts. One is the effects due to changes in nodes' capability/capacity and another is the effects due to changes in linkage pattern. In this regard, the former might be named scale effects and the latter might be named linkage effects. A change in output at each node can occur due to both scale effects and linkage effects.

In this example, changes in the links of the network cause various centralities such as closeness centrality to change; and the following clarifies the relationship between ΔL and centrality. The simple example given by Figure 1 is used, and attention is directed to "closeness centrality," formulated by equation (1) and equation (2). From equation (1), so long as the change in the network structure does not involve new nodes, a change of centralization index can be deduced by:

$$\Delta C_c^{\,g}(i) = \frac{1-g}{\left(\sum_{j=1}^{g} d(i,j)\right)^2}\left[\sum_{j=1}^{g} \Delta d(i,j)\right] \quad (6)$$

In this formula, it should be noted that, as far as our simple case is concerned, the difference of the adjacency matrix between two points of time, indicated by ΔL, is the same as the difference of the distance matrix at each point of time. In a matrix formula, this equation can be given by:

$$\Delta C' = \Delta DG = \Delta LG. \quad (7)$$

where $\Delta C'$ is a vector whose elements are $\Delta C'(i)$ and G is a vector whose elements are

$$\frac{1-g}{\left(\sum_{j=1}^{g} d(i,j)\right)^2}.$$

ΔD is a matrix whose components are $d(i,j)$. By definition, $\Delta D = \Delta L$. Therefore, factors that change the pattern of the network, in particular a change in linkages among nodes, have an influence on the changing pattern of various outcomes at each node in the network.

Conclusion and Further Remarks

It is clear that tourism in a region where the nodes of stakeholders are related to each other can be developed thorough investment or improvement of capacity building at each node, or through networking in a tourism destination. In this research note, following network analysis (NA), we have provided some technical procedures that enable us to give a quantitative analysis not only from a static but also a dynamic perspective. In particular, the research note develops a dynamic analysis of the tourism destination network, which assumes two periods: from the past to the present and from the present to the future (or the target). Incorporating these two stages, it becomes possible to analyze the relationship between network development and node development. This research note introduces two methods as typical analytical measures; one is the use of the quantitative data, which is collected from the actors at each node and, therefore, may well be subjective, depending on their personality, memories, and expectations. In this regard, it was shown that incorporating a fuzzy analysis enabled us to avoid some degree of ambiguity of the data and the overall performance of the network should be estimated though there were some prototypes. This method might be the easiest way to evaluate the dynamic process of networking and tourism development.

Another method is the analysis of factors that affect the dynamic process of network effects. In the first method, it is unclear what factors are important, including networking and promotion of tourism development. To analyze the possible factors to promote tourism development, an output function including inputs and factors of networking development was introduced. Hence, it was shown that there are three major factors to produce tourism development in a network destination: the self-capacity building of nodes, the total effect of tourism destinations, and the network effect on each node through changing patterns of network structure. This procedure utilizes official data, such as income at each period of time. From a research perspective, these two analytical methods should be applied depending on the data available.

There are a number of technical issues that need to be addressed. As already mentioned, a small number of sample data may be efficiently analyzed by using a fuzzy function and by estimating the performance scores (PS) for each node or the performance index for entire network destination (PI). One problem is to investigate how PS or PI is related to the changing pattern of network structure of the tourism destination network. Of course, the main target of this research is to estimate the performance of the tourism destinations and to investigate its cause and effects using network analysis perspectives. The next step is clearly to put the methods developed here to practical use.

Notes

[1]In a real network, there might be many effects affecting tbe centrality, including a geometrical distance and decay effects in travel time along links. In this research note, we ignore these effects for simplicity.

[2]Equation (3) may demonstrate "increasing returns" through network effects. While the derivative with respect to the first term is decreasing, the derivatives with respect to the second or the third terms may be "increasing." This occurs through interrelationships among nodes that are linked together. The same "increasing returns" are found in input–output analysis where there are mutual positive multiplier effects among industries, and also in the "increasing return" production function with respect to production factors.

[3]In equation (3), only the case of new links with bidirection is considered. However, it is possible to incorporate a deepening of the link by setting l_{ij} to be more than 1. Moreover, it is also possible to tbink about one-way links between nodes, for example, by setting $l_{ij} = 1$ but $l_{ii} = 0$. According to this procedure, we can introduce a valued directed graph into the NA.

[4]As a referee commented, whereas the Taylor extension makes a numerical procedure simple, this nonlinearity may have important effects on NA. Some mixed effects caused by development of both nodes and links, for example, can be expected to affect the outcomes in equation (3), and this is an area for further research.

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