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A THEORETICAL MODEL ON MEDICAL TOURISM DESTINATION AND QUALITY PROVISION

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Abstract:
Medical Tourism has become a major industry in the global arena. In the view of the fact that there is a great potential of the industry in India, it is essential to pay more attention to this subdirectory of tourism and reap the economic benefits for the host country. The present paper shall give a theoretical background for the development of medical tourism destination. We have developed a theoretical model that determines the optimal quality of medical service, incorporating the medical sector and an allied sector, providing all the goods and services that make the stay in a destination possible. This scenario is examined when quality of the medical service is (a) homogenous, provided by a monopoly hospital sector, (b) differentiated, provided by high-type and low-type hospitals, in a duopoly market structure. Finally, we compared the quality of medical service provided under (a) and (b) to a coordinated setup, where planning authority of the destination is responsible for maximizing the overall joint profit of the place, to determine ideal quality of medical service. The results show that coordination between hospital sector and allied sector, ensure a higher overall profit-level for the destination, but there exists compromise in the quality of medical service provided under such a setup. This is true for both homogeneous and vertically differentiated service-quality cases. An inferior quality of medical service being provided under coordination setup, implies lower service charge and greater demand of the same. This in turn ensures a sustainable profit for the allied sector.

Keywords: Tourism Economics, Medical Destination, Micro-Economic Model, Hospital Sector, Allied Sector, Income Distribution

INTRODUCTION

Medical Tourism is one of the subfolders of tourism, which has become a major industry in the global forum. This branch of tourism has a great potential in India in the recent years, due to the advancements in communication, information and technology, increase in movements of the producers and consumers of medical and health services, expansion of private sector, encouragement by the Government of many countries through subsidies and providing the ease of doing business. As a result, medical services have been traded more and more every day.

India in recent years has emerged as a major hub for medical tourism and is now considered among the top 6 medical value travel destinations in the world. Medical tourism in India, in mid-2020, was estimated to be worth around USD 9 billion which makes India stand at Number 10 in the Global Medical Tourism Index. Roughly 2 million cases visit India each year from 78 countries for medical, wellness and IVF treatments, generating $6 billion for the assiduity which is anticipated to reach $13 billion by 2026 supported by the government's Heal in India initiative. This not only generates jobs, gains and forex for hospitals but also creates soft power for India, situating it as the Healing Centre of the world. It also creates demand for high-end equipment, which results in continual upgradation of Indian healthcare, resulting in a spiral of demand generating quality,

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generating further demand. Advantages of medical treatment in India include reduced costs, availability of latest medical technologies, compliance on international quality standards, availability of low-cost accommodations, well trained doctors and availability of English-speaking care workers encourage foreigners to choose India as a medical tourism destination.

In this study, we develop a theoretical model that determines the quality of medical services incorporating the medical sector and the allied sector, providing all the differentiated goods and services that make the stay possible, in a destination. We shall examine this scenario in two situations when quality of medical service provided in the destination is (a) homogenous and (b) differentiated.

Literature Review. Research in medical tourism is building up its popularity and is a growing phenomenon, since the industry promises big benefactions to the country. We have empirical studies on extensive medical issues by Piazolo and Zanca (2010), Pourkhaghan (2013), Abdul-Aziz (2015), Connell (2006). However, the theoretical literature regarding medical destination development is really scarce. We identified some studies that highlight the interaction of public and private players in the health care sector, without considering the issue of medical tourism destination that takes account of both medical sector and allied sector.

Pita-Barros and Martinez-Giralt (2002) using a game theoretic model, analysed how a private market outcome for the provision of health care is influenced by the insurance arrangements typical of health care financing. The study identified providers in the primary care sector, making simultaneous decisions on prices and qualities. In contrast, sequential decisions (first qualities and then prices) are an approach to the specialized health care sector. The main conclusion is that enforcing the fixed-copayment rule on the primary healthcare sector is enough to make providers choose the optimal (surplus-maximizing) price and quality levels. In contrast, in the specialized healthcare sector, a regulated (public) provider is needed to reach the first-best solution in prices and qualities and implement either the fixed-copayment or the fixed-reimbursement rules.

Jofre-Bonet (1999) studied the interaction of private and public healthcare providers. The game theoretic model acknowledges that consumers differ in their income levels. Health care is provided by a public firm maximizing social surplus and private providers maximizing profits. This paper has compared three regimes of provision health care: mixed oligopoly, public monopoly and a strictly private regime, under the realistic assumption that quality of health care delivery matters. In addition, it has been assumed that universal coverage of health care is socially desirable, but, due to large marginal costs, private firms would not provide full market coverage. The mixed oligopoly regime has been shown to be the least expensive and the most satisfactory for consumers.

Wolinsky (1997) proposed a scenario of managed competition where providers compete in quality, vs. a scenario of a segmented market where there is a regulated monopolist in each submarket. The aim of the paper is to find the conditions under which each scenario is superior to the alternative one.

Ma and Burgess (1993) considered a game theoretic model combining vertical and horizontal differentiation to study the characteristics of equilibrium allocations under sequential decisions first on quality and then on prices (locations are given). The authors show that sequential decision-making process creates a strategic effect that distorts outcomes compared to a socially optimal outcome. Exploring the efficiency properties of two regulatory policies, Ma and Burgess conclude that a two-part tariff yields better results than does a simple regulation of prices. A similar strategic effect of sequential moves is also present in some of the variants of our model.

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Stenbacka and Tombak (2019) developed a game-theoretic model including some of the features of health care systems like: a limited number of approved treatments of certain qualities, insurance schemes reimbursing costs of a standard service, and non-profit organizations competing with for-profit suppliers. All the equilibria exhibit quality differentiation and the non-profit captures a higher market share. Non-profits (for-profits) supply the standard service when the quality upgrade induces a sufficiently high (low) increase in production costs. When the non-profit provides the standard-quality all patients are served. In discrepancy, in a for- profit duopoly the standard quality provider charges a price distinction, suggesting that there are ruled out consumers.

The present paper shall give a theoretical background for the establishment of medical tourism destination. So far, no importance has been given to the establishment of hospital hub in a destination for attracting tourists/patients and make gains from trading health care/medical services a reality for the country. We have considered medical tourism destination as a conceptual link between the complexity of the sector, the complementarity and substitutability of many goods and services which includes the medical service, and allied products necessary for the survival and growth of hospital sector in a destination. Thus, we contribute to the literature exploring the allied sector.

Other studies like the studies of Jofre-Bonet (1999), Ma and Burgess (1993) and Stenbacka and Tombak (2019), highlighted quality and price differentiation and competition for larger market share in the health care sector but so far, the literature does not talk about how a hospital sector cannot survive on its own. For a place to emerge as a medical tourism destination, along with hospital/ medical centre providing medical services, there should be other allied sectors which provide complementary goods and services that would make the stay in the destination possible. Thus, our paper aims to give a holistic approach towards medical destination development.

We shall consider Medical Tourism Destination from economic perspective: a territorial system supplying medical service from hospital sector and other allied products supplied by allied sector, required for the stay of patient parties. Our theoretical model shall depict the supply side of medical tourism—a combination of hotels and resorts, medical shops, restaurants defined as allied products in our model along with the medical service facilities themselves. By incorporating allied sector, we shall verify if the equilibria relating to market share, remain same as suggested by the literature.

Thus, our objective here is to develop two-stage theoretical model in order to identify whether or not there should be coordination between hospital sector providing medical services and the allied sector, providing differentiated goods and services, required for the people to survive in the destination, for the development of health tourism destination. In this case, first we will consider a monopoly hospital sector in the presence of an allied sector, and find out the optimal level of medical service quality, that should be provided in the tourism destination. Next, we shall extend our model into a vertically differentiated duopoly market structure where hospital sector, consisting of two types of hospitals, provide high-quality and low-quality medical services, and thereafter, determine the differentiated levels of medical service quality that should be provided by the two types of hospitals. Finally, we will compare the quality of medical service provided under monopoly and non-coordinated duopoly sector to a coordinated set up, where a planning authority who develops the destination is responsible for maximizing the overall profit of the destination to determine quality of hospital service.

METHODS

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Theoretical Framework. We present a very simple model of tourism destination following the one developed by Andergassen and Candela (2013). We modify and extend Andergassen's model to specifically represent the optimal development strategy of medical tourism destinations.

Model. The model setup consists of two sectors that are necessary for a place to rise as a medical tourism destination- the Allied Sectors and the Hospital Sector. The economic model developed in this paper stems from two intertwined perspective, empirical and theoretical. From empirical perspective, our model aims being consistent with evidence of the great diversity, in knowledge, information, communication technology, hospital management, accommodation facilities, and other miscellaneous things, of medical tourism destinations throughout the world. From the theoretical perspective, the destination is a novel, interesting object of study of economics. There are distinctive characteristics of the medical destination that are being investigated:

The allied goods and services making the stay possible, supplied and sold within the destination can be defined as a bundle composed of a set of elementary items. Such goods and services (accommodation, medical shops, eateries, other goods(miscellaneous)) are demanded in a complementary or substitutable way by tourist during their stay. This opens up the issue of coordination and cooperation among the local firms and the hospital sector, providing the actual tourism product. In other words, medical tourism destination can be interpreted as a type of cluster.

We consider a unit mass of identical tourists endowed with a CES utility function having the following arguments: i) the length of stay h at the destination; ii) the variety of n≥1 differentiated tourism related goods and services x_i offered at the destination, with $i = 1,2 \ldots . n$ iii) the index measuring the perceived quality z of the destination's medical service. The medical tourism product is defined by a bundle T including overnight stays and the whole variety of local goods, provided by the allied sectors, necessary for the stay in the destination, $T = \{h, \{x_i\}\}$.

Let $U_{T,j}$be the total utility of a tourist j seeking medical service at the destination.

$$U_{T,j} = \frac{1}{h}\left[\sum_{i=1}^{n} x_i^{\alpha}\right]^{\frac{1}{\alpha}}\left(y_i - p_h h - \sum_{i=1}^{n} p_i x_i\right)$$

Here the degree of substitutability among the allied goods is given by $0 < \alpha < 1$. $'h'$ gives the number of days required for treatment and inversely related to the utility. Average per day price required for treatment is p_h and $p_i{}'$ are prices of allied goods. $x_i{}'$gives set of allied products that include:

i) The hospitality sector which is a broad category of fields within the service industry that mainly include lodging and food services
ii) Medical shops
iii) Other miscellaneous goods.

The tourists are assumed to be heterogeneous with respect to income, $y_i \sim \left[\underline{y}, \bar{y}\right]$ uniformly distributed with density f, where $y_i > p_h h$.

We assume 'z' the index of perceived quality of hospital sector is the probability the patient will receive a successful treatment in the destination. Hence, the expected utility of the patient is given as follows:

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$$U = z(U_{T,j}) + (1-z)(0)$$

$$U = \frac{z}{h}\left[\sum_{i=1}^{n} x_i^{\alpha}\right]^{\frac{1}{\alpha}}\left(y_i - p_h h - \sum_{i=1}^{n} p_i x_i\right)$$

We assume h and z are inversely related, since an improvement in the quality of medical service reduces the number of days required for treatment, that is, the length of overnight stay in the destination falls.

$$h = \theta(z),\ \theta'(z) < 0$$

Secondly, we assume that prices charged by the hospital sector for per unit stay p_h is also an increasing function of hospital service quality, that is

$$p_h = \varphi(z)\,, \varphi'^{(z)} > 0$$

Basically, as perceived quality index improves, price per day stay in the destination increases.

Homogeneous quality case under non-coordination. Under non-coordination, allied sector firms and a monopoly hospital sector providing a homogenous medical service quality maximize their individual profits. In this section, we shall determine the demand of allied products coming from the visitors of the medical destination and the optimal quality of medical service that hospital sector should lay out when the quality of medical service provided, is homogeneous, in a monopoly market structure.

Allied Sectors providing differentiated allied goods. Allied sectors include: i) the hospitality sector which is a broad category of fields within the service industry that mainly include lodging and food services; ii) medical shops iii) other miscellaneous goods. The demand of allied products will come from visitors availing the homogenous quality of medical services.

The individual demand for every i^{th} allied good x_i is obtained by maximizing the utility function $U_{T,j}$ (Appendix 1)

The first order condition yields

$$x_i = \frac{1}{2}\frac{y_i - p_h h}{p_i[\sum_{j=1}^{n}\left[\frac{p_j}{p_i}\right]^{\frac{\alpha}{\alpha-1}}]}$$

Now, integrating (5) over the values y_i ranging from $p_h h$ to $\bar{y}$ $(Appendix\ 2)$, we get aggregate demand of i^{th}allied product as

$$X_i^* = \frac{1}{2}\frac{(\bar{y} - p_h h)^2}{2p_i[\sum_{j=1}^{n}\left[\frac{p_j}{p_i}\right]^{\frac{\alpha}{\alpha-1}}](\bar{y} - \underline{y})}$$

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Thus (6) shows that an increase in $'p_h h'$ (total cost of treatment) will reduce the demand for allied goods. Basically, a high hospital cost or a long stay will put burden on tourists/agents visiting the destination. As a result, they will have to reduce their demand of allied goods.

We have assumed n allied-sector firms play Bertrand competition, where firms are simultaneously competing in prices. Considering convex cost function, profit of each allied firm can be given as $\left[p_i X_i - \frac{C_i {X_i}^2}{2}\right]$First order condition, (Appendix 3)

$$\frac{\partial \pi_m^{allied}}{\partial p_i} = \left[\frac{\frac{\alpha}{\alpha-1} p_i^{\frac{1}{\alpha-1}} \left(\sum_{j=1}^{n} p_j^{\frac{\alpha}{\alpha-1}} - p_i^{\frac{\alpha}{\alpha-1}}\right)}{\left(\sum_{j=1}^{n} p_j^{\frac{\alpha}{\alpha-1}}\right)^2}\right] - \left[\frac{C}{4}\frac{1}{2}\frac{(\bar{y}-p_h h)^2}{(\bar{y}-\underline{y})}\left(\frac{\frac{2}{\alpha-1} p_i^{\frac{3-\alpha}{\alpha-1}} \sum_{j=1}^{n} p_j^{\frac{2\alpha}{\alpha-1}} - p_i^{\frac{2}{\alpha-1}} \frac{2\alpha}{\alpha-1} p_i^{\frac{\alpha+1}{\alpha-1}}}{\left(\sum_{j=1}^{n} p_j^{\frac{2\alpha}{\alpha-1}}\right)^2}\right)\right] = 0$$

For i= 1, 2, …….n. π_m^{allied} represents profit of an allied firm, when hospital sector is a monopoly), Solving the n first order conditions simultaneously the prices of the allied goods are determined.

Monopoly Hospital Sector providing Homogeneous medical service quality under non-coordination. Monopoly hospital sector provides homogeneous quality of medical service to the tourists/patients. In particular the maximization problem for hospital sector is $max_z \pi_h$.

Profit of Hospital sector is given by $\pi^h = \frac{p_h h(\bar{y}-p_h h)}{\bar{y}-\underline{y}} - \frac{z^2}{2}$

Using (3) and (4) we have

$$\pi^h = \varphi(z)\theta(z)\left[\frac{\bar{y}-\varphi(z)\theta(z)}{\bar{y}-\underline{y}}\right] - \frac{z^2}{2}$$

$$From \ \frac{\partial \pi^h}{\partial z} = 0, we \ find \ z_{NC}^*$$

$$z_{NC}^* = \frac{1}{\bar{y}-\underline{y}}\{\varphi(z)\theta'(z)[\bar{y}-\varphi(z)2\theta(z)] + \theta(z)\varphi'(z)[y-\theta(z)2\varphi(z)]\}$$

Second order condition $\frac{\partial^2 \pi^h}{\partial z^2} < 0.$

For simplicity, we consider the following functional forms:

$$where \ h = \theta(z) = \frac{\beta}{z} \ \beta > 0$$

$$p_h = \varphi(z) = \gamma z^2 \ . \ \gamma > 0$$

A high value of β implies that the improvement in hospital quality affects the reduction in 'h' at a slower rate. Alternatively, a high value of γ implies prices increase at very faster rate with increase in hospital quality.

Using (11) and (12) optimal monopoly hospital quality is given as follows:

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$$z_{NC}^{*} = \frac{\beta\gamma\bar{y}}{(\bar{y} - \underline{y}) + 2\beta^2\gamma^2}$$

$$\frac{\partial^2\pi^h}{\partial z^2} = \frac{1}{\bar{y} - \underline{y}}\{(\varphi(z)\theta''(z))(\bar{y} - 2\varphi(z)\theta(z)) + (2\varphi'(z)\theta'(z))(\bar{y} - 4\varphi(z)\theta(z)) + (\theta(z)\varphi''(z))(\bar{y} - 2\varphi(z)\theta(z)) + 2\varphi^2(z)(\theta'(z))^2 + 2\theta^2(z)(\varphi'(z))^2\} - 1 < 0$$

RESULT AND DISCUSSIO

Sensitivity Analysis. Proposition 1: $If\ \underline{y} \to 0, \frac{\partial z_{NC}^{*}}{\delta\bar{y}} > 0$ but if $\underline{y}$ is sufficiently large, and above a critical value then $\frac{\partial z_{NC}^{*}}{\delta\bar{y}} < 0$ (Proof in Appendix 4)

As $\bar{y}$ goes up, the range of the distribution of income increases. This actually boost up purchasing power of tourists visiting the destination. In this situation, provided that, the lower limit of income distribution parameter is sufficiently small, hospitals tend to improve their service quality and thus raise the prices charged for the same, in order to capture the increased income in the destination. Improvement in quality of medical services imply increase in prices charged for the respective services, which adversely effects the payoff of the allied sector.

Vertically differentiated duopoly hospital sector under non-coordination. In this section, we consider a vertically differentiated market structure where hospital sector provides both high-quality and low-quality medical services. Let high-quality medical service be z_1, provided by hospital type H; and low-quality medical service be z_2, provided by hospital type L. Here, 'quality of service' is determined by hospital type H and L, individually and simultaneously in the duopoly structure. Since both types of hospital are available in the same medical destination, demand of allied goods come from the visitors of both the type of hospitals.

Allied Sectors providing differentiated allied goods. In this section, we consider that the allied good sector is supplying goods and services to the visitors of both type H and type L hospitals. Our expected utility is same as equation (2).

Patients are indifferent between choosing type H and type L hospitals when

$$\frac{z_1}{h_H}[\sum_{i=1}^{n}[x_i^{\alpha}]]^{\frac{1}{\alpha}}\left[y_i - p_h^H h^H - \sum_{i=1}^{n} p_i x_i\right] = \frac{z_2}{h_L}[\sum_{i=1}^{n}[x_i^{\alpha}]]^{\frac{1}{\alpha}}[y_i - p_h^L h^L - \sum_{i=1}^{n} p_i x_i]$$

$$y_i\left[\frac{z_1}{h^H} - \frac{z_2}{h^L}\right] = \sum_{i=1}^{n} p_i x_i\left[\frac{z_1}{h^H} - \frac{z_2}{h^L}\right] + p_h^H z_1 - p_h^L z_2$$

Assuming, patients with income, y_i where $y^{*} \le y_i \le \bar{y}$ is availing H-type hospital facility, we get (Appendix 5)

$$y_i^{*} = 2\left[\left[\frac{p_h^H z_1 - p_h^L z_2}{\frac{z_1}{h^H} - \frac{z_2}{h^L}}\right] - \frac{p_h^H h^H}{2}\right]$$

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In the present scenario, demand for allied sector products will come from visitors of both type of hospitals. In the first place, we derive the demand from visitors of type H hospital, which provides high-quality medical service (z_1) and is relatively costlier, as:

$$x_i = \frac{y_i - p_h^H h^H}{p_i \sum_{j=1}^{n} [\frac{p_i}{p_j}]^{\frac{\alpha}{\alpha-1}}} \text{ (demand from } i^{th} \text{ H} - \text{type visitor)}$$

Therefore, aggregate demand of an allied good from the visitors of type H hospitals can be given by (Appendix 6)

$$X_i^H = \int_{y^*}^{\bar{y}} \frac{y_i - p_h^H h^H}{p_i \sum_{j=1}^{n} [\frac{p_i}{p_j}]^{\frac{\alpha}{\alpha-1}}} f \, dy_i$$

$$\frac{1}{p_i [\sum_{j=1}^{n} \left[\frac{p_j}{p_i}\right]^{\frac{\alpha}{\alpha-1}}] (\bar{y} - \underline{y})} \left[(\bar{y} - y^*) \left[\frac{1}{2} (\bar{y} + y^*) - p_h^H h^H \right] \right]$$

Secondly, we derive the demand of allied sector products from the type L hospital visitors

$$x_i = \frac{y_i - p_h^L h^L}{p_i \{ \int_{j=1}^{n} [\frac{p_j}{p_i}]^{\frac{\alpha}{\alpha-1}} \}} \text{ (demand from } i^{th} \text{ L} - \text{ type visitor)}$$

Therefore, demand for allied products from all the tourists availing low quality of medical service provided by type L hospitals can be given by, (Appendix 7)

$$X_i^L = \int_{\underline{y}}^{y^*} \frac{y_i - p_h^L h^L}{p_i \{ \int_{j=1}^{n} \left[\frac{p_j}{p_i}\right]^{\frac{\alpha}{\alpha-1}} \}} f \, dy_i$$

$$\frac{1}{p_i [\sum_{j=1}^{n} \left[\frac{p_j}{p_i}\right]^{\frac{\alpha}{\alpha-1}}] (\bar{y} - \underline{y})} \left[(y^* - \underline{y}) \left[\frac{1}{2} (\underline{y} + y^*) - p_h^L h^L \right] \right]$$

Thus, total demand of an allied product when quality of medical services is differentiated, can be given by $X_i^* = X_i^H + X_i^L$, where X_i^H *and* X_i^L represents the aggregate demand of i^{th} allied good from the visitors of type H and type L hospitals, respectively.

$$X_i^* = \frac{1}{p_i (\bar{y} - \underline{y}) [\sum_{j=1}^{n} [\frac{p_j}{p_i}]^{\frac{\alpha}{\alpha-1}}]} \left[\frac{1}{2} (\bar{y}^2 - \underline{y}^2) - \{ (\bar{y} p_h^H h^H - \underline{y} p_h^L h^L) - y^* (p_h^H h^H - p_h^L h^L) \} \right]$$

where, y_i^* is defined in equation (145).

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In the medical sector, Woolley and Frech (1988) pointed out that normal price-reducing market pressures are non-existent or lower. The reason is that in this type of markets consumers are highly insured and have imperfect information and are thus, insensitive to price differences. Therefore, instead of having incentive to engage in price competition, hospitals engage in non-price competition. Non-price competition includes any other avenue of competition other than prices. In hospital markets, non-price competition is usually in the form of factors which affect quality of service. Economists view hospital decision makers as maximizing objective functions depending on quantity and quality of service or hospital prestige. Pauly's study shows that hospitals' response to the external environment is similar whether maximizing profits or serving other goals such as hospital prestige or physicians' incomes. Thus, following previous studies, we are ignoring price competition in our study.

Using (11) and (12) we write

$$p_h^H = \gamma z_1^2;\ h^H \frac{\beta}{z_1}\ ; p_h^L = \gamma z_2^2; h^L = \frac{\beta}{z_2}$$

Hence, we rewrite (15) as:

$$X_i^* = \frac{1}{p_i[\sum_{j=1}^{n}\left[\frac{p_j}{p_i}\right]^{\frac{\alpha}{\alpha-1}}](\bar{y}-\underline{y})}\left[\frac{1}{2}(\bar{y}^2-\underline{y}^2) - \bar{y}\beta\gamma z_1 + \underline{y}\beta\gamma z_2 + \frac{2\beta^2\gamma^2(z_1^3-z_2^3)}{(z_1+z_2)} - \beta^2\gamma^2(z_1^2-z_1z_2)\right]$$

If quality of medical service provided by H-type of Hospitals (z_1) get better, while z_2 is held constant, tourists spend less on allied goods since they have a constrained income and a better-quality medical service calls for a higher cost in treating the disease, thus they shall cut their expense on allied goods.

Interestingly, if quality of medical service provided by L-type of Hospitals 〖(z〗_2) get better, while z_1 is held constant, demand for every i^{th} allied good X_i^*) will increase. This is possibly because, following an increase in the quality provided by L-type hospitals, some of the tourists will shift from H-type hospitals to L-type hospitals, and their real income will increase since they will now have to spend less on treatment. With an increase in real income, they shall spend more on allied goods.

Similar to the monopoly hospital case, considering convex cost function, profit of each allied firm can be given as $\pi_d^{allied} = \left[p_i X_i^* - \frac{C_i(X_i^*)^2}{2}\right]$. First order condition, (Appendix 8)

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$$\frac{\partial \pi_d^{allied}}{\partial p_i} = \left[\frac{\frac{\alpha}{\alpha-1} p_i^{\frac{1}{\alpha-1}} \left(\sum_{j=1}^{n} p_j^{\frac{\alpha}{\alpha-1}} - p_i^{\frac{\alpha}{\alpha-1}}\right)}{\left(\sum_{j=1}^{n} p_j^{\frac{\alpha}{\alpha-1}}\right)^2}\right]$$

$$-\left[\frac{C_i}{2(\bar{y}-\underline{y})}\left[\frac{1}{2}(\bar{y}^2-\underline{y}^2) - \bar{y}\beta\gamma z_1 + \underline{y}\beta\gamma z_2 + \frac{2\beta^2\gamma^2(z_1^3-z_2^3)}{(z_1+z_2)}\right.\right.$$

$$\left.\left. - \beta^2\gamma^2(z_1^2 - z_1 z_2)\right]\left(\frac{\frac{2}{\alpha-1} p_i^{\frac{3-\alpha}{\alpha-1}} \sum_{j=1}^{n} p_j^{\frac{2\alpha}{\alpha-1}} - p_i^{\frac{2}{\alpha-1}} \frac{2\alpha}{\alpha-1} p_i^{\frac{\alpha+1}{\alpha-1}}}{\left(\sum_{j=1}^{n} p_j^{\frac{2\alpha}{\alpha-1}}\right)^2}\right)\right] = 0$$

For i= 1, 2, …….n. π_d^{allied} represents profit of an allied firm, when hospital sector is a duopoly)

Solving the n first order conditions simultaneously, each allied firm can determine prices.

Duopoly Hospital sector providing differentiated quality of medical services. We extend our previous model into a vertically differentiated duopoly structure where 2 types of hospital are available in the same destination. As mentioned earlier, Type H and L hospitals, provide high-quality and low- quality medical services, respectively. Here, we aim to derive the differentiated quality levels provided by the hospital sector. We assume both types of hospitals chose their quality levels simultaneously.

Applying (16) in equation (14), we can write

$$y_i^* = 2\left[\frac{\beta\gamma(z_1-z_2)(z_1^2+z_1z_2+z_2^2)}{(z_1-z_2)(z_1+z_2)}\right] - \beta\gamma z_1$$

The profit earned by Type H hospital, providing high-quality medical service (z_1) can be given as

$$\pi_H^h = \frac{p_h^H h^H(\bar{y}-y^*)}{\bar{y}-\underline{y}} - \frac{{z_1}^2}{2} \text{ After replacing}$$

$$\pi_H^h = \frac{\beta\gamma}{\bar{y}-\underline{y}}\left[\bar{y}z_1 - \frac{\beta\gamma}{z_1+z_2}(z_1^3+z_1^2z_2+2z_2^2z_1)\right] - \frac{z_1^2}{2}$$

Setting $\frac{\partial \pi_H^h}{\partial z_1} = 0$, we derive the reaction curve for this type of hospital, as (Appendix 9)

$$\beta\gamma\left[\frac{2z_1^3+4z_1^2z_2+2z_2^3+2z_1z_2^2}{(z_1+z_2)^2}\right] = \bar{y} - \frac{z_1(\bar{y}-\underline{y})}{\beta\gamma} \qquad 201.$$

$$Where, \frac{\partial^2 \pi_H^h}{\partial z_1^2} = \frac{-(\beta\gamma)^2}{\bar{y}-\underline{y}}\left[\frac{2z_1^3+6z_1z_2^2+6z_1^2z_2-2z_2^3}{(z_1+z_2)^3}\right] - 1 < 0 \; and \; \frac{\partial^2 \pi_H^h}{\partial z_2 \partial z_1} = \frac{-(\beta\gamma)^2}{\bar{y}-\underline{y}}\left[\frac{6z_1z_2^2+2z_2^3}{(z_1+z_2)^3}\right] < 0$$

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The slope of the reaction function:

$$\left.\frac{\delta z_2}{\delta z_1}\right|_{z_1} = -\frac{\frac{\delta^2\pi_H^h}{\delta z_1^2}}{\frac{\delta^2\pi_H^h}{\delta z_2 \delta z_1}} = -\frac{\frac{-(\beta\gamma)^2}{\bar{y}-\underline{y}}\left[\frac{2z_1^3+6z_1z_2^2+6z_1^2z_2-2z_2^3}{(z_1+z_2)^3}\right]-1}{\frac{-(\beta\gamma)^2}{\bar{y}-\underline{y}}\left[\frac{6z_1z_2^2+2z_2^3}{(z_1+z_2)^4}\right]} < 0$$

Thus, we observe that the reaction function of Type H hospital is negatively sloped. The model assumes that the price of hospital service depends on quality. Hence, when Type L hospital improves its service quality, the Type H hospital sector retaliates by deteriorating its own service so that it can charge a lower price to retain its consumers.

In a similar manner, the profit earned by Type L hospitals, providing high-quality medical service (z_2) can be given as $\pi_L^h = \frac{p_h^L h^L(y^*-\underline{y})}{\bar{y}-\underline{y}} - \frac{{z_2}^2}{2}$. After replacing

$$\pi_L^h = \frac{\beta\gamma}{\bar{y}-\underline{y}}\left[\frac{\gamma\beta(z_1^2z_2+z_1z_2^2+2z_2^3)}{(z_1+z_2)} - \underline{y}z_2\right] - \frac{z_2^2}{2}$$

Setting $\frac{\partial\pi_L^h}{\partial z_2} = 0$ the reaction function of 'L' type hospital is given as (Appendix 10)

$$\beta\gamma\left(\frac{z_1^3+2z_1^2z_2+7z_1z_2^2+4z_2^3}{(z_1+z_2)^2}\right) = \underline{y} + \frac{z_2(\bar{y}-\underline{y})}{\beta\gamma}$$

where the second order condition is

$$\frac{\delta^2\pi_L^h}{\delta z_2^2} = \frac{(\beta\gamma)^2}{\bar{y}-\underline{y}}\left[\frac{12z_1^2z_2+12z_1z_2^2+4z_2^3}{(z_1+z_2)^3}\right] - 1 < 0$$

Also we have $\frac{\delta^2\pi_L^h}{\delta z_1\delta z_2} = \frac{(\beta\gamma)^2}{\bar{y}-\underline{y}}\left[\frac{(z_1-z_2)^3+6z_1z_2(z_1-z_2)}{(z_1+z_2)^3}\right] > 0$

Therefore, the slope of L type hospital sector is:

$$\frac{\delta z_2}{\delta z_1} = -\frac{\frac{\delta^2\pi_L^h}{\delta z_2^2}}{\frac{\delta^2\pi_L^h}{\delta z_1\delta z_2}} > 0$$

Interestingly, the reaction curve for Type L hospital is positively sloped, as existence of high-quality H type hospital sector imposes pressure on low quality sector for constant improvement. Hence, to sustain along with high quality sector, low quality hospital has to improve its quality.

Under non-coordination, Slope of Reaction Curve 1 is negative and that of Reaction curve 2 is positive, thus a solution will exist. Stability of reaction function diagram requires that

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$$\boldsymbol{H} = \begin{bmatrix} \dfrac{\partial^2 \pi_H^h}{\partial z_1^2} & \dfrac{\partial^2 \pi_L^h}{\partial z_1 \partial z_2} \\ \dfrac{\partial^2 \pi_H^h}{\partial z_2 \partial z_1} & \dfrac{\partial^2 \pi_L^h}{\partial z_2^2} \end{bmatrix} > \mathbf{0}.$$

The condition is always satisfied where $\frac{\partial^2 \pi_H^h}{\partial z_1^2} < \mathbf{0}$; $\frac{\partial^2 \pi_L^h}{\partial z_2^2} < \mathbf{0}$; $\frac{\partial^2 \pi_H^h}{\partial z_2 \partial z_1} < \mathbf{0}$; $\frac{\partial^2 \pi_L^h}{\partial z_1 \partial z_2} > \mathbf{0}$

Solving (20) and (22) simultaneously we get the equilibrium quality of medical services as z_1^*, z_2^*) The feasibility of solution requires that $\beta\gamma\bar{y} < (\bar{y} - \underline{y}) + 2\beta^2\gamma^2$ and $\underline{y}\ \beta\gamma$.

Graphically, we can represent the solution as Figure 1:

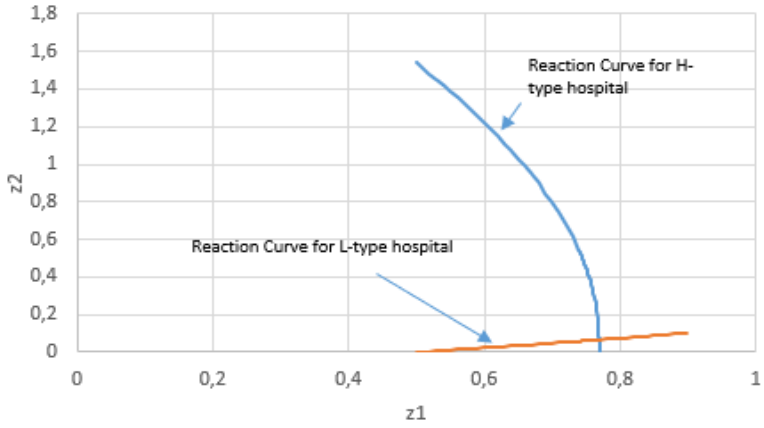

Figure 1. Graphic

For $\bar{y} = 5, \underline{y} = 0.5, \beta = \gamma = 1$, the Nash equilibrium quality levels are $z_1 = 0.7691$ & z_2=0.06671 where the reaction curves intersect with one another.

Sensitivity Analysis. Next, we will try to find the effect of income distribution parameter on quality levels provided by two hospital sectors.

Proposition 2: If z_1^* is above a critical level then $\frac{\delta z_1}{\delta \bar{y}} < 0$ and $\frac{\delta z_2}{\delta \bar{y}} < 0$, otherwise it is ambiguous. (Proof in Appendix 11)

As $\bar{y}$ goes up, the range of the distribution of income increases. This actually boost up purchasing power of consumers visiting the destination. In this situation, if initial service quality of 'H' hospital is above a critical level they will actually reduce their equilibrium quality. Basically, if the initial service quality provided by H-type hospital is already high (above a critical level), any further improvement in quality will also entail a rise in prices of the 'H' type hospital service, which in turn will shift destination visitors to 'L' type hospitals. As a result, when initial quality is high, to retain the customer base, the profit maximizing 'H' type hospital actually reduces the quality, and 'L' hospitals follow suit when $\bar{y}$rises. However, the result is ambiguous when the initial service quality of 'H' hospital is below the critical level.

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Coordination between hospital sector and allied sector in medical destination. For comparison of results with non-coordination case, we present a coordinated setup where planning authority of the destination is responsible for maximizing the overall profit of the destation to determine hospital quality. In this situation also, we will consider two possible cases, where a single homogenous medical service is provided by monopoly hospital sector and differentiated quality is provided in a duopoly hospital sector.

Homogenous quality case under coordination. In this section, we consider that the quality of medical service provided in the medical destination is homogeneous and the planning authority maximizes the joint profit of allied sector and hospital sector to determine the unique quality level. We first derive price of allied goods.

Using equation (7), under the assumption of symmetry we have, $p_1 = p_{2=} \dots \dots \dots \dots . = p$, the price of every allied good as, (Appendix 12)

$$p = \frac{(\bar{y} - p_h h)}{2} \sqrt{C \frac{(n-\alpha)}{\alpha(n-1)(\bar{y} - \underline{y})}}$$

Thus, aggregate demand of allied goods, i.e, X^*assuming symmetry on supply side of tourism products, (that is, $X_1^* = X_2^* = \cdots = X_n^*$) can be given by

$$X^* = \frac{1}{4} \frac{(\bar{y} - p_h h)^2}{(\bar{y} - \underline{y}) np}$$

Now, with coordination (between allied sectors providing differentiated products and hospital sector providing homogeneous medical services), total profit of the destination can be given by, ω=Profit of Allied Sector + Profit of Hospital Sector = $\sum_{i=1}^{n} [p_i X - \frac{C_i X^2}{2}] + p_h h \frac{\bar{y} - p_h h}{(\bar{y} - \underline{y})} - \frac{z^2}{2}$.

Using (23) and (24), we get (Appendix 13)

$$\omega = \frac{(\bar{y} - p_h h)^2}{4(\bar{y} - \underline{y})} \left[1 - \frac{\alpha(n-1)}{2n(n-\alpha)}\right] + p_h h \frac{\bar{y} - p_h h}{(\bar{y} - \underline{y})} - \frac{z^2}{2}$$

Using first order condition, $\partial\omega/\partial z=0$, we derive total profit maximizing quality of medical service that should be provided in the destination as (Appendix 14)

$$z_C^* = \frac{\frac{\beta\gamma\bar{y}}{\bar{y} - \underline{y}} \left[1 - \frac{1}{2}\left(\frac{2n^2 - 3n\alpha + \alpha}{2n^2 - 2n\alpha}\right)\right]}{\left(1 + \frac{2\beta^2\gamma^2}{\bar{y} - \underline{y}}\right) - \frac{1}{2}\frac{\beta^2\gamma^2 z}{(\bar{y} - \underline{y})}\left(\frac{2n^2 - 3n\alpha + \alpha}{2n^2 - 2n\alpha}\right)}$$

Proposition 3

a) Monopoly profit maximizing medical service quality is better than the overall profit maximizing medical service quality provided by destination planning authority.
b) Per-day cost of treatment is greater under monopoly regime.

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c) Average number of days required for treatment under the monopoly setup is lesser than, in case of coordination.
d) Number of patients availing medical service under coordination is greater, than under monopoly.
e) Profit of allied firm is higher under coordination compared to non-coordination where monopoly hospital sector individually determines hospital quality. (Proofs in Appendix 15)

Under non-coordination setup, the monopoly hospital sector that individually maximizes its profit to determine medical service quality, is only concerned about its own profit. Thus, it provides a higher quality of medical service and charges a higher price as compared to the coordinated setup for quality determination. However, under coordination to make the medical service affordable to a larger number of consumers, the planning authority sets a lower quality of service. This in turn reduces total cost of treatment ($'p_h h'$). As a result, from equation (6), the demand for allied good will rise under coordination compared to monopoly case. Next, we compare the profits of allied sector with and without coordination. Total profit of the allied sector in the medical destination is higher when destination development authority determines service quality under coordination. This is possibly because under coordination when joint profit is maximized to determine quality level, quality of medical service provided is lower and thus average days required for treatment increases. Hence stay in the destination increases and so is the demand for allied products which make the stay in the destination possible. This in turn raises the profit of allied sector.

Differentiated quality case under coordination. In this section, we consider that the quality of medical service provided in the medical destination is differentiated and planning authority of the destination maximizes joint profit of allied sector and hospital sector to determine the service qualities.

Now, we shall derive 'quality of service' that the planning authority will fix for the L-type hospitals (which provide a comparatively low-quality service) and H-type hospitals (providing high quality medical service). The planning authority shall work in the interest of the medical destination and maximize the combined profit of the destination. Combined profit can be given as (Appendix (16.ii)

$$\omega = \pi_H^h + \pi_L^h + \pi_{allied} \text{ where under symmetry assumption of allied firms}$$

$$\omega = \frac{(\beta\gamma)^2(2z_2^3 - z_1^3 - z_1 z_2^2)}{(\bar{y} - \underline{y})(z_1 + z_2)} + \frac{\beta\gamma}{\bar{y} - \underline{y}}(\bar{y}z_1 - \underline{y}z_2) - \frac{z_1^2}{2} - \frac{z_2^2}{2} + \frac{1}{(\bar{y} - \underline{y})}\left[\frac{1}{2}(\bar{y}^2 - \underline{y}^2) - \beta\gamma(\bar{y}z_1 - \underline{y}z_2) + \frac{2(\beta\gamma)^2(z_1^3 - z_2^3)}{z_1 + z_2} - (\beta\gamma)^2 z_1(z_1 - z_2)\right]\left[1 - \frac{\alpha}{2(\bar{y} - \underline{y})}\right]$$

First order conditions are

$$\frac{\delta\omega}{\delta z_1} = \frac{\alpha}{2(\bar{y} - \underline{y})^2}(\beta\gamma\bar{y}) - \frac{\alpha}{2(\bar{y} - \underline{y})^2}\frac{(\beta\gamma)^2(2z_1^3 + 3z_1^2 z_2 + 3z_2^3)}{(z_1 + z_2)^2} - z_1 = 0$$

$$\frac{\delta\omega}{\delta z_2} = -\frac{\alpha}{2(\bar{y} - \underline{y})^2}(\beta\gamma\underline{y}) + \frac{\alpha}{2(\bar{y} - \underline{y})^2}\frac{(\beta\gamma)^2(5z_1 z_2^2 + z_1^3 - 2z_1^2 z_2 + 4z_2^3)}{(z_1 + z_2)^2} - z_2 = 0$$

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Solving we will get z_1^C and z_2^C.

Now we compare between (z_1^C, z_1^{NC}) and (z_2^C, z_2^{NC})

Proposition 4

a) If $\bar{y}$ is sufficiently high, then under coordination setup, the planning authority provides lower level of z_1, that is, medical service quality provided by H-type hospital, compared to non-coordinated duopoly setup, is lower.

b) If $\underline{y} \to 0$ quality of medical service in L type hospital is lower under coordinated set up than that of the non-coordinated case.

Proof: To compare these qualities with that of non-coordination level we evaluate $\frac{\delta\omega}{\delta z_1}$ at z_1^{NC} and $\frac{\delta\omega}{\delta z_2}$ Using (20), we get

$$\frac{\delta\omega}{\delta z_1}\Big|_{z_1^{NC}} = -\frac{\beta\gamma\bar{y}}{\bar{y}-\underline{y}}\left(1-\frac{\alpha}{2(\bar{y}-\underline{y})}\right) + \frac{(\beta\gamma)^2}{(\bar{y}-\underline{y})(z_1+z_2)^2}\left[2z_1^3\left(1-\frac{\alpha}{2(\bar{y}-\underline{y})}\right)+z_1^2z_2\left(4-\frac{3\alpha}{2(\bar{y}-\underline{y})}\right)+2z_1z_2^2+z_2^3\left(2-\frac{3\alpha}{2(\bar{y}-\underline{y})}\right)\right]$$

Equation (30) shows that if $\bar{y}$ is sufficiently high then the first term will dominate the second and $\frac{\delta\omega}{\delta z_1}\Big|_{z_1^{NC}} < 0$.

This in turn implies that $z_1^C < z_1^{NC}$, that is, quality of medical service provided is inferior when planning authority of the destination maximizes overall profit to determine z_1.

Similarly, for L type hospitals, using (22) we get

$$\frac{\delta\omega}{\delta z_2}\Big|_{z_2^{NC}} = \frac{\beta\gamma\underline{y}}{(\bar{y}-\underline{y})}\left[1-\frac{\alpha}{2(\bar{y}-\underline{y})^2}\right] - \frac{(\beta\gamma)^2}{(\bar{y}-\underline{y})(z_1+z_2)^2}[(z_1^3+2z_1^3z_2+7z_1z_2^2+4z_2^3) - \frac{\alpha}{2(\bar{y}-\underline{y})^2}(z_1^3+4z_2^3+5z_1z_2^2-2z_1^2z_2]$$

Therefore, If $\underline{y} \to 0$, $\frac{\delta\omega}{\delta z_2}\Big|_{z_2^{NC}} < 0$ and coordination leads to a lower quality level. (Proved)

Finally, we compare the qualities that the planning authority plans to set for the H-type and L-type hospitals (by maximizing the overall profit of the destination under a coordinated setup) to that the respective hospitals choose for themselves in a duopoly market structure (by maximizing their individual profits under non-coordinated setup). We observe that, given a sufficiently high income- dispersion, the planning authority will set lower medical service qualities for both the types of hospital, compared to the ones provided under duopoly situation. Basically, under non-coordination the H-type and L-type hospitals are solely interested in maximising their individual profits. As a profit maximising strategy, hence they serve better qualities than the coordinated situation. A high $\bar{y}$ under non-coordination, induce both H-type and L-type hospitals to improve

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their service quality in order to capture the increased income in the destination. Improvement in quality of medical services imply increase in prices charged for the respective services, which adversely effects the payoff of the allied sector. As $p_h^H h^H$ and $p_h^L h^L$ (average total cost of treatment) increases, X_i^H and X_i^L (demand of consumers availing services from H-type and L-type hospitals for i^{th} allied product) will decrease as shown in equation (Heykal et al., 2024). Thus, demand faced by allied sector and the corresponding profit level is higher under coordination than the non-coordination setup.

CONCLUSION

Our study presents a comprehensive approach towards medical tourism destination development, by incorporating the medical sector of a destination along with the allied sector that provide different allied goods, which make stay in the destination possible. This paper underlines the importance of allied sector for the establishment of hospital hub in a destination, in order to attract tourists and make gains from trading medical services a reality, for the country. We first consider a monopoly hospital sector in the presence of an allied sector, and derive the optimal level of medical service quality, that should be provided in the destination. The homogeneous service-quality is derived by maximizing the individual profit of the monopoly hospital sector. On performing sensitivity analysis, we found that, given a sufficiently lower limit of income distribution parameter, an increase in the upper limit of income distribution parameter, induces the monopoly hospital sector to improve the quality of medical service they provide.

Next, we extended our model into a vertically differentiated duopoly market structure where hospital sector, consisting of two types of hospitals, provide high-quality and low-quality medical services, and thereafter, we determine the differentiated levels of medical service qualities that should be provided by the two types of hospitals. Following the literature, we have ignored price competition in the hospital market. Instead, we considered, quality differentiation in case of a duopoly hospital market. There is a unique equilibrium with the high-type hospital supplying the premium quality and the low-type hospital supplying a relatively lower quality of medical service. We have also demonstrated the effect of income distribution parameter on quality levels provided by two hospitals. Results show that, if initial service quality of high-type hospital is above a critical level, an increase in the upper limit of income distribution parameter will actually reduce the equilibrium quality provided by both high-type and low-type hospitals.

Finally, for comparison of results, we present a coordinated setup where a planning authority is responsible for maximizing the overall profit of the destination to determine hospital quality. In this situation also, we considered two possible cases.

First, we consider a situation where a single medical service quality is provided by the planning authority by maximising the aggregate of monopoly hospital profit and total profit of allied sector. We observe quality of medical service provided under coordinated case is inferior to that of under non-coordinated setup when monopoly individually maximises its own profit. Hence hospital charges under coordination is lower vis à vis, that charged by monopoly hospital sector. Further, a comparatively lower quality of medical service, under coordinated setup, ensures greater demand of the allied products. Per-day expenditure on allied product may increase because of a lower fee to be paid for treatment and thus a sustainable level of profit is maintained for the allied sector. On comparing the profits of allied sector with and without coordination, we found total profit

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of the allied sector in the medical destination is higher when destination planning authority determines service quality under coordination.

Next, we compare the qualities provided by vertically differentiated hospital sectors in a duopoly market structure to that of the situation where a destination planning authority responsible for hospital tourism development chooses the differentiated qualities by maximising overall profit of the destination. Again, this latter case is defined as the coordinated situation. We observe medical service quality provided by high-type hospital is superior in a duopoly market than that of coordinated case, when upper limit of income distribution parameter is high. Alternatively, when lower limit of income distribution parameter reduces, again an inferior quality for the low-type hospital will be chosen by the planning authority, than the monopoly case. As a profit maximising strategy, under non-coordination, the high-type and low-type hospitals serve better qualities than the coordinated situation. This in turn implies lower hospital charges under coordination, which will lead to higher demand for allied products and higher profit for allied sector.

For a place with hospital facilities, to emerge as a medical tourism destination exclusively, there is a requirement of properly planned quality and price strategies, not only in the hospital sector but also in the allied sector. Coordination between both sectors, in fact among the differentiated quality providers in the hospital market, opens up opportunity for a greater surplus in the destination. Extension of the model through incorporating price differentiation and insurance facilities may curb the limitations of our study. The paper shall open up path for more researches exploring the growth and development of medical tourism destination, and empirical research in this regard.

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