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Dependency Model with Congestion and Tourism

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Abstract

This paper presents results regarding the impact of regional and international tourism on the welfare of the domestic economy in the presence of congestion. The model used for this purpose is the dependency model of trade. Three main results are obtained from our investigation. First, it is established that an increase in regional tourism is welfare enhancing in the absence of congestion externalities due to an improvement in the tertiary terms of trade. Second, it is shown that in the presence of congestion, the welfare effect of an increase in tourism is ambiguous as there are three effects: 1) an improvement in the tertiary terms of trade, 2) a congestion effect and 3) a favorable effect on congestion via a decline in it due to the price effect. To correct the distortions policy intervention is required. This takes the form of two simultaneous policies: a tax on the goods consumed by the tourists and a tax on congestion by creating property rights. The results are of great significance for policy making.

Keywords

Congestion, Tourism, Dependency Model

1. Introduction

The object of this paper is to analyze the impact of tourism on congestion where

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the tourists use club type goods. Typical examples of such goods are: Panda sanctuaries, Penguin viewing, TajMahal and other quasi-public goods. This is not the same problem as the tragedy of the commons. In club type goods, it is possible to exclude consumers by charging very high prices which is not the case with certain public goods as exclusion may not be a feasible option (Buchanan, 1965). We utilize the dependency model of trade to introduce congestion in the aggregate utility function. This is done in a novel way and, to our knowledge, this way of introducing congestion has not been attempted in the literature. This new technique can also be used to study snob goods and bandwagon effects, which would not be attempted in this paper.

In the dependency model, two goods are produced: a non-traded good and an exportable good. The exportable good is not consumed domestically, but totally exported. The consumers consume two goods: the non-traded good and an imported good. This imported good is not produced domestically but imported from overseas for consumption purposes. Tourism is defined as temporary inflow of consumers to consume non-traded goods which cannot be moved due to indivisibility and location. For example, to see Notre-Dame, one has to go to Paris; to see TajMahal, one has to travel to India and so on. Although paintings of great artists can be moved around for special exhibitions, they do not have the same effect as seeing them in the original galleries, for example Louvre, Hermitage in St. Petersburg. All these tourist spots attract a very large number of visitors, and therefore, there is congestion which reduces the enjoyment or utility derived from seeing these wonderful places. The same holds for seeing Pandas in Chengdu. It gets very crowded and congested. Children find it very difficult to see the pandas. This paper addresses this problem from the point of view of both tourism literature and the issue of congestion. It is an attempt at finding the optimal level of congestion by either creating property rights and/or a tourism tax or a quota on the number of visitors. While the quota and tax are equivalent, this is not the case with creating property rights. TajMahal and other Indian monuments are good examples where differential prices are charged. Foreigners pay a much higher price than local residents.

We introduce three types of tourists in the model: local tourists who are the residents of the city where such goods are located, for example, Parisians for seeing Notre-Dame, residents of Agra for seeing the TajMahal and residents of Chengdu for seeing the Pandas. Then, we have natives of the country who come to see these facilities and they are defined as regional tourists. Finally, there are international tourists who also bring foreign exchange or an imported good by visiting the tourist attraction. So there are three consuming agents of the club type good: local residents, regional domestic tourists and foreigners.

At this point, it is important to point out that there are two terms of trade in the model: the standard terms of trade between exportables and importables and then the tertiary terms of trade between the consumption of non-traded good and an importable good. The latter are endogenous and create monopoly power in trade. The endogeneity of the tertiary terms of trade creates monopoly power in the model. This was first noted by Hazari and Ng (1993) and elaborated further in Hazari and Sgro (2004). In an important paper in this area, Chao, Hazari, Laffargue and Yu (2009) have shown how to optimally tax the tourists to exploit the monopoly power in trade. Very importantly, the same result can be achieved by taxing regional tourists if the society does not have the political desire to tax the local residents.

2. A Model of Regional and International Tourism with Congestion

2.1. Model Setup

In this section, we develop a model that includes three types of tourists: local, regional and international. For obtaining results, we use the dependency model of trade and incorporate congestion in a novel and very tractable manner. This allows us to capture the effects of all types of tourism on the environment—mainly congestion. The system designed can be used for more general purposes.

The aggregate utility function with congestion for the club good is given below:

$$U = U\left[\left(1-\alpha\right)D_N, M\right] \tag{1}$$

The above utility function is assumed to be strictly concave. The terms D_N and M denote the consumption of the non-traded and imported good respectively. Note that other goods are ignored to keep the model as simple as possible to derive the important results and insights of the paper. In the spirit of Lancaster (1966) on characteristics in demand theory, we introduce a variable for capturing congestion and label it as α. Furthermore, α is assumed to lie in the closed interval of 0 and 1, that is, $\alpha \in [0,1]$. In the extreme case of αbeing one, there is so much congestion that the visitors cannot see the Pandas or the Taj-Mahal at all. It is like having traffic jams where one may be sitting in the car for several hours. Recall the state of traffic jams in Bangkok where portable toilets were being provided in cars to alleviate some of the problems posed by traffic jams. When $\alpha$is zero then the system results to a state where there is no congestion. Throughout the paper we shall take the view that $\alpha$is above the tolerable limit of congestion. This is a unique way of capturing congestion and, to our knowledge, congestion has not been captured in this way. This technique may also be used for analyzing the quality of a product.

Three types of agents consume the club good. These agents are identified by belonging to a certain geographical location: local residents, visitors from some other region of a country and overseas tourists. The price of the imported good; P_M is taken to be the numeraire. From the first order conditions for maximization, it follows that:

$$\frac{U_N}{U_M} = \frac{P_N}{P_M} = P_N \tag{2}$$

where U_N and U_M denote marginal utility of the relevant good.

The marginal disutility from congestion is U_α. The relative price of α is denoted by P'. In the absence of congestion, this price does not exist. In a freely competitive market where property rights on congestion are not defined this price is not observed but exists as a shadow price. A consumer sees Pandas or TajMahal given the state of congestion captured byα.

Now we introduce the production side of this model. The economy produces two goods: X_N and X_2 with the help of labour and capital. Commodity X_N is the non-traded club type good. The production functions are assumed strictly neo-classical and given below:

$$X_N = F_N\left[L_N, K_N\right] = L_N f_N\left(k_N\right) \tag{3}$$

$$X_2 = F_2\left[L_2, K_2\right] = L_2 f_2\left(k_2\right) \tag{4}$$

where K_i denotes capital and L_i labour used in producing good $i\left(i = N, 2\right)$ respectively. It is assumed that the entire production of commodity, X_2, is exported. So the local consumers do not consume any X_2. The non-traded good, X_N is consumed by local residents, regional tourists and international tourists.

Market clearing requires that supply equals demand, therefore, in equilibrium

$$D_N + D_N^O + D_N^R = X_N \tag{5}$$

where, D_N, D_N^R, and D_N^O denote consumption of the non-traded good by local residents, regional tourists and overseas visitors respectively. The national income equation from the production side is given below, where Y denotes real income.

$$Y = P_N X_N + P_2 X_2 \tag{6}$$

The balance of payments condition is given below:

$$M = P_N D_N^O + P_2 X_2 \tag{7}$$

where, M denotes imports, D_N^O the consumption of the non-traded good by overseas tourists and X_2 the exports of good 2 respectively. P_M, as the numeraire, is omitted.

It is important to emphasize the role of relative prices in this model. There are two terms of trade here: traditional terms of trade P_2/P_M and tourism or tertiary terms of trade P_N/P_M. This concept was introduced by Hazari and Ng (1993). The commodity terms of trade guide the volume of imports that can be obtained by exporting, X_2. The tourism terms of trade P_N/P_M guide the consumption mix of imported and the non-traded good. Production is guided by the relative price, P_N/P_2. The separation of relative production and consumption prices as well as terms of trade is the special feature of the dependency model. This is elaborated in the paper by Hazari et al. (1980).

The firm is assumed to have an interior solution in solving its profit maximization problem. Therefore, both goods are produced and the factor returns in equilibrium are:

$$w = P_2\left(f_2 - k_2 f_2'\right) = P_N\left(f_N - k_N f_N'\right) \tag{8}$$

$$r = P_2 f_2' = P_N f_N' \tag{9}$$

As we have assumed complete price flexibility, the economy is in full employment, therefore,

$$L_N + L_2 = \overline{L} \tag{10}$$

$$L_N k_N + L_2 k_2 = \overline{K} \tag{11}$$

The function for the congestion factor can be specified as

$$\alpha = \alpha\left[D_N, D_N^R, D_N^O\right] \tag{12}$$

To complete the specification of the model, we assume αis an increasing function of all its arguments.

2.2. Results

This section presents our results. We take the initial equilibrium to be given and make parametric shifts. We first present results with no congestion effects to highlight the tertiary terms of trade effect of an increase in regional tourism and its welfare implications. The issue of optimal tax is also addressed for this case. To our knowledge this type of analysis is new in tourism literature. Regional tourism has not been analyzed in the theoretical literature on tourism.

Results with no congestion ($\alpha = 0$)

Let us assume that there is an expansion of tourism captured by a shift in the demand for the tourism good by the regional agents, that is, a shift in the demand curve of D_N^R.

By differentiating Equation (2) we obtain:

$$A\mathrm{d}P_N + \frac{\partial D_N}{\partial Y}\mathrm{d}Y = -\frac{\partial D_N^R}{\partial \theta}\mathrm{d}\theta \tag{13}$$

where $A = \frac{\partial D_N}{\partial P_N} + \frac{\partial D_N^R}{\partial P_N} + \frac{\partial D_N^O}{\partial P_N} - \frac{\partial X_N}{\partial P_N}$. Note that θ represents the expansion factor. The sign of A is always negative if we assume all goods are normal in consumption. Since supply curve is upward sloping we know that the last term on its own is positive.

We wish to solve the system for change in the relative price of the non-traded good and real income (which is the same as change in utility at the point of equilibrium).

By differentiating the national income Equation (6), we obtain:

$$\mathrm{d}Y - X_N \mathrm{d}P_N = 0 \tag{14}$$

Now that we have two equations in two unknowns. We can solve the system for the change in income and the relative price of the non-traded good:

$$\frac{\mathrm{d}P_N}{\mathrm{d}\theta} = \frac{-\frac{\partial D_N^R}{\partial \theta}}{A + \frac{\partial D_N}{\partial Y}X_N} \tag{15}$$

$$\frac{\mathrm{d}Y}{\mathrm{d}\theta} = \frac{-X_N \frac{\partial D_N^R}{\partial \theta}}{A + \frac{\partial D_N}{\partial \mathrm{Y}} X_N} \tag{16}$$

To analyze these expressions, we must determine the sign of the denominator, which consists of both price and income effects. For stability we require that the substitution effect always outweigh the income effects. Since all the goods are normal in consumption, the denominator is negative and satisfies Walrasian stability condition, that is, the denominator in Equation (16) is negative. Given this stability condition it follows that the tertiary terms of trade improve, that is, $\frac{\mathrm{d}P_N}{\mathrm{d}\theta} > 0$ and welfare increases as $\frac{\mathrm{d}Y}{\mathrm{d}\theta} > 0$.

Proposition 1: An expansion (contraction) in regional tourism results in an improvement (deterioration) in the tertiary terms of trade and therefore welfare.

Several comments are in order on the above proposition. First, it is well known in trade theory that an improvement (deterioration) in terms of trade raises (lowers) welfare. This result is now extended to the literature in tourism. It is important to note here that this improvement in the terms of trade arises from an expansion of regional tourism expansion. This is a novel and important result as it establishes that a domestic expansion in tourism improves the tertiary terms of trade and therefore national welfare. It is a consequence of monopoly power in trade. Second, with three types of agents in this model, expansion of the demand by any of these agents raises welfare via the tertiary terms of trade effect. Third, this result is in line with a result already proved by Chao et al. (2009) that free trade is not the optimal policy in the presence of tourism due to monopoly power in trade.

In this model, there are a number of tax choices: tax locals; tax regional tourists; tax foreign tourists and tax all of them. The taxes will have to be placed in an optimal manner to exploit monopoly power in trade. The optimal tax rate will depend on the elasticities of these demand curves and if all are taxed then of the aggregate demand curve. The procedure for obtaining the optimal tax will be the same as in Chao et al. (2009). What is interesting and important here is that there is flexibility in terms of who should be taxed. One may wish to tax the locals or regional tourists and not tax the foreigners as they provide foreign exchange and/or to increase the amount of imported good consumed. This is a decision which the Government has to make depending on the weight attached to the consumption of non-traded goods by the tourists.

Results with congestion ($0 < \alpha \leq 1$)

We now proceed to analyze the impact of expansion in regional tourism on tertiary terms of trade and welfare in the presence of both monopoly power in trade and congestion. The latter implies that $\alpha$is strictly positive. For our analysis we shall assume that the value of $\alpha$is at a suboptimal level. Tourism expansion results in an increase in the intensity of the distortion.

By differentiating the utility function and utilizing the national income equation we obtain the first equation of our system.

$$\begin{aligned}&\mathrm{d}Y + Z\mathrm{d}P_N + P_N' D_N \mathrm{d}\alpha = 0\\&\frac{\partial D_N}{\partial Y}\mathrm{d}Y + A\mathrm{d}P_N = -P_N \frac{\partial D_N^R}{\partial \theta}\mathrm{d}\theta\\&-\frac{\partial \alpha}{\partial P_N}\mathrm{d}P_N + \mathrm{d}\alpha = -\frac{\partial \alpha}{\partial \theta}\mathrm{d}\theta\end{aligned} \tag{17}$$

$$V = \begin{bmatrix} 1 & Z & P_N' D_N \\ \frac{\partial D_N}{\partial Y} & A & 0 \\ 0 & -\frac{\partial \alpha}{\partial P_N} & 1 \end{bmatrix} > 0$$

$$\frac{\mathrm{d}P_N}{\mathrm{d}\theta} = \frac{P_N}{V}\frac{\partial D_N^R}{\partial \theta} + \frac{1}{V}\frac{\partial D_N}{\partial Y} P_N' \frac{\partial \alpha}{\partial \theta} \lesseqgtr 0 \tag{18}$$

$$\mathrm{d}\alpha = -\frac{\partial \alpha}{\partial \theta}\mathrm{d}\theta + \frac{\partial \alpha}{\partial P_N}\mathrm{d}P_N \lesseqgtr 0 \tag{19}$$

$$\frac{\mathrm{d}Y}{\mathrm{d}\theta} = -\frac{Z}{V}P_N\frac{\partial D_N^R}{\partial \theta} - \frac{P_N P_N'}{V}\frac{\partial D_N^R}{\partial \theta}\frac{\partial \alpha}{\partial P_N} - \frac{A}{V}P_N' D_N \frac{\partial \alpha}{\partial \theta} \lesseqgtr 0 \tag{20}$$

where $Z = X_N - D_N$. By examining the above equations it is patently obvious that these expressions have ambiguous signs. We will concentrate on discussing the welfare terms, that is, the real income or change in welfare.

This expression consists of three terms. 1) The first term shows the impact of an increase in regional tourism on the relative price of the non-traded good. 2) The second term the effect on congestion via a change in the tertiary terms of trade and 3) the final term the impact of the expansion on the congestion factor. So we have been able to isolate the three effects in very clear terms. If we set α equal to zero then we obtain the result that an increase in tourism is necessarily welfare increasing. It is clear that our derivations are correct and intuitive. The second effect is positive as it shows that congestion falls as the relative price of the non-traded good rises and that benefits the consumers. The third effect is the impact of tourism expansion on congestion. The congestion increases when tourism expands so this is negative. With two positive terms and one negative term, the overall effect is ambiguous.

Proposition 2: An increase in regional tourism in the presence of monopoly power in trade and congestion is not necessarily welfare increasing.

Given the above result the policy maker has to think about optimal policy. This has not been pursued in this paper as it would give results which would be the same as derived by Chao et al. (2009). The policy framework here consists of two parts. One relates to exploiting the monopoly power in trade which can be done with and export tax or a tariff which are equivalent due to Lerner theorem.

However, these results in this structure may also be obtained by taxing local and/or regional residents. Thus the policy maker has more options here than in the standard models of tourism. In the end these are political decisions which depend on the weight the Government attaches to these three agents.

The other two terms require that we price the congestion factor by creating a market for congestion as shown by Laffont (1989) and later shown in a simpler manner by Hazari and Yao (2009).

Creating a Market solution for Congestion

In order to set the distortion at an optimal level we have to create a market for congestion. To do this we re-write our maximization problem with a price on congestion. So our maximization problem becomes:

$$\max U\left[(1-\alpha)D_N, M\right]$$

subject to

$$Y = P_N D_N + P_M M + q_1\alpha \tag{21}$$

where q_1 represents the price for congestion.

So we have

$$\frac{U_N}{U_M} = \frac{P_N + q_1}{(1-\alpha)P_M} \tag{22}$$

Because $P_N + q_1 > P_N$, so consumers consume less non-traded good and congestion falls.

3. Conclusion

The main message of the paper is that policy makers dealing with tourism should try to optimize policy making in order to reduce congestion and capture the gains from monopoly power in trade. The interesting feature of the model is that taxes can be imposed on any or all of the three agents, that is, local residents, regional tourists and international visitors. The rate of taxes would depend on the demand elasticities of the three types of agents. The same holds for congestion tax also, the rate of which would depend on the tolerance of the tourists for congestion. The most important contributions of this paper are: a way of capturing the congestion factor in the utility function and introduction of three types of agents who consume the non-traded good: local tourists, regional tourists and international tourists. This gives rise to a lot of policy choices and provides politicians a nice framework for discussing and pursuing optimal policies with regard to congestion and monopoly power in tourism. One of the limitations is that our model does not explicitly incorporate dynamics over time. A possible future extension is to add time dimension to the current model.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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