Optimal Transport and Trade Policy under Bertrand Competition in the presence of restricted geographical condition

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Abstract

An argument for a strategic trade intervention with Bertrand duopolists is reconsidered in a model which supposes the rivalry between a landlocked firm and a coastal firm in the third market. The government of the landlocked country has incentives investing and subsidizing in transport infrastructure and the coastal government has a possibility to impose a toll fee on the landlocked firm exports. Establishing the three-stage-game, this paper shows that the transportation infrastructure capital investment policies are negative for the coastal country and positive for the landlocked country. Furthermore, it demonstrates that the persecution policy, toll fees, is positive.

Keywords: Landlocked country, Coastal country, Transportation cost, Strategic trade policy

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1 Introduction

Developed countries, due to a benefit of accessing to maritime transport, are typically located in coastal areas. A relationship between geographical location and trade of one country has been examined for a long time (Gallup et al., 1999; Carrere and Schiff, 2005). Trade costs (i.e. Transport costs) are one of the significant factors which link the location and country’s trade volume (Anderson and van Wincoop, 2004). However, a study which specifically focuses on landlocked countries’ trade is at a descriptive statistical analysis1. This paper focuses at the landlocked countries’ transportation policy under imperfect competition which clarifies a rivalry condition between landlocked country and its neighbouring coastal country.

The landlocked country’s government and firm have to reduce the location disadvantage by introducing policies such as subsidizing, investing, and developing transportation sector (Snow et al., 2003; Grigoriou, 2007). However, as stated in a previous study, the existence of neighbouring country or transit country is one of the crucial problems in implementation of such policies (Raballand et al., 2005). Therefore, we attempt to examine this situation where the landlocked and coastal countries’ firms are competing in international trade given supporting policies by the governments.

The dependency of the landlocked firm on the transit country’s transportation infrastructure allows the coastal country’s government a chance for seeking benefits 2. In this paper, we assume that the coastal government charges toll fees to a delivery (i.e. trucks) of the landlocked firm exports which uses its transportation infrastructure (i.e. Highway and seaport). It also assumes that the landlocked firm and the landlocked government invest in transportation infrastructure.

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1Arvis et al. (2007) summarize that the landlocked country trade less, on average 30% less, compared with the coastal country. UNCTAD (2006) reports that the landlocked country trade half as much compared to the coastal country.

2Hoyle and Charlier (1995) report a crucial role of Tanzania and Kenya as a the transit port for the landlocked countries in East African. However, Limao and Venables (2001) note a direct charge by Kenya (i.e. Road transit license’s charge and tolls on truck)
We analyse the Bertrand competition in the presence of the above-mentioned geographical phenomena. In particular, we reexamine the analysis of Eaton and Grossman (1986) by introducing the costs of being landlocked (i.e. The toll fees). In the original model of Eaton and Grossman, the impact of transport cost was not considered because countries were assumed to be identical in geographical conditions. Consequently, a potentially crucial element which not captured by this line of analysis is a policy by one government that can be applied directly to the rival country’s firm. The toll fee charge is a new element that we introduce to the model which captures the direct policy of the coastal country’s government.

The rest of the paper is organized in the following way. In section 2, we develop the three-stage game model of third-country trade; where, the coastal country’s government and landlocked government set the transport infrastructure capital in the first stage; and the coastal government sets the toll fee in the second stage; and the two countries’ firms non-cooperatively choose the prices for the third country in the third stage. We solve this three-stage game using the backward induction method. In section 3, we consider the optimal price choices of the two firms. In section 4, we consider the toll fee of the coastal government. In section 5, we consider the optimal of the government’s transportation infrastructure capital. Concluding remarks are in section 6.

2 The basic model

The model is based on a three-stage game played by two competing firms; a landlocked firm (LF) and a coastal firm (CF) which produce heterogeneous products in their own country and export to the third market and compete on price a la Bertrand. The governments of both country’s pre-commit at the first stage and second stage by imposing strategic transport policies.

In the first stage, the landlocked government (LG) and the coastal government
(CG) set a transportation infrastructure capital (TIC). The LG invests in the TIC in order to reduce its domestic firm burden of being landlocked. While, the CG invests in the TIC in order to improve its domestic firm’s competitiveness and to promote a usage of its seaport by the LF.

Hence, in the second stage, the CG sets the toll fee given the LG and its policy in the first stage. In the first hand, the toll fee is a revenue tool which amount of fees can be collected regarding the volume of freight of the LF. On the other hand, it can be used as a persecution tool. The CG uses the toll fee as a policy of seeking a rent in the third market by persecuting the LF export. However, the world convention has permitted the LF for an access to the open sea.

In the third stage, the firm’s non-cooperatively set their prices in order to maximize their profits under the Bertrand type of price competition, given the political decision in the previous stages. In order to solve this three-stage game we adopt a method of backward induction. The sub-game perfect equilibrium incorporates two stages.

Under the assumptions mentioned above, the profit of the LF is defined as

$$\pi = q(p, p^*)p - cq(p, p^*) + (t + T)q(p, p^*) - \tau q(p, p^*)$$

(1)

where \(q(p, p^*)\) is a demand function, \(c\) is a unit cost function. And, \((t + T)\) is total infrastructure capital, a sum of both governments’ TIC. And \(\tau\) is a unit toll fee that the CG imposes on the LF’s unit of exports. The model shows that the transportation infrastructure capital and toll fee are simplified to a unit cost. Consequently, the profit function of the CF is defined as

$$\pi^* = q^*(p, p^*)p - c^* q^*(p, p^*) + T q^*(p, p^*)$$

(2)

where \(q^*(p, p^*)\) is demand function and \(c^*\) is cost function. And, \(T\) is the TIC of the CG. The CF acts to maximize the profit. We normalize the transport costs of both
firms to be zero for focusing the discussion on the implemented policies.

On the country’s welfare side, taking into consideration that all products are exported to the third country, the economic welfare of the landlocked country and coastal country obtained from the industry in question, is respectively given by

\[ W = \pi - tq \]  \hspace{1cm} (3)

and

\[ W^* = \pi^* + \tau(t, T)q^* - T(q + q^*) \]  \hspace{1cm} (4)

while (3) shows that the landlocked country’s welfare consists of its firm’s profit and its TIC given to its firm and (4) illustrates that the coastal country’s welfare consists of its firm’s profit and the toll fee revenue and its TIC.

3 Firm’s price-choice stage

In a Bertrand-equilibrium each firm conjectures that its rival will hold its price fixed in response to any changes in its own price. Therefore, at the third stage, given all the decisions made by governments and firms in the preceding stages, the Bertrand-Nash equilibrium is given by

\[ \pi_p = q + q_p p - cq_p + (t + T)q_p - \tau q_p = 0 \]  \hspace{1cm} (5)

and

\[ \pi^*_p = q^* + q^*_p p^* - c q^*_p + T q^*_p = 0 \]  \hspace{1cm} (6)

where (5) and (6) are also the reaction function of the LF and CF, respectively.

We also assume, as is supposed in many papers, that the firms’ second-order
conditions are both satisfied

\[ \pi_{pp} < 0, \pi^*_{p,p} < 0, \pi_{pp} > 0, \pi^*_{p,p} > 0, 0 < \pi_{pp} < |\pi_{pp}|, 0 < \pi^*_{p,p} < |\pi^*_{p,p}| \] (7)

and (7) ensures that the firms’ reaction curves in the third stage are both upward sloping and that the industry equilibrium in the third stage is stable. Obviously, the optimal price equilibrium in the third stage depends on the toll fee and the TIC. The simultaneous solution to these equations presents the industry equilibrium, \( p = p(t, T, \tau) \) and \( p^* = p^*(t, T) \).

The geographical disadvantage of the LF, assuming the firms’ marginal costs are constant and similar, is shown from (5) and (6),

\[ p^* - p = t - \tau > 0 \text{ if } t > \tau \] (8)

Accordingly, it is obvious from (8) that the price of the CF depends on the TIC of the LG and the toll fee. If the TIC of the LG is larger than the toll fee than the price of CF in the third market is higher than the price of the LF and otherwise. This result illustrates that the TIC of the CG has not effect in the competition. Obviously, even if the CG subsidies the LF’s export the result is positive.

Totally differentiating (5) and (6) with respect to \( t, T \) and \( \tau \), and taking into consideration of (7), yields

\[ p_t = \frac{-q_p \pi^*_{p,p} p}{D} < 0 \]

\[ p^*_t = \frac{-(-q_p \pi^*_{p,p} p^*)}{D} < 0 \] (9)

where \( D = \pi_{pp} \pi^*_{p,p} - \pi_{pp} \pi^*_{p,p} > 0 \). The increase in the LF’s TIC decreases the LF’s price and the rival’s price. As the result, it is obvious that the LF’s TIC lowers the world price.
Therefore, taking into account of (7), yield the effects of a change in $T$ on $p$ and $p^*$:

$$p_T = -q_p \pi_{p*}^* - \left(-q^* p^* \right) \frac{D}{\pi_{p*}^*} < 0$$

$$p^*_T = -q^* p^* \pi_{pp} - \left(-q_p \pi_{p*}^* \right) \frac{D}{\pi_{p*}^*} < 0$$

Furthermore, taking account of the conditions of (7), we also obtain the effects of a change in $\tau$ on $p$ and $p^*$:

$$p_\tau = \frac{q_p \pi_{p*}^*}{\pi_{p*}^*} > 0$$

$$p^*_\tau = -q_p \pi_{p*}^* \frac{D}{\pi_{p*}^*} > 0$$

where it follows that a rise in the toll fee increases the price of the LF’s price and the CF’s price.

4 Toll fee decision in the second stage

In the second stage, the CG sets the toll fee given the LG and CG policies in the first stage. Therefore, the policies equilibrium in the second stage is;

$$W^*_\tau = \pi^*_\tau + q_\tau + \tau q_\tau = 0$$

where $\pi^*_\tau = \frac{\partial \pi^*}{\partial \tau}$. Assuming that the CG second order condition of welfare maximization is satisfied at the equilibrium. Then (12) yields

$$\tau = \frac{-q_\tau - \pi^*_\tau}{q_\tau} > 0$$

**Proposition 1** The toll fee is positive for the CG.

**Proof 1** by (13) and previous stages equilibrium signs
5 Transportation infrastructure determinations in the first stage

In the first stage, the LG and the CG determine the TIC in order to maximize their own economic welfare defined by (3) and (4), respectively. We assume that both of the governments know the firms’ optimal decisions in the third stage and the CG’s optimal decision in the second stage. Accordingly, the government’s first-order condition are respectively given by

\[
W_t = \pi_p^* p_t^* - q_t - t q = 0
\]
\[
W_T^* = \pi_p^* p_T - q_T - T q_T + \tau_T = 0
\]

The governments’ second-order conditions of welfare maximization are both satisfied at the equilibrium, yield;

\[
t = \frac{\pi_p^* p_t^*}{q_t} > 0
\]
\[
T = \frac{\pi_p^* p_T - q_T + \tau_T}{q - T} < 0
\]

**Proposition 2** The TIC of the LG is positive while the TIC of the CG is negative.

**Proof 2** by (15) and previous stages equilibrium signs

Therefore, it shows that the LG should invest or subsidies the TIC and the CG should tax the TIC.

6 Concluding remarks

This paper analyses the strategic transport policy and the strategic trade policy of the landlocked government and the coastal government when their firms compete a la Bertrand duopoly in the third market. Particularly, we analyse; the transport infrastructure capital investment of the government; the toll fee of the coastal government;
and, the firms’ behaviour. In the three stage-game, that the landlocked and coastal government’s pre-commits to a level of infrastructure capital investment in the first stage and follow in the second stage the toll fee’s determination of the coastal government. Consequently, in the third stage the firms determine the prices.

Since the landlocked country has no seaports for exporting goods via shipping, the LF must transport its goods to the nearest seaport in the coastal country. Hence, the LF has a comparative disadvantage against the CF from a geographical point of view, because it must incur extra transportation costs, ceteris paribus. To focus on the particular economic policy, it is also assumed that the LG and the CG are not hostile in their political relations but just economic rivals.

Our analysis shows that the optimal policy of the transport infrastructure capital is positive for the LG and negative for the CG, respectively. The LG improves the comparative advantages by investing in the particular transportation infrastructure but the CG has to tax the transportation infrastructure capital. However, the toll fee is positive for the CG. The positive toll fee shows that it generates revenue to the country and an optimal strategic policy.

The study has shown that under the geographical inequality, a geographically imprisoned landlocked country fails to compete in the third market if its rival implements a direct persecution policy, i.e. the toll fee. Therefore, in the case of landlocked country, any initiative (i.e. The Almaty Programme) that be implemented must consider such competition condition.

References


