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Tariffs that may fail to protect: A model of trade and public goods

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Abstract

This paper develops a model of small open economy, with a differentiated goods sector and voluntary provisioning of public good. It is shown that trade policy can alter the quantity of public good provided in the equilibrium. Interestingly, tariffs may fail to protect, leading to a Metzler Paradox like situation. This is because the income effect generated due to the imposition of tariff can lead to an increase in the contribution to the public good. An expanding public sector crowds out the import competing sector. This result holds unambiguously in the neighbourhood of free trade.

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1. Introduction

A good or a service is considered to be public, if it is non-rival and non-excludable in consumption. Thus, these goods are potentially for collective consumption. In general, markets fail to allocate public goods efficiently and thus the issue of providing and financing public goods through collective action has become an important issue in the literature. Oslon (1965) had argued that in a society with competing political groups, provision of public good becomes increasingly difficult through voluntary contribution, as the group size increases. Chamberlin (1974) and Mcguire (1974), show that in a competitive set-up, if the public good provided is a normal good, then contribution by each member increases and reaches a finite value with an increasing group size. Cornes and Sandler (1989) builds a model, with both a public good and private good. Both these goods are produced with labour. Increase in labour endowment of each individual increases his contribution to the public good. In the two factor model developed by Vicary (2004) the effect of group size become ambiguous and depends on the relative factor intensities of the public good and the private good.

Pecorino (2009) builds a model, where labour is employed between a differentiated private goods sector and a public good sector. As labour increases, the variety sector expands which in turns implies a higher expenditure on the differentiated goods sector. This increases the marginal utility of income and thus the aggregate contribution made to the public good falls. In Mondal (2013), marginal utility of income is inversely related to the aggregate expenditure on the variety sector and thus increasing group size, in contrast to Pecorino (2009) increases the aggregate contribution to the public good.

The present model, extends Mondal (2013) and incorporates trade in the differentiated goods sector. The economy is assumed to be small, in a sense that the prices of the foreign brands and the number of foreign varieties are exogenously given (See Sen et al. 1997). Imposition of tariff, by the home country in such a set up has interesting implications. An increase in tariff ceteris paribus (that is at the level of constant import demand), increases the income of the individuals through the tariff income rebated to the agents. This generates an "income effect" by which agents would contribute more to the public good and thus increase the aggregate expenditure on public goods. Market clearing implies that an expanding public goods sector draws

labour out of the differentiated goods sector and thus this sector may contract. Tariffs then would fail to protect the import competing sector. Such a result is reminiscent of the famous Metzler Paradox result in classical trade theory (See Metzler 1949).

In general, imposition of tariff has two effects, firstly, it enhances welfare by improving the terms of trade for the tariff imposing country, and secondly, it reduces welfare by causing the import competing sector to expand (and thus crowd out cheaper importables). Competitive trade theory identifies a situation known as the Metzler Paradox (see Metzler 1949), when the improvement in terms of trade, for the tariff imposing nation is so high that it actually lowers the domestic price of the output of the import competing sector and thus fail to protect it. Helpman and Krugman (1989) builds a model of trade with monopolistic competition and scale economies, where trade in varieties is subject to transportation costs. They show that in such set up, the price lowering effect of the tariffs can become more pronounced since it requires much lesser restrictive conditions than Metzler (1949). A single factor of production, labour is allocated between a differentiated goods sector and a homogeneous goods sector. Imposition of tariffs in a two country world leads to re-allocation of firms in the tariff imposing country. Since the relatively cheaper home varieties increases; the aggregate price index faced by the domestic consumers fall which lowers the domestic price of the import competing sector.[1] The present model is also related to this class of literature. However, the possibility that tariffs may fail to protect the import competing sector comes through a completely different channel (not through home market effects) and in a different manner. Increase in the tariff, increases the revenue earned from the imports directly. As this tariff income is rebated back to the agents, it reduces the marginal utility of income and thus agents increase their contribution to the public good. On the other hand, increase in the tariff rate causes the import demand to fall, which may reverse the effect. The net effect thus is ambiguous. To focus on the intuition, we study the equilibrium in the neighbourhood of free trade. Near the free trade equilibrium, the first effect dominates the second and tariffs fail to protect the import competing sector unambiguously. The number of

[1]Davis (1998) builds another model that discusses the implications of home market effects and trade policy.

domestic (import competing) brands falls and the total volume of the import competing sector contracts.

The next section outlines the basic model, and section-3 develops the comparative statics. The last section concludes the model.

2. The Basic Model

Consider a hypothetical small open economy which produces n_h number of varieties domestically and imports n_f number of varieties from foreign. "Smallness" implies that the number and prices of the foreign varieties are exogenously given to this economy [2]. Moreover, the agents also consume a public good, G which is financed by voluntary contribution of the agents. All the agents supply one unit of labour inelastically and total number of residents is assumed to be L. Government imposes a tariff on the import of the foreign varieties. The utility function of the agents is given by

$$U = \log\left(\sum_{i}^{n_h} C_h^{\rho} + \sum_{j}^{n_f} C_f^{\rho}\right)^{\frac{1}{\rho}} + f(G/w). \tag{1}$$

where $f' > 0$ and $f'' < 0$. C_h indicates the representative consumption of the home variety while C_f is the consumption of any foreign variety [3]. σ $(= \frac{1}{1-\rho})$ is the elasticity of substitution and $\sigma > 1$ as $\rho \in (0, 1)$. G and w are the total expenditure on the public good and the wage rate in the economy respectively. For simplicity, it is assumed that one unit of labour is used for producing one unit of public good. Thus $\frac{G}{w}$ is the total labour employed for the production of public good. Since, each worker employed produces exactly one unit of public good, $\frac{G}{w}$ is also the amount of public good produced in the economy. Since, public goods are non-rival and non-excludable, $\frac{G}{w}$ represents the consumption of public good by each consumer.[4] Suppose the voluntary contribution made by each individual is given by g_k. Then $G = \sum_k gL$ as all

[2] Venables (1982), Sen et al (1997), Chakraborty (2001) and Biswas (2013) also build on an identical notion of small open economy.

[3] It is shown in the appendix that the major result of the paper holds even with an alternate specification of the utility function.

[4] See Mondal (2013) for this specification of the utility function.

agents are symmetric and L represents the total number of agents (workers) in this economy. The demand functions can be obtained by maximising "(1)" when the income of each consumer is

$$M = w + T/L. \tag{2}$$

M and w respectively represents the individual income and the wage rate earned by the individual by supplying the one unit of labour it possess inelastically. T is the aggregate tariff revenue earned by the government which we assume to be rebated equally among the agents. Utility maximisation implies

$$\frac{C_h}{C_f} = \left(\frac{p_h}{p_f(1+t)}\right)^{-\sigma}. \tag{3}$$

p_h, p_f and t represents the prices of the home produced brand, imported brand and the tariff rate respectively. The first order condition of utility maximisation also implies

$$\frac{1}{w}f'(G/w) - \lambda = \frac{1}{C} - \lambda P = 0$$

where C and P represents the aggregate consumption index [5] and the aggregate price index respectively for the variety sector. λ is the Lagrange multiplier of the relevant maximisation exercise. Suitably rearranging terms, and substituting into the budget constraint we get the symmetric voluntary contribution made by each agent in Nash equilibrium given by g. [6]

$$g = w + T/L - \frac{w}{f'(G/w)}. \tag{4}$$

Total amount of public good thus produced in the economy would be given by

$$G = wL + T - \frac{wL}{f'(G/w)}. \tag{5}$$

Domestic production of each variety requires α units of labourers to start production and β units of labourers for each additional unit of output produced. The profit of each producer is then given by :

$$\pi_h = p_h x_h - [\alpha + \beta x_h]w$$

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[5] $C = \left(\sum_i^{n_h} C_h^\rho + \sum_j^{n_f} C_f^\rho\right)^{\frac{1}{\rho}}$

[6] See Mondal (2013) for derivation of this demand function.

where π_h and x_h represents the profit and output for each domestic firm. Producers maximise profits by equating the marginal revenue with the marginal cost.

$$p_h(1 - \frac{1}{\sigma}) = \beta w, \tag{6}$$

which implies,

$$p_h = \frac{\beta w}{\rho}. \tag{7}$$

Free entry in the variety sector, means that in the equilibrium, firms would earn no supernormal profits. This is because free entry into the variety sector drives supernormal profits down to zero. Using equation "(7)", the surplus earned by each firm can be expressed as:

$$\pi_h = p_h x_h - [\alpha + \beta x_h]w = \frac{p_h x_h}{\sigma} - \alpha w.$$

Thus, free entry implies,

$$\frac{p_h x_h}{\sigma} = \alpha w \Longrightarrow x_h = \frac{\alpha\rho}{\beta(1-\rho)}. \tag{8}$$

Equation "(8)" determines the per-firm output for the domestic economy. Total value of exports made by this small open economy is $n_h p_h(x_h - LC_h)$ and the aggregate value of imports is given by $n_f p_f LC_f$. Balance of payments would require that value of imports should be equal to the value of exports.

$$n_h p_h(x_h - LC_h) = n_f p_f LC_f. \tag{9}$$

The tariff revenue earned by the government is given by

$$T = t n_f p_f C_f L. \tag{10}$$

Labour is required for production of the public good and the variety sector. Labour is assumed to be the numeraire and thus $w = 1$. Labour required for producing an output x_h by each firm is $\alpha + \beta x_h$. Total labour required by the variety producing sector is $n_h(\alpha + \beta x_h)$. Thus the labour market clearing condition is

$$n_h(\alpha + \beta x_h) + G = L. \tag{11}$$

Equations "(1)" to "(11)" completes the description of the model.

3. Comparitive statics

To understand the effect of tariffs in this model, we totally differentiate equation "(9)" to get, [7]

$$\hat{n_h} - s\hat{C_h} = \hat{C_f}, \tag{12}$$

where $s = \frac{LC_h}{x_h - LC_h}$, and $s > 0$ the ratio of aggregate domestic consumption of each brand to its imports. Utility maximisation implies that $\hat{C_h} = \hat{C_f} + \sigma\frac{dt}{1+t}$ (See equation "(3)"). Substituting this into equation "(12)", we obtain an equation involving $\hat{n_h}$ and $\hat{C_f}$.

$$\hat{n_h} - (1+s)\hat{C_f} = \frac{\sigma s dt}{1+t}. \tag{13}$$

From equation "(5)",

$$dG = tn_f p_f C_f L(\hat{C_f} + \hat{t}) + Lf'^{-2}f''dG.$$

which would in turn imply

$$\hat{G} = \frac{tn_f p_f LC_f(\hat{t} + \hat{C_f})}{G[1 - L\frac{f''}{f'^2}]}. \tag{14}$$

Total differentiation of the labour market clearing condition "(11)" gives,

$$n_h(\alpha + \beta x_h)\hat{n_h} + G\hat{G} = 0$$

Substituting the expression of $\hat{G}$ from equation "(14)", the above expression can be written as

$$-[1 - L\frac{f''}{f'^2}](\alpha + \beta x)n_h\hat{n_h} - tn_f p_f LC_f\hat{C_f} = n_f p_f LC_f dt. \tag{15}$$

Solving equations, "(13)" and "(15)", by applying Cramer's rule, the change in total number of home produced varieties and the import demand due to a change in tariffs can be expressed as:

$$\hat{n_h} = \frac{-(1+s)n_f p_f LC_f + \frac{tn_f p_f LC_f \sigma s}{1+t}}{D}dt, \tag{16}$$

[7] For any arbitrary variable z, $\hat{z} = \frac{dz}{z}$.

$$\hat{C}_f = -\frac{[1 - L\frac{f''}{f'^2}](\alpha + \beta x)n_h \sigma s/(1+t) + n_f p_f L C_f}{D} dt \tag{17}$$

where $D = n_h(1+s)(1 - \frac{Lf''}{f'^2})(\alpha + \beta x) + tn_f p_f L C_f > 0$.

Equations "(16)" and "(17)" can be used to derive the following propositions.

Proposition 1. *Tariffs may fail to protect the import competing sector. Moreover, around the free trade equilibrium an increase in tariffs cause an unambiguous contraction of the import competing sector.*

Proof. Consider equation "(16)". The number of brands produced by the import competing sector will decline if the parametrisation $\frac{\sigma t}{1+t} - \frac{1+s}{s} < 0$ holds. It is straightforward to check that around the free trade equilibrium,$(t = 0)$, imposition of tariffs reduce the total number of varieties produced by the home economy. This implies that tariffs fail to protect the import competing sector in the presence of public good. This is because as the per firm output produced by the import competing sector is constant, the volume of import competing sector's output $(n_h x_h)$ contracts unambiguously. ■

Imposition of tariff increases the total income accruing to the consumers, which thus reduces the opportunity cost of contributing to the public good. Thus the voluntary contribution to the public good increases, which draws labour out of the production of the home produced varieties. As the per firm output is constant, the total number of home produced varieties gets reduced, which in turn implies that the total volume of the import competing sector $(n_h x_h)$ contracts. This can be summarized as the following proposition.

Proposition 2. *In the neighbourhood of the free trade equilibrium, imposition of tariffs increases the tariff revenue.*

Proof. Differentiating equation "(5)" we get

$$\frac{dT}{dt} = tn_f p_f \frac{dC_f}{dt} + n_f pf C_f. \tag{18}$$

Assuming free trade (that is, $t = 0$), $\frac{dT}{dt} > 0$. ■

Equation "(17)" shows the usual effect of tariffs on the import demand. The volume of import falls, because imposition of tariffs makes it dearer to the consumers. From the labour market clearing condition "(11)", near the free trade equilibrium a fall in the number of varieties implies higher output of the public good. [8]

Conclusion

Metzler (1949) had shown that tariffs may fail to protect the import competing sector. This can happen when the improvement in terms is very large. Helpman and Krugman (1989) builds a model of monopolistic competition and love for variety and shows that home market effects can lead to Metzler Paradox type result. The present model generates a similar result, though through a completely different channel. Presence of a public good implies, that around the free trade equilibrium the differentiated goods sector (which is the import competing sector) would contract. Thus, tariffs may fail to protect, though in general, the effect of tariffs on public good and the total volume of the import competing sector remains ambiguous. This is interesting because tariffs are often invoked to protect the domestic import competing industry.

Appendix A.

In [9] this appendix we show that the major results of the paper holds with an alternate specification of the utility function. It is assumed that the agents have the utility function given by:

$$U = \mu \log \left(\sum_{i}^{n_h} C_h^{\rho} + \sum_{j}^{n_f} C_f^{\rho} \right)^{\frac{1}{\rho}} + (1-\mu)\log(G/w). \qquad \text{(A.1)}$$

[8] In a related literature involving the issue of devaluation, devaluation of home currency initially causes a deterioration in the balance of payments of a country, after which the economy may exhibit a trade surplus. This phenomenon is represented by "J curve" in the literature of international economics. Tariffs also increases the relative price of the imports (like devaluation), however it simultaneously generates a tariff revenue. In the present model, trade is always balanced and thus the issue of deterioration of trade balance does not rise. Proposition-2 states that imposition of tariff by an economy involved in free trade would unambiguously improve this revenue.

[9] The author wishes to thank an anonymous referee for suggesting this exercise.

Then each consumer would make a voluntary contribution given by,

$$g = w + \frac{T}{L} - \frac{G\mu}{1-\mu}. \tag{A.2}$$

Total amount of public good thus produced would be

$$G[1 + \frac{\mu L}{1-\mu}] = wL + T. \tag{A.3}$$

Equations "(7)" to "(11)" of the main text remain unchanged. We can proceed to solve for the change in the number of the varieties ($\hat{n_h}$) and the change in the import demand ($\hat{C_f}$) as before. Equation "(13)" remain unchanged. Differentiating equation "(A.3)" and using the labour market clearing condition "(11)" we get,

$$n_h(\alpha + \beta x_h)\hat{n_h} + tn_f p_f LC_f \hat{C_f} = -n_f p_f LC_f dt. \tag{A.4}$$

Solving equation "(13)" and "(A.4)" simultaneously we get,

$$\hat{n_h} = \frac{n_f p_f LC_f(1+s) - \frac{tn_f p_f LC_f \sigma s}{1+t}}{B} dt \tag{A.5}$$

$$\hat{C_f} = \frac{(\alpha + \beta x)n_h \sigma s/(1+t) + n_f p_f LC_f}{B} dt \tag{A.6}$$

where $B = -n_h(1+s)(\alpha + \beta x_h) - tn_f p_f LC_f < 0$. From equation "(A.5)", it is straightforward to check that around free trade ($t = 0$), the number of home produced varieties falls. Moreover, propositions 1 and 2, of the main text remains valid.

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