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TARIFF, TECHNICAL PROGRESS AND TRADE WITH VERTICAL SPECIALIZATION*

Sugata MARJIT

Abstract. A model of trade with vertical specialization is described where intermediate inputs are produced with country specific labor and internationally mobile capital. It is shown that under such structures tariff can be antiprotectionary and technical progress can lead to the contraction of an efficient sector.

INTRODUCTION

The purpose of this paper is to highlight certain features of trade with vertical specialization. A large share of the global trade today, comprises of trade in intermediate or semi-finished goods. A country which is producing the final stage of a product, may import all the necessary ingredients from the rest of the world and just assemble it. Therefore, although this country appears to sell this product in the world, it may enjoy a very small part of the total value added. Structure of this type of trade has been discussed extensively by Dixit and Grossman (1982), Sanyal (1983), Sarkar (1985), and Marjit (1987). All of these papers discussed positive theories of trade in stages of production, mostly explaining the pattern of trade. Normative issues were not dealt with in terms of formal set up. One question that immediately comes up in this context is as follows. Suppose an economy is importing a foreignmade input to use it, along with a home made one to produce final goods. Also suppose that these inputs are substitutes. Can the home country government protect the domestic input producing sector? This type of question is related to structures we very often observed in less developed countries. Particularly in India, television, medicine and computer industries use considerable amount of imported input as well as domestic resource. Import-taxes are thought to be basic protective device for sustaining a reasonable level of domestic activity. The literature on tariff concentrated mostly on restricting trade of final goods. Even the literature on effective protection pioneered by Corden (1971) focused on the protection of final goods. Effective protection theme has never asked questions like whether it is at all possible to protect the intermediate good sector with the help of the usual policies. Problems regarding effective protection of the intermediate sectors have never been analyzed. Since the

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intermediates are traded and used to produce final goods they become crucial in determining the outcome of different types of protective policies. The basic purpose of this paper is to address some of the above issues concentrating exclusively on the intermediate goods sectors. We show that tariff may be antiprotectionary and hence protective policies can give rise to paradoxical outcomes.

The next problem we analyze is the impact of technical progress by which the foreign made unput becomes more efficient in producing a particular final good. We shall show that such technical progress may lead to a contraction of the foreign input sector. The reason for such a counterintuitive outcome is similar in nature to the one that is responsible for the tariff-paradox. These type of paradoxical outcomes are mainly due to the structure of trade in intermediates.

The paper is divided into three sections. In the first section we describe the model and determine the equilibrium. In the second section we discuss the impact of tariff and technical progress on the size of the intermediate good sector. In the last section we conclude the paper.

Section 1

Let us consider a world with two countries, country 1 and country 2. Country 1 will be called the home country and country 2 will be called the foreign country. Each country has one sector producing inpts or intermediates I_1 and I_2 . I_1 and I_2 are used to produce two separate goods X_1 and X_2 . Production of I_1 and I_2 requires country-specific labor and internationally mobile capital which earns the same rate of return in both countries. We assume that both countries are 'small' compared to the rest of the world and face exogeneously given world prices and return to capital. Suppose country 1 is more efficient in producing both X_1 and X_2 , vis-a-vis country 2. Therefore, country 1 exports I_1 , X_1 and X_2 and country 2 exports I_2 . As we shall see later that such pattern of trade is not at all necessary to generate the basic results. As long as I_1 and I_2 are assembled together to produce final goods, tariff on intermediate inputs may result in contraction of the protected sector. We are assuming a particular pattern of trade to highlight the basic issue of antiprotectionary impact of tariff. We assume that all production functions obey constant returns to scale and diminishing marginal returns to inputs. The markets are assumed to be competitive.

Following symbols will be used throughout the paper.

- a_{ij} – per unit requirement of I_i for X_j , $i=1,2, j=1,2$
- a_{Li} – per unit labor requirement for I_i
- a_{Ki} – per unit capital requirement for I_i
- L_i – labor force in the i th country-exogeneously given
- K – total use of capital in these regions
- W_i – wage rate in the i th country
- \bar{r} – return to capital, exogeneously given
- P_j – price of the j th final product

P_i – price of the i th intermediate good.

Competition in final product market implies

$$p_1 a_{11} + p_2 a_{21} = P_1 \quad (1)$$

$$p_1 a_{12} + p_2 a_{22} = P_2. \quad (2)$$

Production of the intermediate goods must match their demand. Therefore,

$$a_{11} X_1 + a_{12} X_2 = I_1 \quad (3)$$

$$a_{21} X_1 + a_{22} X_2 = I_2. \quad (4)$$

Competition in the input markets implies

$$W_1 a_{L1} + \bar{r} a_{K1} = p_1 \quad (5)$$

$$W_2 a_{L2} + \bar{r} a_{K2} = p_2. \quad (6)$$

Finally, full-employment of labor force in each country generate following equations.

$$a_{L1} I_1 = L_1 \quad (7)$$

$$a_{L2} I_2 = L_2. \quad (8)$$

Total use of capital in these countries is given by

$$a_{K1} I_1 + a_{K2} I_2 = K. \quad (9)$$

Given final commodity prices, factor endowments and \bar{r} there are 9 unknowns— $p_1, p_2, W_1, W_2, K, I_1, I_2, X_1, X_2$ to be solved from (9) equations.

One should note that we do not require any additional balance of trade equation in this model. Once we bring in the budget constraint of the home country we can easily check that the balance of payments restriction is automatically satisfied. Home country's national income is given by $p_1 I_1$ (assuming capital income generated within the country is treated as a part of the national income). The budget constraint implies

$$p_1 I_1 = C + C^* \quad (10)$$

where C is the domestic value of consumption and C^* is the import value of consumption. Note that the home economy can import from the rest of the world at given price. Add $p_2 I_2$ on both sides of the budget constraint which yields

$$P_1 X_1 + P_2 X_2 = C + C^* [\text{from equations (1)–(4)}] + p_2 I_2. \quad (11)$$

Interchanging sides we get,

$$P_1 X_1 + P_2 X_2 - C - C^* = p_2 I_2. \quad (12)$$

This is nothing but the balance of trade between the home and the foreign country.

The above structure incorporates a two sector Heckscher-Ohlin model as well as the specific-factor model of trade as developed by Jones (1971). The intermediate inputs are two factors of production entering the final products. However, their supplies are not fixed as in a standard Heckscher-Ohlin set up. These inputs are in turn produced with country specific labor and internationally footloose factor capital. Therefore, production in the intermediate good sector resembles the specific factor model.

Although both goods in their final form are exported by the home country, they do not confer equal benefits to the home country. Consider an increase in P_1 keeping P_2 fixed. So that the relative price of commodity 1 increases. Now depending on the intensities with which I_1 and I_2 are used in X_1 and X_2 , p_1 and p_2 will adjust. An increase in P_1/P_2 may be associated with a fall in p_1 and rise in p_2 if commodity 1 uses I_2 more intensively. This follows from the Stolper-Samuelson theorem. This would unambiguously lead to a fall in income in country 1. In the forthcoming sections we shall develop on this idea to analyze the impact of tariff.

PROTECTION

Section II

At the very outset we shall assume (i) X_1 is I_1 intensive, (ii) There is no barrier to free trade initially. Suppose in country (1) the government decides to increase the size of I_1 sector. One way of doing this is to impose a tariff on imported I_2 . The government can impose tariff on I_2 at uniform rate in both sectors or it can impose tax in a particular sector. One question naturally arises. If tariff is imposed on imported I_2 , then X_1 producers can relocate their production from home to the foreign country and avoid tariff completely. We assume that relocation costs are high enough to rule out such escape. In fact it is reasonable to assume that producers face some amount of fixed shifting costs. As long as the amount of tariff is not high enough, the benefit accrued through escaping tariff may not be significant to outweigh the relocation costs. Given all firms are identical, everyone will choose to stay back. What we are essentially assuming is that the tariff imposed is not high enough to induce the producers to relocate their plants.

Proposition 1.

- a) If the government decides to impose a tax on the use of imported intermediates in X_1 , then I_1 , the domestic intermediate good sector will contract.
- b) A tariff that affects both final goods producing sectors also fails to protect the domestic input producing sector.

Proof.

- a) Consider equations (1) and (2). Differentiating and using the envelope property we get,

$$\theta_{11}\hat{p}_1 + \theta_{21}\hat{p}_2 = -\theta_{21}dt_1 \quad (13)$$

$$\theta_{12}\hat{p}_1 + \theta_{22}\hat{p}_2 = -\theta_{22}dt_2 \quad (14)$$

where t_i is a tax/subsidy (as $dt_i > 0$ or $dt_i < 0$ from an initial level $t_i = 0$) on the use of the imported intermediate in sector i , $i = 1, 2$.

$$\theta_{ij} = \frac{p_i a_{ij}}{P}, \quad \hat{\theta} \text{ denotes proportional change, i.e. } \hat{X} = \frac{dX}{X}.$$

For Proposition 1(a) $dt_2 = 0$, $dt_1 > 0$.

From (13) & (14) we get,

$$\hat{p}_1 = -\frac{\theta_{21}\theta_{22}}{|\theta|} dt_1 < 0 \text{ as } |\theta| > 0 \quad (15)$$

where

$$\theta = \begin{vmatrix} \theta_{11} & \theta_{21} \\ \theta_{12} & \theta_{22} \end{vmatrix} > 0 \text{ as } X_1 \text{ is } I_1 \text{ intensive.}$$

An increase in the tax by dt_1 in the use of intermediate I_2 in X_1 sector, increases the relative cost of producing X_1 . Since I_1 is intensively used in this sector, due to magnification effect, its return p_1 must go down. Similarly

$$\hat{p}_2 = \frac{\theta_{21}\theta_{12}dt_1}{|\theta|} > 0.$$

Now from (7),

$$-\hat{a}_{L1} = \hat{I}_1 \quad \text{and} \quad \hat{a}_{L1} = -\sigma_1 \hat{w}_1 \quad (7')$$

where σ_1 is the elasticity of a_{L1} with respect to wage/rental ratio ($= w_1/\bar{r}$) in I_1 sector. It is easy to show that

$$\hat{a}_{L1} = -\frac{\sigma_1 \hat{p}_1}{\theta_{L1}} \quad \text{where} \quad \theta_{L1} = \frac{w_1 a_{L1}}{p_1}.$$

From (15) and (7)' we get

$$\hat{I}_1 = \frac{\sigma_1 \hat{p}_1}{\theta_{L1}} = -\frac{\sigma_1 \theta_{21} \theta_{22}}{\theta_{L1} |\theta|} dt_1 < 0. \quad (16)$$

Similarly

$$\hat{I}_2 = \frac{\sigma_2 \theta_{21} \theta_{12} dt_1}{\theta_{L2} |\theta|} > 0. \quad (16')$$

As p_1 goes down and p_2 goes up, capital use in sector I goes down and in sector I_2 goes up. With given stock of labor, I_1 contracts and I_2 expands.

(b) If $dt_1 = dt_2 = dt > 0$, then from (13) and (14) it is easy to show that $\hat{p}_1 = 0$ and therefore $\hat{I}_1 = 0$.

From the above analysis it is obvious that if the government imposes a tax on

the use of intermediate input in X_2 , I_1 will be necessarily protected.

Proposition 2. A subsidy on the use of domestic intermediate good in the production of X_1 will increase the size of I_1 sector.

Proof. Consider equation (13) and (14) with $dt_1 < 0$, $dt_2 = 0$ and subsidy on the use of I_1 in X_1 , (13) can be rewritten as,

$$\theta_{11}\hat{p}_1 + \theta_{21}\hat{p}_2 = -\theta_{11}dt_1. \quad (17)$$

(17) and (14) yield,

$$\hat{p}_1 = -\frac{\theta_{11}\theta_{22}dt_1}{|\theta|} > 0. \quad \text{Q.E.D.}$$

A subsidy on the use of I_1 in X_1 reduces the relative cost of production of X_1 and increases p_1 the return to the factor (I_1) used intensively in X_1 . As p_1 increases, I_1 increases and the result follows. If instead of this subsidy was imposed on the use of I_1 in X_2 , the result would have been exactly opposite.

The general lesson for the tariff-subsidy policy that affects the size of the domestic intermediate good sector, is as follows. If the intermediate good is intensively used in a particular product then apply a subsidy on its use. If it is the less intensive factor, apply a tax on its competing substitute.

TECHNICAL PROGRESS

In this section we shall discuss the impact of technical progress on size of I_1 and I_2 . In particular we shall concentrate on the productivity improvement in the final goods production. Consider the following situation. Suppose I_2 becomes more productive in the production of X_1 . This will be captured by $\hat{a}_{21} = \alpha < 0$ at given p_1/p_2 . Note that the production technology used in making I_2 remains absolutely unaffected. It is only at the final stage where I_1 and I_2 is used to produce X_1 , a productivity shift occurs in favor of I_2 . It is the isoquant of X_1 that is affected not that of I_2 . The foreign country definitely suffers from a real income loss as commodity prices are held fixed. With this set up we can put forward the following proposition.

Proposition 3. If I_2 becomes more efficient in the production of X_1 i.e., $\hat{a}_{21} = \alpha < 0$ at given p_1/p_2 , then the foreign country must suffer a real income loss. Similarly if I_1 becomes more efficient in the production of X_2 , the home country must be immiserized.

Proof. From (10) and (11) it follows that

$$\theta_{11}\hat{p}_1 + \theta_{21}\hat{p}_2 = -\theta_{21}\alpha \quad (18)$$

$$\theta_{12}p_1 + \theta_{22}p_2 = 0. \quad (19)$$

(18)–(19) gives $\hat{p}_2 = \theta_{12}\theta_{21}/|\theta| < 0$.

From this and (7'), it follows that I_2 will contract and I_1 will expand. This proves first part of the proposition. The second part can easily be proved by considering (say) $\hat{a}_{12} = \beta < 0$ at given p_1/p_2 . If a_{21} falls, then relative cost of producing X_1 goes down and it helps the return to I_1 because it is intensively used in X_1 and therefore this must lead to an increase in I_1 and contraction in I_2 . Similarly when a_{12} declines relative cost of producing X_2 goes down and by the same logic I_2 must expand and I_1 must contract. In this case though final stage of X_2 is completed at home, certain type of technical progress in this sector is not beneficial to the home country.

CONCLUSION

In this paper we have tried to show the implication of protection and technical progress in the context of trade with vertical specialization. The main results are that a tariff may fail to protect the import-competing sector under certain situations. Similarly, technical progress may lead to immiserization. What we have left out are the direct policies for the intermediate sectors. Policies which affect the internal structure of these industries—like capital or wage subsidies. We have also ignored the strategic possibilities by which one country retaliates against the other.

The basic results in this paper are not sensitive to the assumption regarding pattern of trade as long as one country imports a foreign input to produce a final good. Consider home country exporting X_1 but the foreign country completes the final stage of X_2 and exports it to the home country as well as to the rest of the world. In this case tariff on imported input can still be antiprotectionary in either country. This will depend on the intensity assumptions as have been discussed in the paper. If the home country completely specializes in I_1 , the situation will be exactly symmetric to the one discussed in the paper.

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REFERENCES

- [1] Corden, W. M. (1971), *The theory of protection*, Clarendon Press, Oxford.
- [2] Dixit, A. K. and G. M. Grossman (1982), "Trade and Protection with Multistage Production," *Review of Economic Studies* 49: 583–594.
- [3] Jones, R. W. (1971), "Three factor model in theory, trade and history" in J. N. Bhagwati et al (eds.), *Trade Balance of Payments and growth*, North Holland Amsterdam.
- [4] Marjit, S. (1987), "Trade in Intermediates and the Colonial Pattern of Trade," *Economica*, 54: 173–184.
- [5] Sanyal, K. K. (1983), "Vertical Specialization in a Ricardian Model with Continuum of Stages of Production," *Economica* 50: 71–78.
- [6] Sarkar, A. (1985), "A model of trade in intermediate goods," *Journal of International Economics* 19: 85–98.