Rochester Center for
Economic Research

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Working Paper No. 320
April 1992

University of
Rochester

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March 1992

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ABSTRACT

In a production structure exhibiting both Heckscher–Ohlin and Specific–Factor features, uniform tariffs may fail to protect a lot of import competing sectors. Hence, for a minimum degree of protection, feasible tariff structure tends to be asymmetric.

INTRODUCTION

Section I

To any student of neo-classical trade theory Metzler's tariff-paradox is a well known topic. About fifty years back Metzler (1949) argued how and why tariff may fail to protect a domestic import competing sector. However, the result has been treated as a paradox because the conditions needed for such an outcome are difficult to satisfy in a standard trade model. Treatment of this can be found in Caves and Jones (1985). Metzler's result is not an impossibility but the chance of its occuring is fairly poor. This is not to underestimate the contribution of Metzler's discussion which has improved our understanding of the basic issues related to protection, particularly when the literature was in its infancy. The purpose of this paper is to highlight the possibility of Metzler's type paradox (not in the way he conceived it) in a multi-sector model where each of the protected import-competing sectors is subjected to a uniform tariff rate. The production structure we shall consider is the one that encompasses the features of Heckscher-Ohlin as well the specific-factor model of trade as developed in Jones (1971). The general equilibrium properties of such a structure have been extensively studied in Jones and Marjit (1991) and its various applications are presently being done.[1]

Metzler's paradox arises because of an extremely favourable terms of trade movement in favor of the tariff-imposing economy. In this paper we assume a "small" open economy with exogeneously goven commodity prices and the anti-protectionary impact is solely due to the reallocation of resources following a uniform-tariff. Our results will reveal the importance of particular production structure being studied in this context. The paper will point out why the tariff-structure has to be necessarily assymmetric in some situation if the intention is to provide minimum protection to a large number of import–competing sectors. Of course we can not argue about the optimality of such a protectionary regime. The paper proceeds as follows. In the second section we describe a 3 sector, 3 factor model, its general equilibrium properties and perform comparative statics to derive a few theorems. In the third section we conclude the paper after talking about the generality of the results in a multi–sector context.

Section II The Model

Consider an economy producing 3 goods X_i, i = 1, 2, 3. X_1 and X_2 use labor and capital of type 1 and X_3 uses labor and capital of type 2. Production functions exhibit CRS and diminishing returns to inputs. Labor and both types of capital are fully–employed.[2] Markets are competitive and commodity prices are given in the rest of the world.

Following symbols will be used throughout the paper.

P_i = price of the ith good (i = 1, 2, 3)

w = wage rate

r_j = return to the jth type of capital j = 1, 2.

a_{Li} = labor – output ratio for the the ith good i = 1, 2, 3.

a_{Ki} = capital–output ratio for the ith good, i = 1, 2, 3.

$\bar{L}$ = given amount of labor supply

$\bar{K}_j$ = given capital stock of type j = 1, 2.

General equilibrium of the system is represented by the following set of equations.

$$wa_{L1} + r_1a_{K1} = P_1 \tag{1}$$

$$wa_{L2} + r_1a_{K2} = P_2 \tag{2}$$

$$wa_{L3} + r_2a_{K3} = P_3 \tag{3}$$

$$a_{L1}X_1 + a_{L2}X_2 = \bar{L} - a_{L3}X_3 \quad (4)$$

$$a_{K1}X_1 + a_{K2}X_2 = \bar{K}_1 \quad (5)$$

$$a_{K3}X_3 = \bar{K}_2 \quad (6)$$

(1) – (3) describe competitive equilibrium. (4) – (6) give us the full–employment conditions. We have six equations and six unknowns (w, r_1, r_2, X_1, X_2 and X_3) to solve, given P_1, P_2, P_3, $\bar{L}$, $\bar{K}_1$ and $\bar{K}_2$. This completes the description of the equilibrium.

To start with we shall assume that out of the three goods, two are importables and one is an exportable. Also note that the production structure described by (1) – (6) gives us a mix of the 2 x 2 Heckscher–Ohlin (HO) and the Ricardo–Viner structure. K_2 is the sector specific capital used only in X_3. Labor moves freely among the sectors whereas K_1 is partially mobile, moving only between X_1 and X_2. Given P_1 and P_2, one can solve for w and r_1 from (1) and (2). Plugging the value of w in (3) we get r_2. With CRS this also completes the determination of the factor coefficients. Now we are left with (4) – (6) to determine X_1, X_2 and X_3. As in any "even" system, price and quantity equations are separable in this structure.

As we have said, there are two importables in the system. This brings up two possibilities regarding the positioning of the commodities. a) Both goods in the 2 x 2 subsystem [as described by (1) and (2) and called a "nugget" in Jones and Marjit (1991)] are importables. b) One of the goods in the HO nugget and X_3 are the two importables.

Based on this set–up we write down our first proposition.

Proposition 1 Let dt > 0 be the uniform tariff rate imposed on both of the importables starting from an initial t = 0. Then (i) under situation (a) X_i will contract (expand) if X_i is capital (labor) intensive i = 1, 2 (ii) under situation (b) X_3

must contract if X_i is labor–intensive for i = 1 or i = 2.

Proof: (i) In this case differentiating (1), (2) and using the envelope theorem[3] one gets:

$$\theta_{L1} \hat{w} + \theta_{K1} \hat{r}_1 = dt \qquad (7)$$

$$\theta_{L2} \hat{w} + \theta_{K2} \hat{r}_1 = dt \qquad (8)$$

where $\theta_{Li} = \frac{w a_{Li}}{P_i}$, $\theta_{Ki} = \frac{r_i a_{Ki}}{P_i}$, i = 1. 2 ... and "^" on a variable denotes proportional change. Therefore,

$$\hat{w} = \frac{dt \ |\theta|}{|\theta|} = \hat{r}_1 > 0 \qquad (9)$$

where $|\theta| = \begin{vmatrix} \theta_{L1} & \theta_{K1} \\ \theta_{L2} & \theta_{K2} \end{vmatrix} = \theta_{K2} - \theta_{K1}$ (see Jones (1965)

Consider (6) $X_3 = \frac{K2}{a_{K3}}$. Hence $a_{L3} X_3 = \frac{a_{L3}}{a_{K3}} K_2$

$$\hat{a}_{L3} + \hat{X}_3 = \hat{a}_{L3} - \hat{a}_{K3} = - \sigma_3 (\hat{w} - \hat{r}_2) \qquad (10)$$

where σ_3 is the elasticity of substituion in sector 3. Since $\hat{w}$ = dt, differentiating (3) and using the envelope property we get,

$$dt + \theta_{K3} (\hat{r}_2 - \hat{w}) = 0 \qquad (11)$$

where $\theta_{K3} = \frac{r_2 a_{K3}}{P_3}$

$$\text{or,} \quad \hat{w} - \hat{r}_2 = \frac{dt}{\theta_{K3}} \qquad (12)$$

From (10) and (12) we get,

$$\hat{a}_{L3} + X_3 = - \frac{dt \ \sigma_3}{\theta_{K3}} \qquad (13)$$

Differentiating and noting that $\hat{a}_{L1} = \hat{a}_{L2} = 0$ as $\hat{w} = \hat{r}_1 = dt$,

$$\lambda_{L1}\hat{X}_1 + \lambda_{L2}\hat{X}_2 = -\lambda_{L3}\left(\frac{-d\,t\,\sigma_3}{\theta_{K3}}\right) \tag{14}$$

where $\lambda_{Li} = \dfrac{a_{Li}X_i}{L}$, $i = 1.\ 2.\ 3$

Similarly from (5)

$$\lambda_{K1}\,\hat{X}_1 + \lambda_{K2}\,\hat{X}_2 = 0 \tag{15}$$

$$\lambda_{Ki} = \frac{a_{Ki}X_i}{K_1},\ i = 1,\ 2$$

Note that since $\dfrac{w}{r_1}$ does not change, factor coefficients remain unaltered.

Solving (14) and (15) one gets,

$$\hat{X}_1 = \frac{\lambda_{K2}\,\lambda_{L3}\,\dfrac{\sigma_3}{\theta_{K3}}\,dt}{|\lambda|} \tag{16}$$

Therefore,

$$\hat{X}_1 \gtrless 0 \text{ iff } |\lambda| \gtrless 0$$

$$\text{or} \quad \hat{X}_2 \gtrless 0 \text{ iff } |\lambda| \gtrless 0$$

Since $|\lambda| > 0 \Rightarrow X_1$ is labor–intensive. (16) implies that X_i will contract (expand) if X_i is capital (labor) intensive. This completes the first part of the proof.

(ii) In this case, without loss of generality let us assume X_1 is the import good. Therefore (8) will have a zero on the right hand side.

Hence,

$$\hat{w} = \frac{\theta_{K2}\ d\,t}{|\theta|} \tag{17}$$

Now from (17)

$$\frac{\theta_{K2} \; dt}{|\theta|} + \theta_{K3} (\hat{r}_2 - \hat{w}) = dt \tag{18}$$

or $$(\hat{r}_2 - \hat{w}) = \frac{dt}{\theta_{K3}} (1 - \frac{\theta_{K2}}{|\theta|})$$

Consider (6),

$$\hat{X}_3 = - \hat{a}_{K3} = \sigma_3 \theta_{L3} (\hat{r}_2 - \hat{w}), \; [\theta_{L3} = \frac{w \; a_{L3}}{P_3}]$$

$$= \sigma_3 \frac{\theta_{L3}}{\theta_{K3}} . \; dt \; (1 - \frac{\theta_{K2}}{|\theta|}) \tag{19}$$

or, $$\hat{X}_3 < 0 \text{ iff } 1 - \frac{\theta_{K2}}{|\theta|} < 0$$

Now, $|\theta| = \theta_{K2} - \theta_{K1} > 0$ implies X_1 is labor intensive. Therefore, $\hat{X}_3 < 0$ iff $- \frac{\theta_{K1}}{|\theta|} < 0$

$$\rightarrow \hat{X}_3 < 0 \text{ iff } |\theta| > 0$$

$$\rightarrow \hat{X}_3 < 0 \text{ iff } X_1 \text{ is labor-intensive.}$$

QED

Intuition behind these results is fairly straight forward. In case (a), uniform tariff of dt increased w and r_1 in the same proportion, a result which is standard in a 2 x 2 model. But as w goes up, r_2 must fall implying a decline in X_3. Labor is now released from this sector into the nugget. It activates the Rybczynski effect by increasing X_1 and reducing X_2 if X_1 is labor-intensive. Hence, a tariff fails to protect X_2 although it is protected at the same rate with the other import competing good.

Situation (b) is even simpler to explain. A tariff dt > 0 in the labor-intensive X_1 generates the Stolper-Samuelson result by increasing w in a magnified rate. But in sector 3 the effective price increases by only dt. Hence real wage measured in terms of

X_3 must go up implying a decline in X_2.

Both of these results highlight the possibility of antiprotectionary effects of a uniform tariff. Case (a) actually points to a strong result where one of the import competing sectors must contract under uniform tariff. This is generated by a release of labor into the nugget and the labor–intensive sector must expand at the expense of the capital intensive sector.

Once we understand the mechanics of the model, following propositions are immediate. We are not going to provide detail proofs of these theorems as we think verbal arguments will be sufficient to convince the readers.

Proposition 2: Tariff structure has to be asymmetric if simultaneous protection is to be provided to both of the import–competing sectors, one being the labor–intensive sector in the nugget.

Proof: Consider situation (a). From proposition 1 it is easy to infer that the capital–intensive sector has to be given greater protection than the labor–intensive sector must contract. We have proved it in the uniform tariff case. If labor–intensive sector is protected at even a higher rate then w will increase further. Given the amount of labor supply in the "nugget" it is just like a relative price increase in favour of the labor–intensive sector. So output of the capital–intensive sector must contract on account of this. As more labor is flowing into the nugget from the export–sector, such contractionary effect will be reinforced through the Rybczynski effect. To mitigate such effects it is necessary that the rate of protection should be greater in the capital intensive sector.

In situation (b), if the sector outside the nugget needs to be protected it must be given the benefit of a higher tariff than the labor–intensive sector in the nugget. The argument is derived from proposition 1. As w increases in a magnified proportion, X_3

can expand if it is protected by a higher tariff rate so that it can absorb cost increase and the real wage in this sector comes down.

QED

Section III Conclusion

In this short paper we have described a production model where uniform tariff in different import sectors fails to protect some of these sectors. The results can be easily extended in the multi–sector context. In situation (a) adding a number of sectors outside the nugget does not affect anything–except that the Rybczynski effect tends to be much more severe. Only in case of all importables being located outside the nugget, a uniform tariff on them will protect every such sector at the cost of the labor–intensive export sector in the nugget. When the nugget contains one of the importables and the rest are located outside the nugget our earlier result holds. If this importables is labor–intensive, protecting it with a uniform tariff along with other importables will squeeze all other importables.

Further research on this area can concentrate on the political economic implications of tariff–formations in this type of structures. The existence of a labor–intensive import sector within a nugget puts a severe restriction on protectionary policy. The cost of protecting such a sector might be to commit to a high tariff–structure everywhere in the economy even to maintain the initial size of the other import–competing sectors. On the other hand if the import–competing sector in the nugget is capital intensive, protecting it with a tariff will also mean indirect protection to all other import–competing sectors as w will tend to go down. Given the simple structure of such a general equilibrium model, one can think of many more applications.

Footnotes

1. For example see Beladi and Marjit (1992). This work is also related to an example of Gruen and Corden (1970) and a paper by Deardorff (1984).

2. This production structure is not as arbitrary as it seems to be. A multisector "small" economy with each sector having plenty of subsectors using the same specific factor and labor, can converge, through trade, to only two possible production structures. Either it would be a pure specific factor structure or it would be the one that we study in this paper. For a formal proof of the above hypothesis the reader is referred to Jones and Marjit (1991).

3. Derivations here are similar to Jones (1965).

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