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PROTECTION AND FACTOR MOBILITY

Michihiro OHYAMA*

Abstract: This paper considers the response of output of a commodity to a rise in its own price under different degrees of international factor mobility. Generalizing Jones' (1984) analysis of the question in the context of international capital mobility, it shows that relaxing the quantitative restriction on any internationally mobile factor cannot but strengthen the restrictive effects of trade taxes on commodities and other mobile factors, and therefore, may be harmful to the country's economic welfare.

It has been argued that the liberalization of international capital movements may be harmful to a small country with import tariffs. For instance, Hamada (1974) makes it clear that an arbitrary capital inflow harms a country importing a capital intensive commodity under tariffs. Minabe (1981) analyzes the symmetric case of protectionist country importing a labor intensive commodity to argue that a capital outflow will harm the country. Brecher and Findlay (1983) considers a sector-specific capital model to show that the imposition of a tariff on the import of a commodity will incur an extra loss if capital of the type used in that sector is allowed to flow into the country. More recently, Jones (1984) goes further to establish a more general relationship between protection and welfare. In the context of a general two-commodity trade model, he demonstrates that a country's loss in welfare arising from an increase in the level of a binding tariff is accentuated by any production response at home to the induced flow of capital. Clearly, the distinguishing feature of this result is its generality. It is completely free from the restrictive assumptions of previous papers concerning the factor intensity of the commodity being imported, the type of capital flow being induced, and the production structure of the economy. In fact, it is as general as the underlying basic proposition that the increase in the output of a commodity in response to a given rise in tis own price is greater when capital is internationally mobile than when there is no such capital mobility. The generalized *Le Chatelier* principle advanced by Samuelson (1947) suggests, however, that this basic proposition admits of further generalizations. The present note is an attempt to extend it to the case where there are many commodities *and many* internationally mobile factors.

Consider a small price-taking country which produces m commodities by using s factors with constant returns to scale technology. All commodities and some

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factors are traded internationally with their prices given in the world markets. The country is supposed to be endowed with a fixed amount of each factor.[1] In what follows, we employ the following notation:

$p=(p_1, \cdots, p_m)$: the vector of domestic commodity prices.
$w=(w_1, \cdots, w_s)$: the vector of domestic factor prices.
$y=(y_1, \cdots, y_m)$: the vector of domestic commodity outputs.
$v=(v_1, \cdots, v_s)$: the vector or domestic factor inputs.
$A=(a_{ij})$: The $m\times s$ matrix of unit input coefficients.[2]

Furthermore, let ${}_kA$ denote the matrix consistaing of the first k columns of A, and A_k the matrix consisting of the last $s-k$ columns of A. In a similiar vein, for any vector $x=(x_1, \cdots, x_l)$, let ${}^kx$ be the vector of its first k elements, and x^k the vector of its last $l-k$ elements.

Suppose that all tradeables are actually traded with or without trade taxes or subsidies in the intital situation. Thus, the domestic prices of all commodities and mobile factors are initially given to the country. Let the first n factors be internationally immobile and the last $s-n$ factors mobile. The competitive zero profit conditions are written,

$$ {}_nA^nw+A_nw^n=p\ . \tag{1}$$

By definition, we also have

$$ {}_nA'x={}^nv\ , \tag{2}$$

$$ A_n'x=v^n\ . \tag{3}$$

where ${}_nA'$ (resp. A_n') is the transpose of ${}_nA$ (resp. A_n). We assume that prices and outputs are flexibly adjusted so as to clear the markets for immobile factors. This allows us to identify ${}^nv$ with the endowment vector of immobile factors, and (2) with the conditions for their full employment.

With the present neoclassical technology, each a_{ij} is a function of w. Therefore, given p, w^n and ${}^nv$, $m+n$ equations in (1) and (2) contain the same number of unkowns, ${}^nw$ and x. Let us assume here that the number of immobile factors is equal to or greater than the number of commodities ($n\geqq m$) and that equations in (1) and (2) uniquely determine the values of ${}^nw$ and x for the given values of p, w^n and ${}^nv$.[3] Then, $s-n$ equations in (3) uniquely determine the values of the same number of unknowns v^n correspondingly. We assume that the initial values of ${}^nw$, x and v^n satisfy these functional relationships for the given values of p, w^n and ${}^nv$.

[1] In other words, the amount of each factor owned by its resident is fixed. Needless to say, this does not imply that the amount of factor used in the country is fixed.

[2] The ij-th element of A represents the amount of factor j used in the production of one unit of commodity i.

[3] If the solution for (1) and (2) is to be unique, the rank of ${}_nA$ must be m, and therefore, the number of immobile factors must be equal to, or greater than the number of commodities. See Chang (1979), Lemma 1, p. 711.

Starting from this initial situation, let us assume that some mobile factors are now constrained to stay within the national border (by the government decree, say). Without loss of generality, suppose that the inputs of the first ν factors ($\nu>n$) are now fixed at their initial levels. Then we may express ${}^{\nu}w$, x and v^{ν} as functions of p, w^{ν} and ${}^{\nu}v$, i.e.,

$$ {}^{\nu}w=f_{\nu}(p, w^{\nu}, {}^{\nu}v) , \tag{4} $$

$$ x=g_{\nu}(p, w^{\nu}, {}^{\nu}v) , \tag{5} $$

$$ v^{\nu}=h_{\nu}(p, w^{\nu}, {}^{\nu}v) . \tag{6} $$

We are concerned with how the output elasticity of a commodity with respect to its own price depends on the number of constrained factors.

To examine this problem, consider the equations in (4) and (5):

$$ w_{\nu}=f_{\nu\nu}(p, w^{\nu}, {}^{\nu-1}v, v_{\nu}) , \tag{7} $$

$$ x_i=g_{\nu i}(p, w^{\nu}, {}^{\nu-1}v, v_{\nu}) . \tag{8} $$

Define

$$ \left.\frac{\partial x_i}{\partial p_i}\right|_{\nu=r}=\frac{\partial g_{ri}}{\partial p_i} . $$

In view of (7) and (8), we may write

$$ \left.\frac{\partial x_i}{\partial p_i}\right|_{\nu=r-1}=\left.\frac{\partial x_i}{\partial p_i}\right|_{\nu=r}+\frac{\partial g_{ri}}{\partial v_r}\frac{\partial v_r}{\partial p_i} , \tag{9} $$

where

$$ \frac{\partial v_r}{\partial p_i}=-\frac{\partial f_{rr}}{\partial p_i}\Big/\frac{\partial f_{rr}}{\partial v_r} . $$

By Samuelson's (1953) reciprocity theorem, the effect of a rise in p_i on w_r is equal to the effect of an increase in v_r on x_i, or

$$ \frac{\partial f_{rr}}{\partial p_i}=\frac{\partial g_{ri}}{\partial v_r} . \tag{10} $$

Substituting (10) into (9) yields

$$ \left.\frac{\partial x_i}{\partial p_i}\right|_{\nu=r-1}=\left.\frac{\partial x_i}{\partial p_i}\right|_{\nu=r}-\left(\frac{\partial g_{ri}}{\partial v_r}\right)^2\Big/\frac{\partial f_{rr}}{\partial v_r} . \tag{11} $$

Since $\partial f_{rr}/\partial v_r$ is negative,[4] we have

$$ \left.\frac{\partial x_i}{\partial p_i}\right|_{\nu=r-1}\geqq\left.\frac{\partial x_i}{\partial p_i}\right|_{\nu=r} \qquad (r=n+1, \cdots, s) \tag{12} $$

which means that the own price elasticity of an ouptut increases as the number of

[4] See, for instance, Chang (1979), Theorem 2, p. 716.

constrained factors decreases.[5]

Obviously, this result can be regarded as an econnomic illustration of Samuelson's generalized *Le Chatelier* principle. In fact, it may be shown in a similar manner that the input elasticity of an unconstrained factor with respect to its own price also increases as the number of constrained factors decreases. Thus, every step in the process of relaxing quantitative restrictions on international factor movements cannot but strengthen the restrictive effects of trade taxes on commodities and unconstrained factors, and therefore, may be barmful to the country's economic welfare.[6]

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[5] This is an extension of the result obtained by Jones (1983) for the world with endogenous capital flows.

[6] See Jones (1983) for this point.