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CENTER FOR ECONOMIC STUDIES

ON THE HECKSCHER-OHLIN
ANALYSIS AND THE GAINS FROM
TRADE WITH PROFIT-MAXIMIZING
AND LABOUR-MANAGED FIRMS

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Abstract

This paper is concerned with the pattern of trade and the gains from trade between the profit-maximizing and labour-managed countries in a general equilibrium setting of the Heckscher-Ohlin type. Thus all the markets are assumed to be perfectly competitive. The production technologies are, however, assumed to follow decreasing returns to scale with fixed costs. Then it is shown that the Heckscher-Ohlin theorem on the pattern of trade prevails but one country may lose from trade because of the existence of the fixed costs.

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On the Heckscher-Ohlin Analysis and the Gains from Trade with Profit-Maximizing and Labour-Managed Firm

1. Introduction

Although much attention has been paid to labour-managed firms or economies, almost none of the studies focused on the analysis of general equilibrium trade theories. The only exceptions are the work of Ishii (1986 and 1990). In particular, Ishii (1986) dealt with the Heckscher-Ohlin analysis in an economy with two countries, one of which is a labour-managed country and the other is a capitalist country. Under the assumption of constant returns to scale technologies, he showed that the traditional trade theorems such as the Rybczynski, the factor price equalization, the Stolper-Samuelson and the Heckscher-Ohlin theorems prevail.

In this paper we re-examine his analysis in a two-country, two-commodity and two-factor general equilibrium model but under a different assumption regarding the production technologies. As often assumed in the theory of labour-managed firms, we incorporate a fixed cost in production at the firm's level and give up the constant returns to scale technologies. Each firm behaves as an average labour-income maximizer or, alternatively, a profit-maximizer. Except for these two points, all other assumptions are the same as in the traditional Heckscher-Ohlin model.

We then show that the standard theorems of international trade necessarily hold regardless of whether firms are profit-maximizing or labour-

managed. In fact, the various theorems prevail for any mixture of profit-maximizing and labour-managed firms in any industries of either countries. Moreover, we extend our analysis to the gains from trade. In Ishii's framework (1986), the gains from trade are obviously obtained. Under our assumption of the existence of the fixed costs in production, however, the number of the firms is crucial to the gains from trade. We show that trade is gainful under certain circumstances. Though this is our main result, we can also point out one further significant aspect arising from our model: In responses to price changes, all firms change their factor inputs but never change the levels of their outputs.

The paper consists of the following sections: The next section presents the model. The Heckscher-Ohlin analysis is given in Section 3. Section 4 is devoted to the analysis of the gains from trade. The last section summarizes our findings with an interpretation of the model.

2. Model

Consider a world economy with two countries, each of which produces two commodities with two primary factors. Concentrating on one country, for the time being, we suppose that each industry consists of only labour-managed firms. Later, we will relax it and incorporate profit-maximizing firms as well in any industry. A labour-managed firm produces output by the use of two primary factors, which are labour and capital, in order to maximize the average income of labour. Thus, under perfect competition, a

typical labour-managed firm in industry i maximizes

$$\frac{p_i F^i(L_i, K_i) - rK_i - p_i T_i}{L_i}, \quad i = 1, 2,$$

by the choice of L_i and K_i , which are labour and capital inputs, respectively, where p_i is the price of the i th commodity, $p_i T_i (> 0)$ is the fixed cost incurred by a firm in industry i , r is the rental price on capital, and $F^i(\cdot)$ is the production function of a firm in industry i and is assumed to have positive but diminishing marginal productivities. In this formulation, we implicitly assume that the fixed cost of a firm is charged in terms of the firm's output. In this sense, T_i can be thought of as the fixed amount of output to be used up in order produce any positive amount of the same good. We make the following assumption on the production functions:

Assumption 1

$F^i(L_i, K_i)$, $i = 1, 2$, are strictly quasi-concave, but not linearly homogeneous.⁽¹⁾

Two steps are taken to solve the above optimization problem of the labour-managed firms. First, we consider Y_i as given and maximize $w \equiv (p_i Y_i - rK_i - p_i T_i) / L_i$ subject to $Y_i \leq F^i(L_i, K_i)$, with respect to L_i and K_i $i = 1, 2$. Solving this optimization problem, we have

$$w = \lambda L_i F_L^i \text{ and } r = \lambda L_i F_K^i, \quad i = 1, 2,$$

where $F_K^i \equiv \partial F^i / \partial K_i$ and $F_L^i \equiv \partial F^i / \partial L_i$, $i = 1, 2$, and λ is the Lagrangean

multiplier. Hence $r/w = F'_K/F'_L$ is established. Therefore, taking account of $Y_i = F^i(L_i, K_i)$, we can define the cost function of a firm in the i th industry as $C^i(w, r, Y_i) \equiv wL_i + rK_i$, where $C^i(w, r, Y_i)$ satisfies the property of linear homogeneity with respect to w and r . Moreover, the zero profit condition assures

$$p_i Y_i = p_i T_i + C^i(w, r, Y_i), \quad i = 1, 2. \quad (1)$$

In the second step, for given p_i , T_i and r , we maximize w with respect to Y_i in (1). The first order condition of the problem is described as

$$dw/dY_i = (p_i - C_r^i)/C_w^i = 0,$$

where $C_r^i \equiv \partial C^i / \partial r$ and $C_w^i \equiv \partial C^i / \partial w$, which in turn implies

$$p_i = C_r^i(w, r, Y_i), \quad i = 1, 2. \quad (2)$$

Now, we suppose that the produced commodities are internationally mobile but the primary factors are only domestically mobile. Hence, assuming full employment, the factor market equilibrium conditions can be introduced as

$$n_1 L_1 + n_2 L_2 = L, \quad (3)$$

$$n_1 K_1 + n_2 K_2 = K, \quad (4)$$

where n_i is the number of the firms in industry i , for $i=1, 2$, and L and K are, respectively, the labour and capital endowments. Both factor endowments are assumed to be given and constant.

Let (p_i) be numeraire and equal to unity. Then, the general equilibrium system of this small open economy consists of the following

equations:

$$Y_1 - T_1 = C^1(w, r, Y_1), \quad (5)$$

$$p(Y_2 - T_2) = C^2(w, r, Y_2), \quad (6)$$

$$1 = C_r^1(w, r, Y_1), \quad (7)$$

$$p = C_r^2(w, r, Y_2), \quad (8)$$

$$L = n_1 C_w^1 + n_2 C_w^2, \quad (9)$$

$$K = n_1 C_r^1 + n_2 C_r^2, \quad (10)$$

where $p \equiv p_2/p_1$ and $C_r^i \equiv \partial C^i / \partial r$, $i = 1, 2$. Equations (9) and (10) are obtained from (3) and (4) since Shephard's Lemma assures $C_w^i = L_i$ and $C_r^i = K_i$. This equation system determines Y_i , n_i , w and r , once p , L and K are given.

3. The Analysis of Trade Theorems

In this section, we examine the Rybczynski, the factor price equalization, the Stolper-Samuelson, and the Heckscher-Ohlin theorems.

Equations (9) and (10) can be solved for n_1 and n_2 , if w , r , and Y_i , $i = 1, 2$, are determined by equations (5)-(8).

Hence the solutions of n_1 and n_2 are given by

$$\left. \begin{aligned} n_1 &= \frac{C_r^2 L - C_w^2 K}{C_w^1 C_r^1 - C_w^2 C_r^2} = \frac{L}{C_w^1} \left(\frac{k_2 - k}{k_2 - k_1} \right), \\ n_2 &= \frac{C_w^1 K - C_r^1 L}{C_w^1 C_r^1 - C_w^2 C_r^2} = \frac{L}{C_w^2} \left(\frac{k - k_1}{k_2 - k_1} \right), \end{aligned} \right\} \quad (11)$$

where $k_i \equiv K_i/L_i = C_r^i/C_w^i$ and $k \equiv K/L$.

Suppose that unique and positive solutions of w, r , and Y_i , $i = 1, 2$, are obtained from (5)-(8). Then equations (11) assure positive η_i , $i = 1, 2$, if and only if the factor endowment ratio is strictly in between the factor intensities of two industries. So we impose the following assumption on factor intensities throughout our analysis.

Assumption 2

The factor endowment ratio is strictly in between the factor intensities of two industries, namely, $k_1 < k < k_2$ or $k_2 < k < k_1$.

As for the Rybczynski theorem and the factor price equalization theorem, their validity is obvious by the fact that the factor endowments do not affect each firm's output and the factor prices. Let the total output of industry i be denoted as $X_i \equiv \eta_i(Y_i - T_i)$. Then, changes in X_i caused by the shifts of factor endowments are summarized as follows: If $k_i > k > k_j$ for $i, j = 1, 2$, and $i \neq j$, then we have $\partial X_i / \partial L = (Y_i - T_i)(\partial \eta_i / \partial L) < 0$, $\partial X_j / \partial L = (Y_j - T_j)(\partial \eta_j / \partial L) > 0$, $\partial X_i / \partial K = (Y_i - T_i)(\partial \eta_i / \partial K) > 0$ and $\partial X_j / \partial K = (Y_j - T_j)(\partial \eta_j / \partial K) < 0$, by (11). Moreover, equations (11) assure Jones' magnification effect. That is, $\hat{X}_i > \hat{K} > 0 > \hat{X}_j$, $\hat{X}_j > \hat{L} > 0 > \hat{X}_i$, $\hat{X}_j > 0 > \hat{K} > \hat{X}_i$ and $\hat{X}_i > 0 > \hat{L} > \hat{X}_j$, for $k_i > k_j$, where ' $\wedge$ ' denotes percentage change, i.e., $\hat{X}_i \equiv dX_i / X_i$.

So we may state

Theorem 1

The Rybczynski theorem with Jones' magnification effect holds under

Assumptions 1 and 2. That is

$$\hat{X}_i(\hat{X}_j) > \hat{K}(\hat{L}) > 0 > \hat{X}_j(\hat{X}_i) \text{ and } \hat{X}_i(\hat{X}_j) > 0 > \hat{L}(\hat{K}) > \hat{X}_j(\hat{X}_i) \text{ if } k_i > (<) k_j.$$

The factor prices w and r are determined by equations (5)-(8), independently of (9) and (10). Hence w and r are not dependent on L and K , which means that the factor price equalization is also valid.

Theorem 2

Suppose that the production technologies are the same between countries. Then, under Assumptions 1 and 2, the factor prices are equalized between countries.

Now we proceed with our analysis to the Stolper-Samuelson theorem.

To do this, differentiate equations (5)-(8) totally. Then, we obtain

$$C_{rw}^1 dw + C_{rr}^1 dr + C_{Yr}^1 dY_1 = 0 \quad (12)$$

$$C_{rw}^2 dw + C_{rr}^2 dr + C_{Yr}^2 dY_2 = dp \quad (13)$$

$$\theta_{1w} \hat{w} + \theta_{1r} \hat{r} = 0, \quad (14)$$

$$\theta_{2w} \hat{w} + \theta_{2r} \hat{r} = \hat{p}, \quad (15)$$

where

$$C_{rw}^i \equiv dC_r^i / dw, \quad C_{rr}^i \equiv dC_r^i / dr, \quad C_{Yr}^i \equiv \partial C_r^i / \partial Y_i, \quad \theta_{1w} \equiv wC_w^1 / C^1 \text{ and } \theta_{1r} \equiv rC_r^1 / C^1,$$

for $i=1,2$.

In view of (14) and (15), the analysis can assure the validity of the Stolper-Samuelson theorem with Jones' magnification effect. So we can state

Theorem 3

Under Assumptions 1 and 2, the Stolper-Samuelson theorem with Jones' magnification effect holds, namely,

$$\hat{w}(\hat{r}) > \hat{p}_1 > 0 > \hat{r}(\hat{w}) \text{ and } \hat{r}(\hat{w}) > 0 > \hat{p}_2 > \hat{w}(\hat{r}) \text{ if } k_1 > (<) k_2.$$

In order to examine whether the Heckscher-Ohlin pattern of trade holds or not, we need to analyze the price-output relation. For this purpose, we restrict the production functions to homothetic type. So the following assumption is made.

Assumption 3

$F^i(L_i, K_i)$, $i = 1, 2$ are homothetic as well as strictly quasi-concave.

Then, with the use of a linear homogeneous function $f^i(\cdot)$ and an increasing function $g^i(\cdot)$, $F^i(L_i, K_i)$ can be expressed as $g^i(f^i(L_i, K_i))$. Hence the cost function becomes to be separable between factor prices and output, which yields

$$C^i(w, r, Y_i) \equiv c^i(w, r)h^i(Y_i). \quad (16)$$

where $c^i(w, r)$ is linear homogeneous with respect to w and r and

$$h^i(Y_i) \equiv (g^i)^{-1}(Y_i)/Y_i.$$

Bearing (16) into mind, we can rewrite (12) and (13) as

$$\theta_{1w}\hat{w} + \theta_{1r}\hat{r} + \varepsilon_1\hat{Y}_1 = 0, \quad (17)$$

$$\theta_{2w}\hat{w} + \theta_{2r}\hat{r} + \varepsilon_2\hat{Y}_2 = \hat{p}, \quad (18)$$

where $\varepsilon_i \equiv Y_i(d^2h^i/dY_i^2)/(dh^i/dY_i)$. Combining (14), (15), (17) and (18)

together, we obtain $\hat{Y}_i = 0$, $i = 1, 2$. This implies that the level of each firm's

output does not depend on the commodity prices.⁽²⁾

Theorem 4

Under Assumptions 2 and 3, the firm's output of any industry is not influenced by any commodity price change.

Thus, the commodity prices affect the output of each industry level through the number of firms in the industry. Equations (9) and (10) can be rewritten as

$$n_1c_w^1(w, r)h^1(Y_1) + n_2c_w^2(w, r)h^2(Y_2) = L, \quad (19)$$

$$n_1c_r^1(w, r)h^1(Y_1) + n_2c_r^2(w, r)h^2(Y_2) = K, \quad (20)$$

from which the standard analysis of the price-output relation gives $d(n_1h^1(Y_1))/dp < 0$ and $d(n_2h^2(Y_2))/dp > 0$. Since Y_i , $i = 1, 2$, are insensitive to price changes, it obviously holds that $dn_1/dp < 0$ and $dn_2/dp > 0$. As a result we have $dX_1/dp < 0$ and $dX_2/dp > 0$.

Theorem 5

Under Assumptions 2 and 3, the price-output relation is normal.

That is, $dX_i/dp_i > 0$ and $dX_i/dp_j < 0$, for $i, j = 1, 2$, and $i \neq j$.

Now we are in a position to present our conclusion on the validity of the Heckscher-Ohlin pattern of trade. Suppose that technologies and preferences are identical between two countries and that the preferences are homothetic. Then, in view of Theorems 1 and 5, we can apply the usual analysis of the Heckscher-Ohlin type to our present discussion and obtain the following result:

Theorem 6

Under Assumptions 2 and 3, if production technologies and consumption preferences are identical between two countries and if the preferences are homothetic, the Heckscher-Ohlin pattern of trade prevails. Namely, the country which is endowed with more labour (capital) relative to capital (labour) exports the labour-intensive (capital-intensive) commodity and imports the other.

4. Gains from Trade

The traditional Heckscher-Ohlin analysis ensures from (7), (8), (19) and (20) that the equilibrium locus of (n_1, n_2) is concave to the origin because changes in p do not affect Y_i . In Figure 1, this equilibrium locus is drawn and a price line is tangential to this locus. Thus,

$$\frac{dn_1}{dn_2} = -p$$

[Figure 1 is about here]

Bearing $X_i = (Y_i - T_i)n_i$ in mind, we have

$$\frac{dX_1}{dX_2} = \frac{Y_1 - T_1}{Y_2 - T_2} \frac{dn_1}{dn_2} = -\frac{Y_1 - T_1}{Y_2 - T_2} p,$$

where the equilibrium locus of (X_1, X_2) is also concave to the origin.

Therefore, as shown in Figure 2, trade is gainful if

$Y_i - T_i > Y_j - T_j$ and $(p_i^0/p_i^1) > (p_j^0/p_j^1)$, for $i, j = 1, 2$ and $i \neq j$, where p_i^0 and p_i^1 are, respectively, autarkic and international prices of the i th commodity, for $i = 1, 2$

[Figure 2 is about here]

In Figure 2, let point A be an autarkic equilibrium. Then, since

$$\frac{Y_i - T_i}{Y_j - T_j} \frac{p_i^0}{p_i^1} > \frac{Y_i - T_i}{Y_j - T_j} \frac{p_j^0}{p_j^1},$$

the post-trade equilibrium production point, say point B, is somewhere upward from point A in the locus. As the line $((Y_i - T_i)/(Y_j - T_j)) \cdot (p_i^1/p_j^1)$ is tangential to the concave locus at B and $Y_i - T_i > Y_j - T_j$, the budget line after trade, which is indicated by the line p_i^1/p_j^1 passing through B covers point A clearly. Hence the consumption at the autarkic equilibrium is possible even after trade.

It is also clear that the price line p_i/p_j approaches to the line $((Y_i - T_i)/(Y_j - T_j)) \cdot (p_i/p_j)$ tangential to the locus of (X_1, X_2) as $(Y_i - T_i)/(Y_j - T_j)$ becomes close to unity. So trade becomes more likely to yield gains. As an extreme case, suppose that $Y_i - T_i = Y_j - T_j$. Then trade is always gainful.

Our discussion in this section can be summarized as

Theorem 7

If, after the opening of trade, the price of the commodity whose net output at the firm's level is larger than that of the other commodity becomes relatively high, the country will gain from trade. If the net output at the firm's level is equal between industries, then trade is always gainful.

Based on this theorem together with Theorem 6, we can extend the analysis a little further. Consider a two-country economy and suppose a country which is endowed with relatively abundant labour. Then, if the net output per firm of the labour-intensive commodity is not less than that of the other commodity, trade between two countries is gainful for this country. This is obvious because the price of the labour-intensive commodity facing this country becomes relatively higher after trade. Thus, we generally state

Theorem 8

Consider a two-country economy. A country has gains from trade if the relatively abundant factor for this country is intensively used in the industry where the net output per firm is not less than that of the other industry.

5. Concluding Remarks

We have three concluding remarks.

First, up to the previous section, we assumed that all industries of all

countries consist of labour-managed firms only. Now we relax this assumption and allow profit-maximizing firms to operate in any industries of any countries. Consider a profit-maximizing firm operating in an industry, for instance. The firm's profit-maximizing conditions ~~are~~ ⁽²⁾ expressed by ~~(3) and (5)~~. Moreover (1) can be interpreted as the zero-profit condition of this firm which should be satisfied under perfect competition in the commodity market. Therefore nothing is changed by the introduction of a profit-maximizing firm. So all of our results in this section can be extended as follows:

§

All Theorems 1 to 5 are still valid if some or all of the firms in any industry in either countries are of profit-maximizing type.

The implication of the above statement is that whether firms are of the labour-managed or the profit-maximizing type in any industry in either countries, the Heckscher-Ohlin pattern of trade and other theorems of trade continue to be valid. In Komiya's (1988) discussion which is cited by a number of Japanese economists, some Japanese firms are pointed out to be of rather the labour-managed type than the profit-maximizing type⁽³⁾. However, it does not matter for the pattern of trade as long as the Heckscher-Ohlin framework holds in other respects.

Secondly, as shown in the Section 3, the theorems of international trade carry over in our economy where labour-managed firms and profit-maximizing firms co-exist. This conclusion is essentially the same as Ishii's, though he only considered the trade between capitalist and labour-

managed countries. In our model, however, the constant returns to scale technologies are given up and fixed costs are incorporated, by which our present model differs from Ishii's and reveals an interesting aspect: The output of the firm level is influenced by neither commodity prices nor factor endowments, while commodity prices affect the factor employment at the firm's level. Therefore, the number of the firms is crucial to the validity of the Heckscher-Ohlin Theorem.

More importantly, fixed costs affect the validity of the gains from trade in the Heckscher-Ohlin framework. In Theorem 7, we presented a sufficient condition for the gainful trade that the price of the commodity whose net output of the firm's level is larger becomes relatively high after opening trade. This condition can be intuitively interpreted as follows: If the relative price of one commodity rises, then the number of the firms producing that commodity increases. So national income is likely to increase, if the firms in that industry produce more in net amount than those of the other industry. This is because production becomes more efficient by concentrating on a more productive industry.

Finally, our model is somewhat similar to the standard Heckscher-Ohlin model with decreasing returns to scale technologies, where the firms behave as profit maximizers. In that case, the firms gain a positive profit which is endogenously determined. In our model, this positive profit is substituted to a fixed cost which is exogenously given. The firm's production level is determined so as to satisfy the zero profit condition

under a given fixed cost, whatever the amounts of factor endowments there are. In order to attain market clearing in factor markets, the number of firms adjusts in each industry.

Footnotes

- (1) Haruna (1986) verified that a labour-managed firm does not operate if the production function is homogeneous with degree α not equal to one. In contrast, in our model, a labour-managed firm does operate under the homogeneous production function of this sort. Conversely, our model does not allow a linear homogeneous property to yield any positive solution. This is because a positive fixed cost is incorporated into the model.
- (2) Under a homogeneous production function, a similar phenomenon comes out in the analysis of the rate-of-return regulation on a labour-managed firm. Okamura, Tawada and Mizuno (1994) showed that the degree of the rate-of-return regulation does not affect the firm's output level under homogeneous production technologies.
- (3) There have appeared several papers which treat theoretical extensions of a labour-managed firm in favor of Komiya's work. See, for example, Iwai (1988), Kishimoto (1989) and Miwa (1992).

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Figure 1

Figure 2

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