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Trade volume and country size in the Heckscher-Ohlin model

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Abstract

This paper develops a model of international trade based on differences in factor endowments across countries. We use this model to show that in such an environment, holding relative endowments and the size of the world economy constant, the volume of trade increases as countries become more similar to each other in terms of their relative sizes.

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1 Introduction

The objective of this paper is to explore the predictions for the volume of trade, of the Heckscher-Ohlin model of international trade based on factor endowment differences across countries. Our key result is that, holding countries' endowment ratios constant relative to one another and the size of the world economy constant, relative country sizes do matter in determining the volume of trade.

This result clarifies the statement in Helpman and Krugman (1985) that "... in some sense relative country size has no effect on the volume of trade" (p. 24). This statement holds along any ray that is parallel to the diagonal of the Dixit-Norman-Helpman-Krugman rectangle[1], and some variant of this statement has been oft-cited in the literature, in Helpman (1987), Hummels and Levinsohn (1995), and Debaere (2005). We establish two results. First, a movement along any such ray, does not correspond to a situation where relative factor endowments are constant across countries. Second, we show that if relative endowments are held constant across countries, then the volume of trade increases as countries become more similar in relative size.

The way we proceed is as follows. First, we set up the model. We then demonstrate our two results, before providing some concluding comments.

2 The model

Suppose that there are two countries in the world, Home and Foreign, and two goods, x and y. There are two sector-specific factors of production in the economy, capital K and labour L. Capital is used only in producing good x, while labour is used only in producing good y.[2] There are identical preferences and technologies across countries, and free trade in goods but not in factors of production. All markets are perfectly competitive. Choose units such that the output of each good is equal to the product-specific factor of production used in producing that good:

$$Q_x = K \qquad\qquad Q_y = L \tag{1}$$

[1] First popularised by Dixit and Norman (1980), then used in a variety of contexts by Helpman and Krugman (1985).

[2] We adopt simple functional forms to focus attention on our main results. These results continue to hold if we allow for each good to be produced using both factors of production.

The representative consumer's utility function takes the following Cobb-Douglas form:

$$U = \log c_x + \log c_y \tag{2}$$

The utility function implies that the representative consumer will spend equal shares of his income on each type of good. Each country's endowment of the two factors of production is:

$$\left.\begin{array}{c} K^H + K^F = 2 \\ L^H + L^F = 2 \end{array}\right\} \qquad \frac{K^H}{L^H} > \frac{K^F}{L^F} \tag{3}$$

That is, Home is relatively abundant in capital, while Foreign is relatively abundant in labour. World endowment of each factor of production is equal to 2, and therefore so is world output of each type of good. Given identical expenditures on each type of good, in free trade, prices of both goods are the same and are normalised to 1. This also implies that returns to factors are equal to 1 for both factors of production.[3] Given the normalisations, national incomes are equal to $L^H + K^H$ for Home, and $L^F + K^F$ for Foreign.

The volume of trade can be obtained by the difference between expenditure on each good and the value of production of each good. Following Helpman and Krugman (1985), when Home is relatively abundant in capital, the volume of trade is defined as:

$$VT = p_x \left(Q_x^H - s^H \overline{Q_x}\right) + p_y \left(Q_y^F - s^F \overline{Q_y}\right) \tag{4}$$

where $\overline{Q_x}$ and $\overline{Q_y}$ are the world output of each good, and s^H and s^F are the shares of Home and Foreign in world income. Given our normalisations, the volume of trade reduces to:

$$VT = \frac{2\left(K^H L^F - K^F L^H\right)}{K^H + L^H + K^F + L^F} \tag{5}$$

This shows the standard result, that the volume of trade decreases the more similar are countries' relative factor endowments; if for example $\frac{K^H}{L^H} = \frac{K^F}{L^F}$, then the volume of trade is equal to zero.

3 The volume of trade

Helpman and Krugman (1985) show that the volume of trade is constant along a ray that is parallel to the diagonal linking the origins of the two countries in the Dixit-

[3] This is the complete general equilibrium solution of the model. The Appendix shows the autarkic equilibrium.

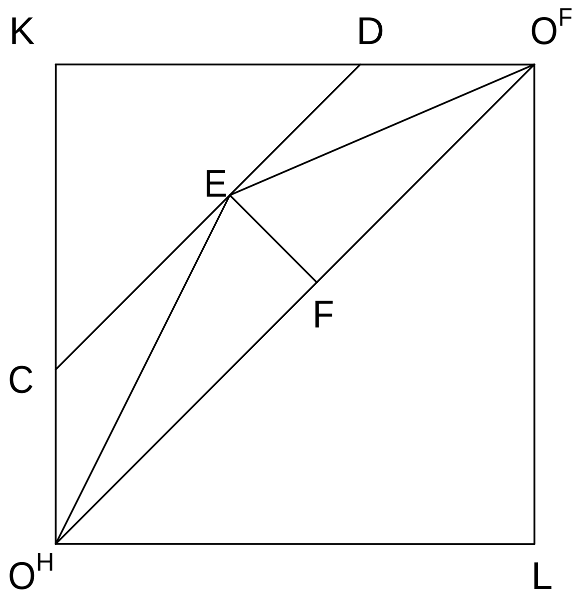

Figure 1: The constant trade volume line in the Dixit-Norman-Helpman-Krugman rectangle.

Norman-Helpman-Krugman (DNHK) rectangle. A natural question to ask is, what is the implication of this constant-trade-volume ray for relative endowments?

To answer this question, consider the DNHK rectangle Figure 1, where O^H is Home's origin, O^F is Foreign's origin, $O^H K$ is the world endowment of capital, and $O^H L$ the world endowment of labour. Suppose that the distribution of endowments between the two countries is at point E, so that the line CED is the constant-trade-volume line which passes through the endowment point, and EF is the net factor content of trade, which is here also a measure of the volume of trade.

Given the parameters of the model, the equation of the constant-trade-volume line CED is $VT = K^H - L^H$. To investigate what happens to the endowment ratio of Home along this ray, we first totally differentiate this expression, holding the volume of trade constant:

$$dK^H - dL^H = 0 \tag{6}$$

A movement along this ray changes relative endowments in Home according to the following proportions:

$$\left.\frac{d\left(\frac{K^H}{L^H}\right)}{\left(\frac{K^H}{L^H}\right)}\right|_{dK^H=dL^H} = d\log K^H - d\log L^H$$

$$= \frac{dK^H}{K^H} - \frac{dL^H}{L^H}$$

$$= \frac{\left(L^H - K^H\right)dK^H}{K^H L^H} \tag{7}$$

since $dK^H - dL^H = 0$. If Home is capital-abundant relative to Foreign so that the endowment point lies above the diagonal as in point E in Figure 1, then $K^H > L^H$, so that an increase in Home capital stock, whilst remaining along the constant-trade-volume line CED, reduces Home's capital-labour ratio. The analogous expression for Foreign is:

$$\left.\frac{d\left(\frac{K^F}{L^F}\right)}{\left(\frac{K^F}{L^F}\right)}\right|_{dK^F=dL^F} = \frac{\left(L^F - K^F\right)dK^F}{K^F L^F} \tag{8}$$

Since in general $K^H L^H \neq K^F L^F$, for any movement along the constant-trade-volume line CED, (7) is not equal to (8), so we can conclude that a movement along the constant-trade-volume line CED does not preserve the relative capital-labour ratios between the two countries.

We next derive the curve that represents a constant relative endowment ratio between the two countries. The equation of this curve satisfies the relation:

$$\frac{\left(\frac{K^H}{L^H}\right)}{\left(\frac{K^F}{L^F}\right)} = \beta$$

where β is a constant. Rewriting this gives the equation of this curve:

$$K^H L^F = \beta K^F L^H \tag{9}$$

Then, substituting this into the expression for the volume of trade (5), the volume of trade along this curve is

$$VT = \frac{2\left(K^H L^F - K^F L^H\right)}{K^H + L^H + K^F + L^F} = \frac{\left(\beta K^F L^H - K^F L^H\right)}{2} = \frac{(\beta - 1)\, K^F L^H}{2} \tag{10}$$

Figures 2 and 3 show the properties of such a constant-endowment-ratio curve, for a value of $\beta = 10$ (Home's relative endowment of capital to labour is ten times that of

Foreign). Figure 2 shows how Home's endowment of labour varies with its endowment of capital in order to preserve the relative endowment ratio. Figure 3 shows the volume of trade (the red line) and the absolute difference in national incomes (the blue line) as we move along the constant-endowment-ratio curve. The volume of trade is maximised when the two countries' incomes are most similar to one another. Note that since our results are derived holding total world endowments constant, our results also hold for the trade volume relative to the sum of the two countries' incomes.

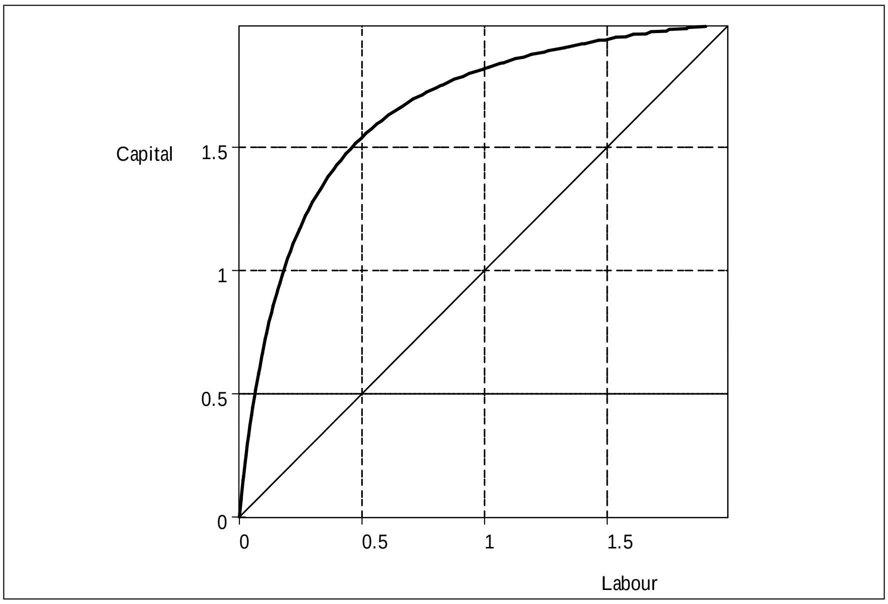

Figure 2: The constant-endowment-ratio curve.

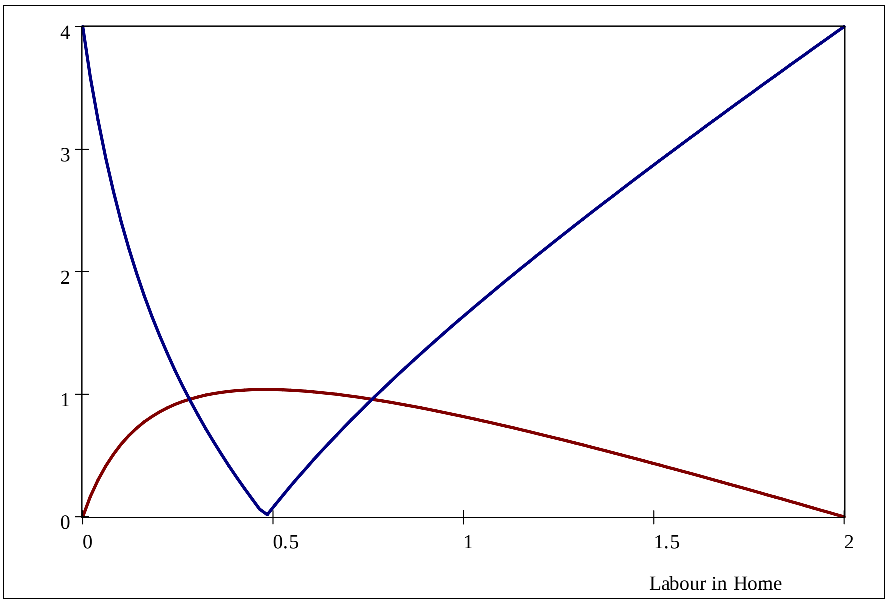

Figure 3: Trade volume (red line) and absolute difference in national incomes (blue line) when moving along a constant-endowment-ratio curve.

4 Conclusions

This paper develops a trade model based on factor endowments, which is then used to clarify the cases when relative country size has no impact on the volume of trade. Relative country size does not matter for the volume of trade when we move along any constant-trade-volume line, which is parallel to the diagonal of the DNHK rectangle. However, movement along this line does not preserve constant endowment ratios across countries. We derive the expression for the curve representing constant endowment ratios, and show that the volume of trade along this curve does depend on relative country size.

The practical implication of this result is the following. It shows that, once relative endowments have been controlled for, the fact that trade shares increase as countries' GDPs become more similar to one another, cannot be used to distinguish between models of trade based on factor endowment differences, and those based on monopolistic competition.

5 Appendix A: Autarkic equilibrium

The solution of the model when goods trade is prohibited is as follows (here, we solve for Home; the solution for Foreign follows the same steps). Since the expenditure on each good is the same, relative prices and hence relative factor prices are:

$$\frac{p_x}{p_y} = \frac{r}{w} = \frac{L^H}{K^H}$$

Given the assumptions on technologies, output and hence consumption of each good is equal to the endowment of the factor of production associated with that good.

References

[1] Debaere, P. (2005), "Monopolistic Competition and Trade, Revisited: Testing the Model Without Testing for Gravity", *Journal of International Economics* 66(1): 249-266.

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[5] Hummels, D. and J. Levinsohn (1995), "Monopolistic Competition and International Trade: Reconsidering the Evidence", *Quarterly Journal of Economics* 110(3): 799-836.