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Endogenous Sunk-Costs Technology and Home Market Effects

Shin-Chyang Lee[1]

[1] Department of International Trade, Chihlee University of Technology, Taiwan

Correspondence: Shin-Chyang Lee, No. 313, Sec. 1, Wunhua Rd., Banciao District, New Taipei City, 22050, Taiwan. Tel: 886-2-2257-6167. E-mail: gtolove007@yahoo.com.tw

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Abstract

Sutton (1991, 1998) proves that the home market effects would reverse with the assumption of the labor requirements with endogenous sunk costs. Departing from the original Helpman-Krugman modeling assumptions, we introduce the endogenous sunk costs of production to trading partners, and show that home market effects will be offset but not reverse, a result opposite of Sutton (1991, 1998).

Keywords: endogenous sunk costs, home market effects

1. Introduction

The purpose of this paper is to explore the relationship between endogenous sunk costs and home market effects. By using the assumptions of Dixit and Stiglitz's (1977) preferences and 'iceberg' transport costs, in a monopolistic competition model, Krugman (1979, 1980) and Helpman and Krugman (1985) point out the home market effects meaning that a relatively larger country tends to share a large proportion of the differentiated manufacturing goods characterized by scale economies.

The existing literature on home market effects specifies the linear labor requirements with exogenous fixed labor requirements and constant marginal labor requirements, for example, Ricci (1999), Forslid and Wooton (2003) and Huang et al. (2014). Ricci (1999) and Forslid and Wooton (2003) assume that the marginal costs and the fixed costs of production vary across the monopolistically sectors respectively and then confirm the home market effects. Conversely, Huang et al. (2014) assume both the marginal costs and the fixed costs of production are different across the monopolistically sectors. Huang et al. find that the relative technology difference may lead to a reversal home market effects.

In another development in the home market effects literature, Sutton (1991, 1998) addresses the impact of the labor requirements with endogenous sunk costs on the home market effects. Sutton emphasizes that an increase in the endogenous sunk costs can act as a barrier to entry and lead to a decrease in the number of firms in a larger market size. That is to say, Sutton proves that the home market effects would reverse with the assumption of the labor requirements with endogenous sunk costs.

However, the main contribution of this paper is that we consider endogenous sunk costs in our general equilibrium framework and find that the specification of endogenous sunk costs would shrink the conventional home market effects after free trade, but can't reverse the conventional home market effects.

The remainder of this paper is organized as follows. Section 2 constructs the theoretical model. Section 3 solves for the equilibrium under both autarky and free trade. Section 4 concludes the paper.

2. The Model

There are two countries in the world, Home and Foreign denoted by an asterisk (*) and assume that they are similar with regard to consumers' preferences and production technologies but not necessarily in their sizes. Labor is the only factor of production and the relative country size is measured by the labor force. L represents the size of the world's total labor force. γL ($0<\gamma<1$) belongs to the home country and $(1-\gamma)L$ belongs to foreign. Hence, γ represents the relative home country size. Suppose that there are two sectors in each country. A competitive sector produces homogeneous goods (Y), and a monopolistic competition sector produces a large number of varieties of a firm-specific differentiated goods (X). The homogeneous goods are produced with constant returns to scale technology and taken as the numeraire.

Suppose that there is a positive transport cost for the differentiated goods under free trade. That is, the international shipment incurs an 'iceberg' transport cost wherein for t (t>1) units of the differentiated goods shipped, only one unit arrives. Hence, the home's price of the imported differentiated goods is tp*, where p* represents the producer's price for foreign. In addition, assume that the homogeneous goods are costless and each country produces them under free trade. The assumption of identical technology in this sector implies that the wage rates are equal between home country and foreign country.

With the assumption of the same consumers' preferences between home country and foreign country, the utility function can be specified as follows:

$$U = C_Y^{1-s} C_X^s, \quad 0 < s < 1 \tag{1}$$

where C_Y represents the consumption of the homogeneous goods, C_X represents the quantity index of the differentiated goods consumed, and s is the share of spending on the differentiated goods. The well-know form of the quantity index can be shown as follows:

$$C_X = \left(\sum_{i=1}^{n} c_i^{\theta} + \sum_{i^*=1}^{n^*} c_i'^{\theta} \right)^{1/\theta}, \quad 1/\alpha < \theta < 1 \tag{2}$$

where n (n^*) represents the number of the differentiated goods produced in Home (Foreign), c_i (c_i') is the quantity of the home (foreign) differentiated goods i consumed by the home consumers. $1/(1-\theta)$ represents the elasticity of substitution between every pair of the differentiated goods. We will introduce the parameter $\alpha > 1$ in Equation (6).

Solving the consumer's utility maximization problem can obtain Home demand function (c_i) for each unit of Home product i.

$$c_i = p_i^{\frac{1}{\theta-1}} P^{\frac{\theta}{1-\theta}} sw\gamma L \tag{3}$$

where p_i is the price of Home product i and P is the price index for the differentiated goods. w is the nominal wage and hence $w\gamma L$ is the income of the home country. And then, the demand function for foreign product i on the part of home consumers (c_i') can be derived as follows:

$$c_i' = (tp_i^*)^{\frac{1}{\theta-1}} P^{\frac{\theta}{1-\theta}} tsw\gamma L \tag{4}$$

Similarly, we can derive the foreign consumers' demand function for the foreign goods (c_i^*), and for the imported goods from the home country ($c_i'^*$), as follows:

$$c_i^* = p_i^{*\frac{1}{\theta-1}} P^{*\frac{\theta}{1-\theta}} sw^*(1-\gamma)L \tag{3a}$$

$$c_i'^* = (tp_i)^{\frac{1}{\theta-1}} P^{*\frac{\theta}{1-\theta}} tsw^*(1-\gamma)L \tag{4a}$$

The price index for the differentiated goods can be derived as:

$$P = \left[\sum_{i=1}^{n} p_i^{\frac{\theta}{\theta-1}} + \sum_{i^*=1}^{n^*} (tp_i^*)^{\frac{\theta}{\theta-1}} \right]^{\frac{\theta-1}{\theta}}, \quad P^* = \left[\sum_{i=1}^{n} (tp_i)^{\frac{\theta}{\theta-1}} + \sum_{i^*=1}^{n^*} (p_i^*)^{\frac{\theta}{\theta-1}} \right]^{\frac{\theta-1}{\theta}} \tag{5}$$

Assume that one unit output requires one unit labor input in the homogeneous sector. In the monopolistically competitive sector, following Dasgupta and Stiglitz (1980), suppose that the amount of labor required l_i (l_i^*) to produce the quantity x_i (x_i^*) is given by:

$$l_i = \alpha (x_i)^{\frac{1}{\alpha}} - 1, \quad l_i^* = \alpha (x_i^*)^{\frac{1}{\alpha}} - 1, \quad \alpha > 1 \tag{6}$$

The parameter α is the technology factor. Apart from the traditional set-up which labor requirements are linear with exogenous fixed labor requirements and constant marginal labor requirements, we allow for labor requirements with endogenous sunk costs (Note 1). While the elasticity of labor requirements of the traditionally linear labor requirements function is increasing in output (x_i), the elasticity of labor requirements with endogenous sunk costs is decreasing in output. The differences in the characters of the elasticity of labor requirements are importance in our analysis.

3. Equilibrium

We will derive the autarky equilibrium and free trade equilibrium in Sections 3.1 and 3.2 respectively.

3.1 Autarky Equilibrium

First, $c_i'=0$ represents the home country under a state of autarky. Each monopolistic competition firm will take the exogenous price index P. In the monopolistic competition equilibrium, two conditions must hold, i.e., profit maximization and the zero-profit condition. Hence, from the profit maximization condition, we have

$$p_i = \frac{w(x_i)^{\frac{1}{\alpha}-1}}{\theta}, \quad p_i^* = \frac{w^*(x_i^*)^{\frac{1}{\alpha}-1}}{\theta} \tag{7}$$

The zero-profit condition implies that the unit price of p_i equals the average cost. By making use of the zero-profit condition and Equation (7), the equilibrium quantity of production for the home (foreign) firm x_i (x_i*) can be derived as follows:

$$x_i = \left(\frac{\theta}{\alpha\theta-1}\right)^{\alpha}, \quad x_i^* = \left(\frac{\theta}{\alpha\theta-1}\right)^{\alpha} \tag{8}$$

Substituting Equation (8) into (7) can obtain the unit prices of Home and Foreign as follows:

$$p_i = \frac{w(\alpha\theta-1)^{\alpha-1}}{\theta^{\alpha}}, \quad p_i^* = \frac{w^*(\alpha\theta-1)^{\alpha-1}}{\theta^{\alpha}} \tag{7a}$$

For simplification, we delete subscript i in what follows. And then, in the home (foreign) differentiated sector, the full employment condition can be shown as follows:

$$s\gamma L = n(\alpha x^{\frac{1}{\alpha}} - 1), \quad s(1-\gamma)L = n^*[\alpha(x^*)^{\frac{1}{\alpha}} - 1] \tag{9}$$

Substituting Equation (8) into (9) can obtain:

$$n^A = s\gamma L(\alpha\theta - 1), \quad n^{A*} = s(1-\gamma)L(\alpha\theta-1) \tag{10}$$

Obviously, the superscript '*A*' denotes 'autarky'.

3.2 Free Trade Equilibrium and Home Market Effects

Under free trade, the world market clearing condition for each of the differentiated goods of the home firms (x) should satisfy $x=c+c'^*$. Using Equations (3), (4a), and (8) can obtain the world market clearing condition for each home goods as follows:

$$\left(\frac{\theta}{\alpha\theta-1}\right)^{\alpha} = p^{\frac{1}{\theta-1}} P^{\frac{\theta}{1-\theta}} sw\gamma L + (tp)^{\frac{1}{\theta-1}} P^{*\frac{\theta}{1-\theta}} tsw^*(1-\gamma)L$$

$$= \frac{p^{\frac{1}{\theta-1}} sw\gamma L}{\phi_1} + \frac{\tau p^{\frac{1}{\theta-1}} sw^*(1-\gamma)L}{\phi_2} \tag{11}$$

where

$$\phi_1 \equiv np^{\frac{\theta}{\theta-1}} + n^*\tau p^{*\frac{\theta}{\theta-1}}, \text{ and } \phi_2 \equiv n\tau p^{\frac{\theta}{\theta-1}} + n^* p^{*\frac{\theta}{\theta-1}} \tag{12a}$$

$$\tau \equiv t^{\frac{\theta}{\theta-1}}, \quad 0 < \tau < 1 \tag{12b}$$

Similarly, the world market clearing condition for each foreign goods is $x^*=c'+c^*$. Using Equations (3a), (4), and (8) can obtain the world market clearing condition for each foreign goods as follows:

$$\left(\frac{\theta}{\alpha\theta-1}\right)^{\alpha} = (tp^*)^{\frac{1}{\theta-1}} P^{\frac{\theta}{1-\theta}} tsw\gamma L + (p^*)^{\frac{1}{\theta-1}} P^{*\frac{\theta}{1-\theta}} sw^*(1-\gamma)L$$

$$= \frac{p^{*\frac{1}{\theta-1}} \tau sw\gamma L}{\phi_1} + \frac{p^{*\frac{1}{\theta-1}} sw^*(1-\gamma)L}{\phi_2} \tag{13}$$

In order to simplify the model, assume that the homogenous sector remains active in Home and Foreign under free trade, e.g., Feenstra (2003), Davis (1998), Ricci (1999), and Huang *et al*. (2014). The identical technology and costless trade in homogenous goods ensure an identical wage rate between Home and Foreign. That is, the wage rate of Home (w) should be equal to that of Foreign (w^*), i.e., $w=w^*$. Using the relationship of $w=w^*$, Equations (11) and (13) can get (Note 2):

$$n^T = (\alpha\theta - 1)sL\left[\frac{(1+\tau)\gamma - \tau}{1-\tau}\right] > 0 \tag{14}$$

$$n^{T*} = (\alpha\theta - 1)sL\left[\frac{1-(1+\tau)\gamma}{1-\tau}\right] > 0 \tag{15}$$

if

$$\frac{\tau}{1+\tau} < \gamma < \frac{1}{1+\tau}$$

Obviously, the superscript 'T' denotes 'free trade'. To analyze the role of technology factor for the home market effects, we have to compare the number of firms both before and after the free trade. From Equations (14) and (10), we get:

$$n^T - n^A = \frac{(\alpha\theta - 1)sL\tau(2\gamma - 1)}{1-\tau} \tag{16}$$

For the foreign country, using Equations (15) and (10) has:

$$n^{T^*} - n^{A^*} = \frac{(\alpha\theta - 1)sL\tau(1-2\gamma)}{1-\tau} \tag{17}$$

As in the literature, both transport costs τ and country size γ will affect the home market effects from Equations (16) and (17). In addition to τ and γ, we can observe that the technology factor α is also an important factor affecting the home market effects. Because of the symmetry between Home and Foreign, we can only consider the case of Home country. From Equation (16), the partial differential can be deriver as follows:

$$\frac{\partial(n^T - n^A)}{\partial\alpha} = \frac{\theta\tau sL(2\gamma - 1)}{1-\tau} > 0\text{, if } \gamma > \frac{1}{2} \tag{18}$$

Equation (18) indicates that the relationship between α and $(n^T - n^A)$ is positive when the country size is larger. The economic intuition can be stated as follows. First, the conventional home market effects argue that in a two-country world, a relatively larger country ($\gamma > 1/2$) tends to share a large proportion of the differentiated manufacturing goods, i.e., the larger number of firms. Second, the larger technology factor (α) represents the higher sunk costs and hence the firms have to accomplish higher mark-ups in order to cover these extra sunk costs (Note 3). But higher mark-ups are only enforceable when the market is less competitive, so that the number of firms must decrease. More specifically, the higher sunk costs tend to shrink the conventional home market effects after free trade, but can't reverse the conventional home market effects.

4. Concluding Remarks

Sutton (1991, 1998) proves that the home market effects would reverse with the assumption of the labor requirements with endogenous sunk costs. Departing from the original Helpman-Krugman modeling assumptions, we introduce the endogenous sunk costs of production to trading partners, and show that home market effects will be offset but not reverse, a result opposite of Sutton (1991, 1998).

Appendix Solving for the equilibrium number of firms under free trade

First, from Equations (11) and (13), we have the matrix form as follows:

$$\begin{bmatrix} p^{\frac{1}{\theta-1}}sw\gamma L & \tau p^{\frac{1}{\theta-1}}sw^*(1-\gamma)L \\ p^{*\frac{1}{\theta-1}}\tau sw\gamma L & p^{*\frac{1}{\theta-1}}sw^*(1-\gamma)L \end{bmatrix}\begin{bmatrix} \frac{1}{\phi_1} \\ \frac{1}{\phi_2} \end{bmatrix} = \begin{bmatrix} (\frac{\theta}{\alpha\theta-1})^{\alpha} \\ (\frac{\theta}{\alpha\theta-1})^{\alpha} \end{bmatrix} \tag{A.1}$$

Using Cramer's rule can get:

$$\frac{1}{\phi_1} = \frac{(\frac{\theta}{\alpha\theta-1})^{\alpha}(p^{*\frac{1}{\theta-1}} - \tau p^{\frac{1}{\theta-1}})}{sw\gamma Lp^{\frac{1}{\theta-1}}p^{*\frac{1}{\theta-1}}(1-\tau^2)} \tag{A.2}$$

$$\frac{1}{\phi_2}=\frac{(\frac{\theta}{\alpha\theta-1})^{\alpha}(p^{\frac{1}{\theta-1}}-\tau p^{*\frac{1}{\theta-1}})}{sw^*(1-\gamma)Lp^{\frac{1}{\theta-1}}p^{*\frac{1}{\theta-1}}(1-\tau^2)} \tag{A.3}$$

From Equations (A.2) and (A.3), we find:

$$\phi_1=\frac{sw\gamma Lp^{\frac{1}{\theta-1}}p^{*\frac{1}{\theta-1}}(1-\tau^2)}{(\frac{\theta}{\alpha\theta-1})^{\alpha}(p^{*\frac{1}{\theta-1}}-\tau p^{\frac{1}{\theta-1}})} \tag{A.2a}$$

$$\phi_2=\frac{sw^*(1-\gamma)Lp^{\frac{1}{\theta-1}}p^{*\frac{1}{\theta-1}}(1-\tau^2)}{(\frac{\theta}{\alpha\theta-1})^{\alpha}(p^{\frac{1}{\theta-1}}-\tau p^{*\frac{1}{\theta-1}})} \tag{A.3a}$$

Second, substituting Equations (A.2a) and (A.3a) into Equation (12a) can obtain the matrix form as follows:

$$\begin{bmatrix} p^{\frac{\theta}{\theta-1}} & \tau p^{*\frac{\theta}{\theta-1}} \\ \tau p^{\frac{\theta}{\theta-1}} & p^{*\frac{\theta}{\theta-1}} \end{bmatrix}\begin{bmatrix} n \\ n^* \end{bmatrix}=\begin{bmatrix} \dfrac{sw\gamma Lp^{\frac{1}{\theta-1}}p^{*\frac{1}{\theta-1}}(1-\tau^2)}{(\frac{\theta}{\alpha\theta-1})^{\alpha}(p^{*\frac{1}{\theta-1}}-\tau p^{\frac{1}{\theta-1}})} \\ \dfrac{sw^*(1-\gamma)Lp^{\frac{1}{\theta-1}}p^{*\frac{1}{\theta-1}}(1-\tau^2)}{(\frac{\theta}{\alpha\theta-1})^{\alpha}(p^{\frac{1}{\theta-1}}-\tau p^{*\frac{1}{\theta-1}})} \end{bmatrix} \tag{A.4}$$

By Cramer's rule and the relationship of w=w*, we can derive n^T and n^T* as follows:

$$n^T=(\alpha\theta-1)sL\left[\frac{(1+\tau)\gamma-\tau}{1-\tau}\right] \tag{A.5}$$

$$n^{T^*}=(\alpha\theta-1)sL\left[\frac{1-(1+\tau)\gamma}{1-\tau}\right] \tag{A.6}$$

References

Dasgupta, P., & Stiglitz, J. E. (1980). Industrial structure and the nature of innovative activity. *Economic Journal*, *90*, 266-293. http://dx.doi.org/10.2307/2231788

Davis, D. (1998). The home market, trade, and industrial structure. *American Economic Review, 88*, 1264-1276.

Dixit, A., & Stiglitz, J. (1977). Monopolistic competition and optimum product diversity. *American Economic Review, 67*, 297-308.

Feenstra, R. C. (2003). *Advanced International Trade: Theory and Evidence*. Princeton: Princeton University Press.

Forslid, R., & Wooton, I. (2003). Comparative advantage and the location of production. *Review of International Economics*, *11*, 588-603. http://dx.doi.org/10.1111/1467-9396.00405

Helpman, E., & Krugman, P. (1985). *Market Structure and Foreign Trade, Increasing Returns, Imperfect Competition, and the International Economy*. Cambridge, MA and London: MIT Press.

Huang, Y. Y., Lee, C. T., & Huang, D. S. (2014). Home market effects in the Chamberlinian-Ricardian world. *Bulletin of Economic Research, 66*, S36-S54. http://dx.doi.org/10.1111/boer.12008

Krugman, P. (1979). Increasing returns, monopolistic competition and international trade. *Journal of International Economics, 9*, 469-479. http://dx.doi.org/10.1016/0022-1996(79)90017-5

Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *American Economic Review, 70*, 950-959.

Leahy, D., & Neary, P. J. (1996). International R&D rivalry and industrial strategy without government commitment. *Review of International Economics*, *4*, 322-338. http://dx.doi.org/10.1111/j.1467-9396.1996.tb00107.x

Ricci, L. A. (1999). Economic geography and comparative advantage: Agglomeration versus specialization.

European Economic Review, *43*, 357-377. http://dx.doi.org/10.1016/S0014-2921(98)00065-8

Spence, M. (1984). Cost reduction, competition, and industry performance. *Econometrica*, *52*, 101-121. http://dx.doi.org/10.2307/1911463

Sutton, J. (1991). *Sunk Costs and Market Structure*. Cambridge, London: MIT Press.

Sutton, J. (1998). *Technology and Market Structure*. Cambridge, London: MIT Press.

Notes

Note 1. For alternative specifications of labor requirements function with endogenous sunk costs, please see Leahy and Neary (1996).

Note 2. Please see Appendix for the mathematical derivation.

Note 3. By using Equations (8) and (6), the marginal cost (*MC*) can be derived as: $MC = w\theta^{(1-\alpha)}(\alpha\theta - 1)^{(\alpha-1)}$.