Professor Tybout

4th Homework Assignment
Economics 507A: International Trade

Suggested answers

1. **[This question is based on notes prepared by Pol Antras]** Consider a world with two identical countries, Home and Foreign. Let goods in each country be horizontally differentiated, with demand for a representative good in country *i* given by:

$$x^i(p) = A^i p^{-\varepsilon}, \quad i = H, F$$

Also, assume that production of a unit of any variety requires one unit of labor, which costs *w*. Also, setting up a firm involves a fixed headquarters cost, f_E, as well as a fixed plant overhead cost, f_D, for each plant that the firm operates. Finally, let the iceberg transport costs per unit exported be τ-1.

a) Derive an expression in terms of *A*'s, *w*, τ, ε, f_E and f_D for the profits of a firm that chooses to service the foreign market through exports.

Profits for (non-multinational) exporter are:

$$\pi_X = \left(p^H - w\right)x^H + \left(p^F - \tau w\right)x^F - wf_E - wf_D$$

Plugging in the demand equations and optimizing over domestic and foreign price yields the first-order conditions:

$$A^H\left(p^H\right)^{-\varepsilon} - \left(p^H - w\right)\varepsilon A^H\left(p^H\right)^{-\varepsilon-1} = 0,\ A^F\left(p^F\right)^{-\varepsilon} - \left(p^F - \tau w\right)\varepsilon A^F\left(p^F\right)^{-\varepsilon-1} = 0$$

These expressions yield standard mark-up expressions for prices in terms of marginal costs and the elasticity of demand. Plugging these optimal prices into the profit function yields:

$$\pi_X = \frac{A^H}{\varepsilon}\left(\frac{\varepsilon w}{\varepsilon - 1}\right)^{1-\varepsilon} + \frac{A^F}{\varepsilon}\left(\frac{\varepsilon \tau w}{\varepsilon - 1}\right)^{1-\varepsilon} - wf_E - wf_D$$

b) Derive a similar expression for the profits of a firm that chooses to service the foreign market though a foreign plant (i.e., through foreign direct investment).

A multinational (integrated) firm avoids transport costs on its exports but pays fixed costs on two plants—one at home and one abroad. So its profit function takes the form

$$\pi_I = \left(p^H - w\right)x^H + \left(p^F - w\right)x^F - wf_E - w2f_D$$

Retracing the steps in part (a) with this function leads to

$$\pi_I = \frac{A^H}{\varepsilon}\left(\frac{\varepsilon w}{\varepsilon - 1}\right)^{1-\varepsilon} + \frac{A^F}{\varepsilon}\left(\frac{\varepsilon w}{\varepsilon - 1}\right)^{1-\varepsilon} - wf_E - 2wf_D$$

c) Show that firms will choose foreign direct investment over exporting whenever:

$$\pi_I = \frac{A^H}{\varepsilon}\left(\frac{\varepsilon w}{\varepsilon - 1}\right)^{1-\varepsilon} + \frac{A^F}{\varepsilon}\left(\frac{\varepsilon w}{\varepsilon - 1}\right)^{1-\varepsilon} - wf_E - 2wf_D$$

$$\frac{A^F}{\varepsilon}\left(\frac{w\varepsilon}{\varepsilon - 1}\right)^{1-\varepsilon}\left(1 - \tau^{1-\varepsilon}\right) > wf_D$$

Interpret this expression in terms of its implications for the role of transport costs, scale economies and market size in determining FDI.

The difference between the profit expressions in part (b) and the profit expression in part (a) yields the condition above. It implies that, given market size and factor prices, firms will choose to service foreign markets through direct investment rather than exports when trade costs are high and the fixed costs of creating a new plant are low (i.e., plant-level scale economies are modest).

d) Now assume that free entry ensures that the firms make zero profit, and that the *A*'s adjust to ensure this. (What, precisely, will cause *A*'s to change?) Further assume that all firms are exporters and write down two equations that give the free entry condition for home and foreign firms, and solve them to determine *A*'s in terms of w, τ, ε, f_E and f_D.

Setting profits for exporting firms equal to zero at home and abroad, then solving for the demand shifters, yields:

$$A^F = A^E = \left(\frac{\varepsilon w}{\varepsilon - 1}\right)^{\varepsilon - 1} \cdot \left(\frac{w\varepsilon(f_E + f_D)}{1 + \tau^{1-\varepsilon}}\right)$$

With Dixit-Stiglitz preferences, these demand shifters can be viewed as the ratio of total expenditures on final goods, $w[L-n(f_E + f_D)]$, to $\bar{P}^{1-\varepsilon}$, where $\bar{P}$ is a CES price index. Because countries and firms are symmetric, and because all goods are consumed in all countries, this price index can be written (using the mark-up rule) as

$$\bar{P} = \left[np^{1-\varepsilon} + n(\tau p)^{1-\varepsilon}\right]^{1/(1-\varepsilon)} = n^{1/(1-\varepsilon)}\left(\frac{w\varepsilon}{1-\varepsilon}\right)\cdot(1+\tau^{1-\varepsilon})^{1/(1-\varepsilon)}.$$

Clearly, as the number of product varieties in each country grows, the price index falls, causing $\bar{P}^{1-\varepsilon}$ to rise and A to fall. This is because consumers spread their income over more goods, leaving each producer with less profit. (A also falls as n grows become more income is absorbed as fixed expenditures on plants and headquarters.) That is, with more competitors around, competition intensifies.

e) Using the A expressions you found in part (d) above, show that no one will wish to deviate from a pure exporting equilibrium so long as multinational profits are negative:

$$\pi_I = \left(\frac{2w(f_E + f_D)}{1+\tau^{1-\varepsilon}}\right) - wf_E - 2wf_D < 0$$

Do scale economies and transport costs play the same role as in part c, when market sizes were taken as exogenous? Why is market size no longer a determinant of the decision concerning whether to switch to multinational production?

Evaluating $\pi_I = \frac{A^H}{\varepsilon}\left(\frac{\varepsilon w}{\varepsilon - 1}\right)^{1-\varepsilon} + \frac{A^F}{\varepsilon}\left(\frac{\varepsilon w}{\varepsilon - 1}\right)^{1-\varepsilon} - wf_E - 2wf_D$ at

$A^F = A^E = \left(\frac{\varepsilon w}{\varepsilon - 1}\right)^{\varepsilon - 1} \cdot \left(\frac{w\varepsilon(f_E + f_D)}{1+\tau^{1-\varepsilon}}\right)$ yields the left-hand side of the expression above.

Scale economies and transport costs play the same role as in part (c). However, the effect of market size on profits has disappeared because the A's adjust until profits per exporter are zero. Thus, for example, it doesn't matter how many workers are in each country.

2. Suppose car production involves two activities: R&D (activity x) and production (activity y). When General Motors (GM) does both stages of production itself, the resulting revenue is $R(x,y)$, and profits are $\pi^I = R(x,y) - a\alpha y - cx$ (a, $c > 0$; $\alpha > 1$). When, alternatively, GM outsources production to a Mexican firm, it earns profits $\pi^O = \theta[R(x,y) - r_a y - r_c x] + xr_c - cx$. Here θ is the share of the surplus that GM will take away from a Nash bargaining game with the Mexican firm, and r_c is the reservation value of GM's investment in *R&D* if the bargaining breaks down. For its part, the Mexican firm that supplies GM earns $\pi^L = (1-\theta)\cdot[R(x,y) - r_a y - r_c x] + yr_a - ay$, where r_a is the reservation value of the Mexican firm's investment in production. (Both GM and the Mexican firm must invest in their activities before the bargaining over profits begins.) Critically assess each of the following assertions:

a) Whenever there is a complementary relation between the two activities (i.e., $\frac{\partial^2 R}{\partial x \partial y} > 0$), overall surplus ($\pi^O + \pi^L$) in the outsourcing equilibrium is maximized for intermediate values of the bargaining power parameter, θ.

True. If the two activities are complements, surplus is maximized in the outsourcing equilibrium when both take place in significant volume, and the extent of underinvestment in one activity is aggravated by underinvestment in the other activity. For substantial volumes of both activities to take place (and thus for a large total surplus), both GM and the Mexican supplier must thus be able to capture a substantial share of the surplus. Very low and very high values of θ rule this out. Indeed, for very low or very high values, the outsourcing equilibrium is unlikely to emerge at all, as demonstrated by Barba-Navaretti and Venables (2004).

b) If the reservation price for the Mexican firm's activity matches the total cost of that activity (i.e., $r_a = a$), GM will definitely want to do both stages of production itself. (That is, it will never want to outsource.)

False. If GM does the production itself it earns $\Pi^I = (1-\mu)R^*(c,\alpha a)$. If it outsources, it earns $\left[1-\mu\eta-\mu(1-\eta)\frac{r_a}{\tilde{w}_y}\right]\theta R^*(\tilde{w}_x,\tilde{w}_y)$, which collapses to $[1-\mu]\theta R^*(\tilde{w}_x,a)$ where $\tilde{w}_x = \frac{c-r_c}{\theta}+r_c > c$, given that $r_a = a$. So GM will want to do all of the production itself *only* if $\theta R^*(\tilde{w}_x,a) < R^*(c,\alpha a)$. This can go either way, depending upon the magnitude of α, θ, *a* and *c*. Intuitively, while $r_a = a$ increases the bargaining power of the Mexican supplier, it also increases the total amount of surplus by eliminating one aspect of the hold-up problem. And it remains true that the Mexican supplier can do the *y* activity (production) more efficiently than GM.