

Oligopoly

- Firms have market power and behave strategically.
- Increased competition can act as a basis for trade.
- Free trade price may fall below both autarky prices.
- Gains from the potential for trade, even in the absence of trade.
- Possible to have wasteful trade with transportation costs and segmented markets.

1 Helpman and Krugman 1985

- Two countries: Home and Foreign (*)
- Two goods: Y and X
- Good Y is competitively produced, with price normalized to one $P_Y = 1$
- Good X oligopoly: n Cournot firms at home and n^* abroad.
- One factor of production: labor
- m consumers in home country and m^* in foreign country
- $D(p; w)$ is the individual consumer's demand curve: a consumer demands quantity $D(p; w)$ of good X

1.1 Autarky

- One unit of labor produces one unit of good Y .
- Producers of good Y are perfectly competitive, which implies zero profit so wage must equal one $w = 1$.
- If a producer of good X makes x units of output, then total output its total cost is given by $c(w, x)$.
- Profits are $\pi = p(x)x - c(w, x)$.
- First order condition for profit maximization

$$\frac{d\pi}{dx} = x \frac{dp}{dx} + p - c_x(w, x) = 0$$

- Occurs at the output such that marginal cost equals marginal revenue

$$c_x(w, x) = p \left(1 + \frac{x}{p} \frac{dp}{dx} \right)$$

- Total amount of X produced equals $X = nx \leftrightarrow x = \frac{X}{n}$ by symmetry, so

$$c_x(w, x) = p \left(1 + \frac{1}{n \frac{p}{X} \frac{dx}{dp}} \right) \quad (1)$$

- The elasticity of demand is $\varepsilon(p, w) \equiv \frac{p}{X} \frac{dx}{dp}$, so

$$c_x(w, x) = p \left(1 - \frac{1}{n\varepsilon(p, w)} \right)$$

- Assume marginal cost is constant and equals $c_x(w, x) = c$ in each country and the elasticity of demand is constant at $\varepsilon(p, w) = \varepsilon$.

- Therefore, first order condition for X producers becomes (and similar for foreign)

$$p \left(1 - \frac{1}{n\varepsilon} \right) = c = p^* \left(1 - \frac{1}{n^*\varepsilon} \right) \quad (2)$$

This relationship allows us to compare prices under autarky.

$$p^A = \frac{c}{1 - \frac{1}{n\varepsilon}}, \quad p^{A*} = \frac{c}{1 - \frac{1}{n^*\varepsilon}}$$

Proposition 1 *If the domestic country has more firms $n > n^*$, then the domestic country must have the lower autarkic price $p^A < p^{A*}$. If $n = n^*$, then the autarky prices are equal $p^A = p^{A*}$.*

- Does this imply that the domestic country has comparative advantage in good X ? No!
- We cannot apply the comparative advantage theorem here since its defined under perfect competition.
- What prediction can we obtain regarding the pattern of trade?

1.2 Free Trade

- Assume free trade generates a single world market.
- Under trade, total number of firms becomes $n + n^*$.
- Consequently,

$$p^T \left[1 - \frac{1}{(n + n^*)\varepsilon} \right] = c$$

- Free trade equalizes prices across countries

$$p^T = \frac{c}{1 - \frac{1}{(n+n^*)\varepsilon}}$$

- Competition reduces the price of good X through increasing the number of firms.

Proposition 2 *Free trade results in a lower price than the autarky price of either country: $p^T < \min\{p^A, p^{A*}\}$.*

- Total world output is given by $(n + n^*)x$.
- Consumers have identical tastes, so domestic quantity demanded as percentage of world is

$$\frac{mD(p^T)}{mD(p^T) + m^*D(p^T)} = \frac{m}{m + m^*}$$

- Domestic production as a percentage of world is

$$\frac{nx}{nx + n^*x} = \frac{n}{n + n^*}$$

- Therefore if home's share of firms exceeds home's share of resources, then the home country exports good X.

$$\frac{n}{n + n^*} > \frac{m}{m + m^*}$$

Proposition 3 *If the number of firms per capita at home exceed the number of firms per capita abroad $n/m > n^*/m^*$, then the home country exports good X.*

- While autarkic prices in the country depend upon the absolute size of the X industry, direction of trade is determined by the per capita number of firms.
- Depending upon the relative sizes of the two countries, the country with the lower relative price in autarky may still be importing under free trade (if it is large enough).
- Comparative advantage does not predict the pattern of trade in this model.
- If the two countries are identical ($n = n^*$ and $m = m^*$), no trade (intraindustry or otherwise) arises!
- While goods are not traded, competition does have beneficial effects – gains from the potential to trade.

2 Brander and Krugman (JIE 1983)

- Two identical countries: Home and Foreign (starred variables denote the foreign country)
- One homogeneous good with domestic demand $p(Z)$ and foreign demand $p^*(Z^*)$ implying segmented markets, and some other numeraire good.
- Duopoly (under trade): One firm in each country (no entry) producing one homogeneous good.
- In the home market, $Z \equiv x + y$, where x denotes the home firm's sales in the home market and y the foreign firm's sales in the home market.
- In the foreign market $Z^* \equiv x^* + y^*$, where x^* denotes home firm's sales abroad and y^* denotes foreign firm's sales abroad.

- Cournot behavior: Firms choose quantities for each market, given quantities chosen by the other firm
- Constant marginal costs c and c^* with fixed costs F and F^* . Assume home and foreign firms have the same marginal costs $c = c^*$.
- Iceberg type transportation costs: for every one unit exported, only g arrives, $0 \leq g \leq 1$. Thus, the marginal cost of export c/g is inflated by the extent that not all of the exports arrive safely abroad.

2.1 Dumping

- Dumping means charging a lower price abroad than in the home market (or than cost).
- This model demonstrates that dumping can occur due to oligopolistic behavior.
- Here, dumping is reciprocal: each firm dumps in the other's market.
- Reciprocal dumping involves wasteful transportation costs.

2.2 Equilibrium

- The domestic and foreign profit functions are

$$\pi = xp(Z) + x^*p^*(Z^*) - c\left(x + \frac{x^*}{g}\right) - F$$

$$\pi^* = yp(Z) + y^*p^*(Z^*) - c\left(\frac{y}{g} + y^*\right) - F^*$$

- Considering the profits of the domestic firm, the first term reflects sales in the home market, the second term sales revenue from the foreign market, the third term marginal costs, and the last term fixed costs.
- The market in each country can be considered separately due to the segmented nature of markets.

- Consider the domestic economy. The domestic and foreign FOCs for choosing output (x and y) for the domestic market to maximize profits are

$$\pi_x = xp' + p - c = 0$$

$$\pi_y^* = yp' + p - \frac{c}{g} = 0$$

- Let $f \equiv y/Z$ be the foreign firm's share of the home market, $h \equiv x/Z$ be the home firm's share of the home market (so $h + f = 1$), and $\varepsilon = -\frac{p}{Zp'}$ be elasticity of home demand.

- The home firms' FOC becomes

$$x \left(-\frac{p}{Z\varepsilon} \right) + p = c$$

$$\leftrightarrow p \left(1 - \frac{h}{\varepsilon} \right) = c$$

$$\leftrightarrow p = c \left(\frac{1}{1 - \frac{h}{\varepsilon}} \right)$$

- Similarly, the foreign firm's FOC becomes

$$\leftrightarrow p = \frac{c}{g} \left(\frac{1}{1 - \frac{f}{\varepsilon}} \right)$$

- Solving for p and f (using $h = 1 - f$), gives the Nash equilibrium price

$$p = \frac{c\varepsilon(1 + g)}{g(2\varepsilon - 1)}$$

and foreign market share

$$f = \frac{1 - \varepsilon(1 - g)}{1 + g}$$

- Firms suffer a smaller markup over cost abroad than in their domestic markets (might be found guilty of dumping)

$$\frac{p/(c/g)}{p/c} = g < 1$$

- For an interior solution ($0 < f < 1$), we need the autarkic price to exceed the foreign monopoly's marginal cost of selling in the home market

$$\frac{c\varepsilon}{\varepsilon - 1} > \frac{c}{g} \rightarrow g > 1 - \frac{1}{\varepsilon}$$

assuming constant elasticity of demand $p = AZ^{-\frac{1}{\varepsilon}}$
(see Figure 1).

- Thus, we have a unique stable equilibrium with two-way (intraindustry) trade.

2.3 Welfare Analysis

- Overall welfare measures total surplus

$$W = 2(u(Z) - cZ - ty) - F - F^*$$

where $t \equiv c \left(\frac{1}{g} - 1 \right)$.

- The 2 arises due to having two symmetric countries (except for fixed costs), using $ty = tx^*$.
- Considering the effect of a small increase in transportation costs,

$$\frac{dW}{dt} = 2 \left[u' \frac{dZ}{dt} - c \frac{dZ}{dt} - t \frac{dy}{dt} - y \right]$$

which can be rewritten as

$$\frac{dW}{dt} = 2 \left[(p - c) \frac{dZ}{dt} - t \frac{dy}{dt} - y \right]$$

by collecting terms, since the relative price of Z equals the marginal utility u' .

- Focus on a special case where transportation costs are prohibitively high. so imports are zero $y = 0$.

- Furthermore, $\frac{dZ}{dt} = \frac{dx}{dt} + \frac{dy}{dt}$.

- Using these properties ($t = p - c$),

$$\frac{dW}{dt} = 2(p - c) \frac{dx}{dt} = 2t \frac{dx}{dt} > 0$$

- Therefore, when t is large, a small lowering of t lowers welfare.

- But for small t , there are clear gains because of increased competition.

- For negligible transportation costs $t = 0$,

$$\frac{dW}{dt} = 2(p - c) \frac{dZ}{dt} < 0$$

- In general, three effects determine welfare.
- First is the increased consumption of the good that comes from increased competition.
- Second is the reduced profits of domestic firms since increased consumption comes from increased imports.
- Third are the wasteful transportation costs incurred.
- When t is large, this last effect dominates.

Trade Policy in Oligopolistic Markets

- The existence of positive profits in oligopoly models alters the implications for trade policy.
- Since profits are split between domestic and foreign firms, the domestic government wants to implement policies that capture a greater share of world profits for its own firms.
- The traditional argument for intervention is that a large country can improve its terms of trade: by restricting trade (imports or exports), a large country can achieve a higher price of its exports relative to its imports.
- The policy literature on oligopoly (called strategic trade theory) is unique in that it furnishes an intuitive argument for promoting exports rather than restricting them, thereby reversing conventional wisdom.

- This export promotion view has struck a chord with policy makers and business people who see exports as a means of achieving greater profits and thus feel that exports should be encouraged rather than restricted.
- Government policy in many NICs such as South Korea has sought to expand exports.
- Even U.S. policy pushing foreign countries such as Japan to give U.S. firms more access to their markets.
- Why would market access be important if profits were not involved?

3 Brander and Spencer JIE 1985

- Two homogenous products: one oligopolistic and one numeraire good produced under perfect competition (so that wage equals unity).
- Two Cournot firms: One domestic firm – whose output is denoted by x , and one foreign firm – whose output is denoted by y .
- $\pi_{xy} \leq 0$ and $\pi_{yx}^* \leq 0$ (strategic substitutes), where $\pi(x, y)$ and $\pi^*(x, y)$ denotes the profit functions for the two firms.
- Firms sell output in only a third market (no domestic or foreign consumer surplus) and government in the third country is not a player (not policy active).
- One factor of production, labor L .

- Constant marginal costs c and c^* and fixed costs F and F^* .
- The domestic government chooses a subsidy s (export subsidy is equivalent to production subsidy as no domestic consumption).
- The game has two stages: policy and output.
- The domestic government sets a (specific) subsidy s per unit for the domestic firm and then firms compete in the product market (Cournot competition).
- The structure of the game implies that the domestic government can commit itself to a specific policy intervention (a level of the export tax or subsidy).
- The government cannot change its policy if it is no longer optimal once the firms have chosen their output.

- Solve for the SPNE of this game by backward induction.

- In the second stage, the subsidy s is given.

- Profit functions for the domestic and foreign firms

$$\pi(x, y) = (p - c + s)x - F$$

$$\pi^*(x, y) = (p - c)y - F^*$$

- First order conditions for the domestic and foreign firms

$$\pi_x = xp' + p - c + s = 0$$

$$\pi_y^* = yp' + p - c = 0$$

- Totally differentiate the FOCs with respect to the subsidy s

$$\begin{bmatrix} \pi_{xx} & \pi_{xy} \\ \pi_{xy}^* & \pi_{yy}^* \end{bmatrix} \begin{bmatrix} \frac{dx}{ds} \\ \frac{dy}{ds} \end{bmatrix} = \begin{bmatrix} -\pi_{xs} \\ -\pi_{ys}^* \end{bmatrix}$$

- Using the FOCs, $\pi_{xs} = 1$ and $\pi_{ys}^* = 0$ so,

$$\begin{bmatrix} \pi_{xx} & \pi_{xy} \\ \pi_{xy}^* & \pi_{yy}^* \end{bmatrix} \begin{bmatrix} \frac{dx}{ds} \\ \frac{dy}{ds} \end{bmatrix} = \begin{bmatrix} -1 \\ 0 \end{bmatrix}$$

- Applying Cramer's rule

$$\frac{dx}{ds} = - \frac{\begin{vmatrix} -1 & \pi_{xy} \\ 0 & \pi_{yy}^* \end{vmatrix}}{D} = - \frac{\pi_{yy}^*}{D} > 0$$

$$\frac{dy}{ds} = \frac{\begin{vmatrix} \pi_{xx} & -1 \\ \pi_{xy}^* & 0 \end{vmatrix}}{D} = \frac{\pi_{xy}^*}{D} < 0$$

where $D = \pi_{xx}\pi_{yy}^* - \pi_{xy}^*\pi_{xy} > 0$ is positive by the stability condition.

Proposition 4 *An increase in the domestic export subsidy s causes the output of the domestic firm x to increase and the output of the foreign firm y to decrease.*

3.1 Optimal Subsidy

- In the first stage, the domestic government chooses its export subsidy s to maximize national income (welfare)

$$W = L + \pi - sx$$

- The first term is labor income (labor supply times the wage of one), the second term is domestic profits and the third term is subsidy payments.
- This specification assumes that the government weights the profits of domestic firms and government revenue equally in evaluating domestic welfare.
- Thus, as a function of s , the objective function of the government is

$$W(s) = L + \pi(x(s), y(s); s) - sx(s)$$

- The FOC for choosing the subsidy to maximize domestic welfare is

$$\frac{dW(s)}{ds} = \underbrace{\pi_x}_{0} \frac{dx}{ds} + \pi_y \frac{dy}{ds} + \underbrace{\pi_s - x}_{0} - s \frac{dx}{ds} = 0 \quad (3)$$

- But $\pi_x = 0$ (by domestic firm's FOC) and $\pi_s = x$ (by definition of domestic profits) so that the first, third and fourth terms drop out leaving

$$\frac{dW(s)}{ds} = \pi_y \frac{dy}{ds} - s \frac{dx}{ds} = 0$$

- Evaluated at an initial point of no intervention $s = 0$, an increase in the subsidy raises domestic welfare

$$\left. \frac{dW(s)}{ds} \right|_{s=0} = \pi_y \frac{dy}{ds} > 0$$

- The above expression spells out the intuition for the export subsidy raising domestic welfare: an increase in the subsidy reduces the foreign firm's output $dy/ds < 0$ and an increase in foreign firm output decreases domestic firm profits $\pi_y < 0$, so the subsidy must raise domestic profits and thus domestic welfare.
- The optimal subsidy is found by solving the FOC (3) for

$$s^* = \frac{\pi_y \frac{dy}{ds}}{\frac{dx}{ds}} = \frac{-\pi_y \pi_{yx}^* / D}{\pi_{yy}^* / D} = \frac{-\pi_y \pi_{yx}^*}{\pi_{yy}^*} > 0$$

- Since x and y are strategic substitutes ($\pi_{yx}^* < 0$), the optimal subsidy is positive.

3.2 Criticism

- Brander and Spencer made three broad points.
 1. Under oligopoly, profits matter and should count as part of national welfare - unobjectionable.
 2. Government can alter the rules of the game and affect the strategic interaction among players - an assumption that may or may not hold.
 3. Under Cournot competition, export subsidies are the optimal policy - this point has invited most of the criticism since it is highly sensitive to assumptions such as: number of firms (Dixit 1984), nature of the strategic variable (Eaton and Grossman 1986), and general equilibrium (Dixit and Grossman 1986).
- Brander (1995) provides an excellent survey of these and other concerns.

4 Eaton and Grossman QJE 1986

- The Eaton and Grossman critique is that if firms play Bertrand instead of Cournot (pick prices rather than quantities), the optimal policy is a tax.
- Under Bertrand competition, the domestic government wants its firm to be able to commit to a higher price instead of higher output.
- A tax achieves this objective by raising the firm's marginal cost.

4.1 Output

- Let small letters denote the home country and capital letters the foreign country.
- The domestic and foreign revenue functions are $r(x, X)$ and $R(x, X)$.
- Let t denote the domestic ad valorem tax per unit of output (or subsidy if negative).
- Again, all consumption occurs in a third country so a tax on all output is a tax on exports.
- Domestic profits (after tax) and foreign profits are

$$\pi = (1 - t)r(x, X) - c(x)$$

$$\Pi = R(x, X) - C(X)$$

- Let γ and Γ denote the home and foreign firm's conjectures about how its rival responds to a change in its own output.
- Then, the FOCs for choosing x and X to maximize profits are

$$(1 - t)(r_x + \gamma r_X) - c' = 0$$

$$R_X + \Gamma R_x - C' = 0$$

where $r_x = \partial r(x, X)/\partial x$ and $r_X = \partial r(x, X)/\partial X$ are understood to be functions of the quantities x and X (and likewise for R_x and R_X).

- The solution to the foreign firm's FOC gives its reaction function $X = \Psi(x)$, foreign firm output as a function of domestic firm output.
- Let the slope of the foreign firm's reaction function be $g \equiv \Psi'(x)$, the actual response of the foreign firm to a change in the output of the domestic firm.

4.2 Policy

- Let the home welfare function be

$$\begin{aligned}w &= \pi + tr \\ &= (1 - t)r(x, X) - c(x) + tr(x, X) \\ &= r(x, X) - c(x)\end{aligned}$$

- Differentiating with respect to the tax t gives

$$\frac{dw}{dt} = (r_x - c')\frac{dx}{dt} + r_X\frac{dX}{dt}$$

- Substituting from the FOC gives

$$\frac{dw}{dt} = \left(-\gamma r_X + \frac{tc'}{1-t} \right) \frac{dx}{dt} + r_X \frac{dX}{dt}$$

- Domestic welfare is maximized when

$$\frac{dw}{dt} = \left(-\gamma r_X + \frac{tc'}{1-t} \right) \frac{dx}{dt} + r_X \frac{dX}{dt} = 0$$

or incorporating g as the slope of the foreign firm's reaction function implies the condition

$$\left(-\gamma r_X + g r_X + \frac{tc'}{1-t} \right) \frac{dx}{dt} = 0$$

$$\Leftrightarrow (g - \gamma)(-r_X) = \frac{tc'}{1-t}$$

- Since $r_X < 0$ and $c' > 0$, $g - \gamma$ on the LHS and $\frac{t}{1-t}$ on the RHS must have the same sign.
- The term $g - \gamma$ measures the difference between the actual response of X to a change in x and the home firm's conjectural variation.

- If the actual response is greater than conjectured $g > \gamma$, then a tax is required $t > 0$; if the actual response is smaller than conjectured $g < \gamma$, then a subsidy is required $t < 0$.
- Government policy allows the domestic firm to achieve the outcome it would as a Stackelberg leader (where picks output before the foreign firm).

Proposition 5 *An increase in the export tax raises domestic welfare relative to nonintervention if the domestic firm's conjecture is smaller than the foreign firm's actual response.*

4.3 Cournot

- Cournot conjectural variations zero $\gamma = \Gamma = 0$ (each assumes other will not respond to changes in output), so welfare-maximizing condition becomes (where g from totally differentiating FOCs)

$$-r_X g = \frac{tc'}{1-t}$$

$$\frac{r_X R_{21}}{R_{22} - C''} = \frac{tc'}{1-t}$$

- Sign of optimal policy determined by sign of R_{21} (rest is determined by SOC for foreign firm).
- R_{21} usually negative (it is for linear demand) so subsidy required.
- Domestic welfare gains at expense of foreign welfare (sum of profits minus subsidy lower), but world welfare higher (higher total output and lower price).

4.4 Bertrand

- What happens if firms act as Bertrand competitors?
- Let $d(p, P)$ denote the demand function facing the home firm.

- The domestic and foreign profits are

$$\pi = (1 - t)pd(p, P) - c(d(p, P))$$

$$\Pi = PD(p, P) - c(D(p, P))$$

- The domestic and foreign FOCs for profit maximization are

$$\pi_1 = (1 - t)(d + pd_1) - c'd_1 = 0$$

$$\Pi_1 = D + PD_1 - c'D_1 = 0$$

- Quantity demanded must equal quantity supplied

$$d(p(P), P) \equiv x$$

$$D(p, P(p)) \equiv X$$

- Totally differentiate the demand functions

$$\begin{bmatrix} dx \\ dX \end{bmatrix} = \begin{bmatrix} d_1 & d_2 \\ d_1 & D_2 \end{bmatrix} \begin{bmatrix} dp \\ dP \end{bmatrix}$$

- Using FOC, can write down the actual response of foreign sales to domestic sales

$$g = \frac{dX/dp}{dx/dp} = \frac{D_1 - D_2 \frac{\Pi_{21}}{\Pi_{22}}}{d_1 - d_2 \frac{\Pi_{21}}{\Pi_{22}}}$$

whereas the Bertrand conjecture is that

$$\gamma = \left. \frac{dX/dp}{dx/dp} \right|_{dP=0} = \frac{D_1}{d_1}$$

- We can show using the stability conditions that $g - \gamma$ is positive iff Π_{21} (foreign firm responds to a price cut by cutting its price).
- Thus, sign t^* is the same as the sign of Π_{21} , which is positive when the products are substitutes and returns to scale are non-increasing, so a tax would be required.

Proposition 6 *When the home firm's conjectures are 1) consistent, free trade is best; 2) Bertrand, export tax is best; 3) Cournot, export subsidy is best.*

4.5 Complications

- The direction of the optimal policies is robust to foreign policy response.
- What if the number of firms is greater than two (a multifirm oligopoly)?
- Assume symmetric countries except for that the number of firms at home equal n and m abroad.
- Further assume consistent conjectures to isolate the role of the number of firms.
- The optimal policy is a tax when the number of home firms exceeds one $n > 1$.
- This result is the usual terms of trade argument – want to increase the price of your exports.

- By taxing the firms, you lower sales abroad, increase price and transfer foreign consumer surplus to the domestic economy.
- With entry, profit shifting benefits can be dissipated by increased entry costs or enhanced by foreign exit and domestic entry.
- With domestic consumption (and consistent conjectures), increasing marginal costs for the foreign firm give rise to export subsidy being optimal.

5 Dixit and Grossman JIE 1986

- Dixit and Grossman argue that in reality there are many oligopolistic industries that can potentially be targeted for export subsidies.
- They show that if these any industries use a common factor that is available in fixed supply, optimal policy cannot be determined in partial equilibrium (one industry at a time).
- An export subsidy to one industry bids up the factor price and essentially discourages the other industries.
- Hence the government would need detailed information on which industries would most benefit from receiving export subsidies.
- Two countries: home and foreign

- $n > 1$ symmetric high-tech industries - output $y_i = y$ - and one low-tech industry - output x
- Two factors: workers and scientists (skilled labor), each in fixed supply: l and k (foreign country does not face resource constraint for simplicity)
- CRS technology: one unit of scientists and a units of workers produces one unit of any high-tech good; one unit of workers produces one unit of low-tech good
- each high-tech industry is a Cournot duopoly with one domestic and one foreign firm, low-tech industry has perfect competition
- All consumption of high-tech goods occurs in a third country.

- Normalize the price of the low-tech good to one, which then implies that the wage for workers is one (value of the marginal product of workers).
- The cost of producing one unit of a high-tech good is $c = a + z$ where z is the wage for scientists.
- Firms take the scientific wage z as given.

5.1 Resource Constraints

- The demand for workers must equal supply

$$x + any = l$$

and the demand for scientists must equal supply

$$ny = k$$

- The two resource constraints imply that output of the numeraire good is determined by the residual supply of workers after producing the high-tech goods

$$x + ak = l \rightarrow x = l - ak$$

(the numeraire good and the workers play no key role in the symmetric model).

- The second resource constraint implies output of each high tech good equals the number of scientists per industry

$$y = \frac{k}{n}$$

5.2 High-Tech Output

- Consider a symmetric export subsidy for all high-tech industries.
- Let s be the subsidy per unit of domestic production.
- Let $r(y, Y)$ be the revenue function for a home firm.
- Profits for a home firm are thus

$$\pi = r(y, Y) - [a + z - s]y$$

- The first order condition for the domestic firm choosing y to maximize its profits equates marginal revenue to marginal cost (net of the subsidy)

$$r_y(y, Y) = a + z - s$$

- Profits for a foreign firm are

$$\Pi = R(y, Y) - CY$$

and the foreign firm's FOC also equates marginal revenue to marginal cost

$$R_Y(y, Y) = C$$

- The foreign FOC gives the foreign firm's reaction function

$$Y = B(y)$$

- The equilibrium is the output of domestic and foreign firms, scientific wage, and output of the numeraire good $\{y, Y, z, x\}$ that solve the two resource constraints and the two FOCs.
- In the symmetric case, the two resource constraints pin down y and x , so the FOCs determine Y and z .

- Since the output of each domestic firm y is determined exclusively by resource availability, the subsidy fails to shift profits toward domestic firms.
- All that happens is the scientific wage z rises by the amount of the subsidy.
- Hence, the domestic firm's costs net of the subsidy $z + a - s$ is unchanged and Y is unchanged.
- To be effective, any export subsidy must be asymmetric - to target some industries but not others.
- But to implement an asymmetric subsidy scheme, the government needs information on which industries to favor over others.

5.3 Optimal Policy

- Define domestic welfare as the sum of factor earnings and profits minus subsidy payments which is equivalent to consumption of the numeraire good plus total revenue from the high-tech sector.

$$w = l + zk + n\pi - nsy$$

$$\rightarrow w = l + zk + n(\pi - sy)$$

$$\rightarrow w = l + zk + n(r - [a + z - s]y - sy)$$

$$\rightarrow w = l + zk + n(r - ay - zy)$$

$$\rightarrow w = l - any + zk - nz\frac{k}{n} + nr$$

$$\rightarrow w = x + nr$$

- Any subsidy level yields the same x , y , Y , and $z - s$, so export subsidies fail to raise domestic welfare as they fail to shift profits towards domestic firms (for symmetric industries).

- When oligopolistic industries all use a factor available in fixed supply, the export promotion property of export subsidies hinges on the ability to target subsidies to the industries with the greatest profit shifting potential.
- However, the government is apt to lack the information needed to determine which industries have the greatest profit shifting potential, so export promotion is apt to fail as a method of raising domestic welfare.