Module 3: "Dynamic games of complete information"

Lecture 20: "Dynamic Game: Tariffs and imperfect international competition"

The Lecture Contains:

Tariffs and imperfect international competition

- Two identical countries, $i = 1,2$
- Total quantity in market in country $i = Q_i$
- Market clearing price is $P_i(Q_i) = a - Q_i$
- Firm in country i(firm i) produces h_i for home consumption and e_i for export i.e. $Q_i = h_i + e_j$
- Cost of production for firm i: $C_i(h_i, e_i) = \mathbf{c}\,(h_i + e_i)$, c= marginal cost of production
- Tariff costs- if firm i exports e_i to country j (where Govt. j has set the tariff rate t_j) then firm i must pay $t_j e_i$ to Govt.j

Previous Next

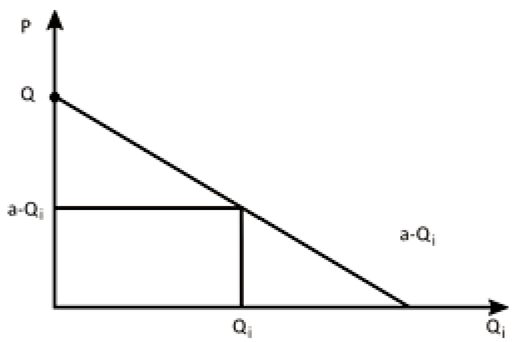
Module 3: "Dynamic games of complete information"

Lecture 20: "Dynamic Game: Tariffs and imperfect international competition"

Timing of the game and payoffs

- In the first stage, the governments simultaneously choose tariff rates, t_1 & t_2
- In the second stage, the firm observe the tariff rates & simultaneously chooses quantities for home consumption and for export (h_1, e_1) and (h_2, e_2)
- Payoffs
  - payoff to firm i is given by
    $\pi_i(t_i, t_j, h_i, e_i, h_j, e_j)$
    $= [a-(h_i+e_j)]h_i + [a-(e_i+h_j)]e_i - c(h_i+e_i) - t_j e_i$
- Payoff to government
  - total welfare to government i
    - Sum of aggregate consumer surplus in country i_j profits earned by firm i and tariff revenue collected by government i from firm j
- Given $P_i(Q_i) - a - Q_i$

  aggregate consumer surplus = $\frac{1}{2}Q_i^2$



Government's payoff is given by

$W_i(t_i, t_j, h_i, e_i, h_j, e_j) = \frac{1}{2}Q_i^2 + \pi_i(t_i, t_j, h_i, e_i, h_j, e_j) + t_i e_j$

Previous Next

Solution: Solving the game by backward induction

- Start from stage 2
  - Governments have already chosen the tariff rates t_1 *and* t_2.
  - Simultaneous game between firm 1 and firm 2 is played in stage 2
  - Nash Equilibrium $\Rightarrow (h_1^*, e_1^*, h_2^*, e_2^*)$
- For each i (h_i^*, e_i^*) solves the following problem:

$$\underset{h_i, e_i \geq 0}{Max} \quad \pi_i(t_i, t_j, h_i, e_i, h_j^*, e_j^*) \text{ ---------- (1)}$$

- Note $\pi_i(t_i, t_j, h_i, e_i, h_j^*, e_j^*)$ = Firm $i's$ (Function of h_i & e_i^* only) profit in market i + Firm $i's$ (Function of $e_i, h_j^* \& t_j$) profit in market j
- Problem 1 is equivalent to solving the following pair of problems, one for each market
  - h_i^* solves $\quad \underset{h_i \geq 0}{Max} \quad h_i[a - (h_i + e_j^*) - c]$
  - e_i^* solves $\quad \underset{e_i \geq 0}{Max} \quad e_i[a - (e_i + h_j^* - c)] - t_j e_i$
- $h_i^* = \frac{1}{2}(a - e_j^* - c)_{i=1,2}$ assuming $e_j^* \leq a - c$
- $e_i^* = \frac{1}{2}(a - h_j^* - c - t_j)_{i=1,2}$ assuming $h_j^* \leq a - c - t_j$
- Four equations in four unknowns
  - $[h_1^*, e_1^*, h_2^*, e_2^*]$
- Solution of the 2nd stage game

$$h_i^* = \frac{a - c - t_i}{3}, e_i^* = \frac{a - c - 2t_j}{3}, i = 1,2$$

Previous Next

Module 3: "Dynamic games of complete information"

Lecture 20: "Dynamic Game: Tariffs and imperfect international competition"

Solving the game by backward induction [Contd...]

- Now by proceeding backwards, the first stage game will be solved.
- The government simultaneously choose tariff rates t_1 and t_2
- Payoffs are given by $W_i\left(\mathrm{t_i}, \mathrm{t_j}, h_i^*, e_i^*, h_2^*, e_2^*\right)$

  for government $i = 1,2$
- h_i^*, e_i^* are already solved from second stage as functions of $t_i \; and \; t_j$
- Therefore payoffs in first stage are given by $W'_i\,(t_i, t_j)$
- If (t_1^*, t_2^*) is a Nash Equilibrium in the first stage, then for each i, t_i^* must solve

  $$\underset{t_i \geq 0}{Max} \quad w_i'\left(t_i, t_j^*\right)$$
- Solving the problem, one gets

  $t_i^* = \dfrac{a-c}{3}, \qquad i = 1,2$
- Substituting $t_i^* = t_j^* = \dfrac{a-c}{3}$ into h_i^* & e_i^* , one gets $h_i^* = \dfrac{4\,(a-c)}{9} \quad e_i^* = \dfrac{a-c}{9}$
- Sub game - perfect outcome of this tariff game: $t_1^* = t_2^* = \dfrac{a-c}{3}$,

  $h_1^* = h_2^* = \dfrac{4(a-c)}{9}, \;\; e_1^* = e_2^* = \dfrac{(a-c)}{9}$
- Note if governments had chosen $t_1^* = t_2^* = 0$, then aggregate quantity $= \dfrac{2(a-c)}{3}$

  (just as in Cournot model)
- Consumer's surplus - much lower in this case then in the case when government chooses zero tariff rate.

Previous Next