



**::Solutions::**

Problem Set #5: Due end of class December 7, 2017.  
[Updated 11/30/2017]

*You may discuss this problem set with your classmates, but everything you turn in must be your own work.  
Please read the “problem set guidelines” on the course web page before beginning.*

1. The United States taxes U.S. firms on a residence basis. Canada taxes U.S. firms on a source basis. The U.S. corporate tax rate is 40 percent and the Canadian corporate tax rate is 26 percent. Monsanto, a U.S. multinational corporation, earned \$500 in the U.S. market and \$100 in the Canadian market.

- a. Suppose the United States did not offer foreign tax credits. How much tax does Monsanto owe the U.S. government? How much tax does it owe the Canadian government? Compute Monsanto’s total tax rate (the total tax rate is  $\tau = (T^H + T^F)/(\pi^H + \pi^F)$ ).

$$T^H = 0.40 (500 + 100) = 240$$

$$T^F = 0.26 (100) = 26$$

$$\tau = (26 + 240)/600 = 0.44$$

- b. Assume the U.S. government offers foreign tax credits to Monsanto. How much tax does Monsanto owe the U.S. government? How much tax does it owe the Canadian government? Compute Monsanto’s total tax rate

The foreign tax remains unchanged.

$$T^F = 0.26 (100) = 26$$

The U.S. tax credit is  $C = \tau^F \pi^F = 0.26 (100) = 26$ ; the U.S. tax is

$$T^H = 0.40 (500 + 100) - 26 = 214$$

Monsanto’s total tax rate is

$$\tau = (214 + 26)/600 = 0.40.$$

- c. How do Monsanto’s incentives to invest in other countries differ across the tax systems in parts a. and b.?

Without the foreign tax credit (part a.), Monsanto is taxed twice on its foreign income: once by the Canadian government and once by the U.S. government. The higher tax rate on foreign income provides a disincentive for Monsanto to invest abroad. When the government offers foreign tax credits (part b.), the tax rate on foreign income is the same as the tax rate on domestic income, eliminating the disincentive.

2. Consider a final good firm that owns the final good technology  $q = Am^\alpha$ . The final good sells for price  $p$ . If the final good firm chooses to make the intermediate good  $m$ , it pays a fixed cost  $f^I$  and it costs  $p_m\gamma$  per unit. A specialized supplier can produce the intermediate good for price  $p_m$  per unit.
- a. The intermediate good can only be used by the final good firm. It has no value to an outside company. It is also very difficult for someone outside of the relationship to judge the quality of the intermediate good. How do these two properties of the intermediate good lead to the possibility that the final good firm can “hold up” the intermediate good firm?

Since an outside party, like a court, cannot judge the intermediate good, the final good firm has an incentive to claim that the intermediate good produced is not as expected. The final good firm will demand a lower price for the not-quite-right goods. If the court cannot judge the goods, it cannot determine if an agreement has been broken.

Since the goods are specific to the final good firm technology, the intermediate supplier cannot sell them to someone else. The choice is to accept the lower price, or lose its investment in the goods it has produced.

- b. If  $\alpha = 0.8$ ,  $A = 1.5$ ,  $p_m = 1$ ,  $p = 2$ ,  $\beta = 0.5$ ,  $\gamma = 1.25$ , and  $f^I = 0.4$ , what are the profits of the final good firm if it produces the intermediate good in-house?

$$m^I = 26.09, q = 20.38$$

$$\pi_F = 2 * 20.38 - 1.25 * 1 * 26.09 - 0.4 = 7.75$$

- c. If  $\alpha = 0.8$ ,  $A = 1.5$ ,  $p_m = 1$ ,  $p = 2$ ,  $\beta = 0.5$ ,  $\gamma = 1.25$ , and  $f^I = 0.4$ , what are the profits of the final good firm if it outsources to the supplier firm and the two firms bargain after production of the intermediate good? Assume that the supplier has bargaining power  $\beta$  and the final good firm has bargaining power  $1 - \beta$ .

$$m^B = 2.49, q^B = 3.11$$

$$\pi_F^B = (1 - 0.5) * 2 * 3.11 = 3.11$$

- d. Should the final good firm produce the final good itself, or purchase it from a supplier? Why?

The firm should produce the good itself. This is an example of a situation where the hold up problem causes a big enough problem with incentives that it is best to own the intermediate supplier.

3. Consider the licensing model that we developed in class. The license agreement has the supplier pay  $L_t$  and  $L_{t+1}$  to the firm in order to use the firm's technology. If the supplier creates one unit of the intermediate good at cost  $p_m$ , the technology generates revenue  $R$ . In the second period the supplier can defect from the license agreement and produce on its own. If it does so,  $L_{t+1} = 0$ , but the supplier must pay  $f^S$  to maintain the technology.
- a. Assume  $R = 6$ ,  $p_m = 1$ ,  $f^S = 1.3$ , and the supplier's discount rate is  $r^S = 0.04$ . What is  $L_{t+1}$ ? Why?

$L_{t+1} = 1.3$ . Any license payment larger than  $f^S$  will incentivize the supplier to leave the contract, since it would provide more profit to pay  $f^S$ . The final good firm wants the largest payment that keeps the licensee in the contract, so it charges exactly  $f^S$ .

- b. Assume  $R = 6$ ,  $p_m = 1$ ,  $f^S = 1.3$ , and the supplier's interest rate is  $r^S = 0.04$ . If there are a large number of potential licensees, the final good firm can drive the first license payment  $L_t$  up to the point that the licensee breaks even,  $\pi_S = 0$ . What is  $L_t$ ?

$$L_t = (6 - 1) + \frac{6 - 1 - 1.3}{1.04} = 8.56$$

- c. Explain why  $L_t > L_{t+1}$ .

The contract has a decreasing schedule of payments because the licensee has an increasing incentive to leave the agreement.

The license agreement has a smaller payment in the future to keep the licensee in the contract. In the second period the licensee has learned how to use the technology — the value of leaving has increased, so the payment has to decrease.

In the first period, the licensee earns nothing if it leaves the contract, so the licensor can ask for a larger fee.

**True/False-Explain.** Respond to the following statements by *explaining why they are true or false*. No partial credit will be awarded for stating TRUE or FALSE without explanation.

4. Transfer pricing takes place when a multinational firm moves its intellectual property assets to a low-tax country. This allows the firm to pay less tax.

FALSE. Transfer pricing takes place when a firm moves goods (or services) between units of the firm located in different countries. Since these are not market transactions, the firm needs to compute a (justifiable) price at which to value the goods.

5. In the ex post bargaining scenario of the hold-up model we developed in class, the parameter

$\beta$  represents the bargaining power of the supplier. The final good firm earns the most profit when  $\beta$  is very close to zero and the supplier has little bargaining power.

FALSE. When  $\beta$  is close to zero, the supplier firm's incentives are extremely distorted. The supplier firm produces almost nothing, and production of the final good is also almost nothing. The final good firm gets almost all of the revenue, but the revenue is tiny.

At an intermediate value of  $\beta$ , the supplier firm will produce more  $m$ , which will generate more revenue. As long as  $\beta$  is not too big, the final good firm will receive a large enough share of the revenue to make profit larger than in a situation with  $\beta \approx 0$ .

**Bonus question!**

6. Log on to Canvas and complete the Student Rating of Teaching Effectiveness (SRTE). You will (or already have) receive an email with a reminder and a link to the SRTE website as well. I think the link is <https://rateteaching.psu.edu>. The SRTE is one of the ways that the University evaluates my performance, and I use your responses to improve my teaching. Thank you for SRTEing!