

## Problem 1

Consider the following financial information that a regulator would have to use when regulating a natural monopoly.

- (a) A firm's equity has  $\beta = 3$  and the S&P 500 market rate is  $r_m = 4\%$ . What is the firm's cost of equity? Assume the risk-free rate is zero.

**Solution.** The cost of equity refers to the fact that a firm has to continually invest (i.e. spend) in order to keep the company growing so that stock holders remain happy. Since those funds could have been spent on something else (e.g. giving everyone a bonus), it is therefore an opportunity cost for the firm. Most important conceptually though is that stock holders have to remain happy with their rate of return.

When the risk-free rate is zero, the cost of equity is given by  $r_e = \beta \times r_m$ , in this case  $r_e = 3 \times 4 = 12\%$ . Intuitively,  $\beta = 3$  means that this firm's equity has a rate of return three times more volatile than the average market rate of return: when the average market stock price goes up (or down) by 1 percentage point, then the firm's stock price goes up (or down) by 3 percentage points. Because the firm's equity rate of return is more volatile – that is, riskier – than the market average, the firm has to offer its equity holders a higher return than the market average as compensation for that risk. In other words, it is expensive for this firm to raise capital through equity relative to the market average.

- (b) The firm is financed by 40% equity and 60% debt. There are two forms of debt. First, the firm has 2,000 debt with a rate of 7%. Second, the firm has 3,000 debt with a rate of 12%. The marginal tax rate is 30%. What is the firm's cost of capital?

**Solution.** The cost of debt refers to the fact that a firm has to pay back interest on any funds it borrows. Those who lend money to the firm expect a certain rate of return for having lent money.

The pre-tax weighted average interest rate for debt is

$$\frac{2,000}{5,000}(7\%) + \frac{3,000}{5,000}(12\%) = 10\%,$$

but interest payments are tax deductible, so the after-tax cost of debt is going to be a lower number, specifically  $r_d = 10\%(1 - 0.30) = 7\%$ .

We know that the cost of equity is  $r_e = 12\%$  from the previous problem. Therefore the weighted average cost of capital is  $WACC = 0.40(12\%) + 0.60(7\%) = 9\%$ .

- (c) The firm has operational costs of 5,000 and a rate base of 20,000. Given your answer to the previous question, what should the regulator allow for required revenue?

**Solution.** First, recall that the *rate base* is the capital (e.g. machines, factories, computers, etc) used to produce the good or service. It is funded by investors and must be “used and useful” to be considered part of the rate base.

Second, recall that *required revenue* is just enough revenue so that a natural monopoly can 1) cover its operational expenses, and 2) generate profit “at a level that is adequate to enable the utility to attract investors to finance the replacement and expansion of its facilities so it can fulfill its public utility service obligation.” Required revenue is the amount that ensures a natural monopoly earns “normal” economic profit, i.e. zero economic profit. Any more and they’re earning positive profit and therefore benefiting from their market power; any less and they are unable to remain economically profitable.

We have  $RR = 5,000 + (0.09)20,000$ , which gives  $RR = 6,800$ . This number allows the natural monopoly to cover its operational costs (which yields zero accounting profit) as well as to replace depreciated capital and fund investments (which yields positive accounting profit), but no more. Regulators set the rate of return (here at 9%) to ensure the required revenue is earned.

- (d) The industry suddenly becomes riskier. Do you expect the firm’s required revenue to increase or decrease?

**Solution.** When the industry becomes riskier, the regulator allows for a higher rate of return as compensation for that additional risk. This implies a higher required revenue for the firm. For example, the firm will have to issue debt at a higher interest rate, which increases the firm’s cost of capital.

## Problem 2

Consider a monopolistic firm that manufactures frozen pizza (the upstream firm), and a monopolistic grocery store that sells the frozen pizzas to consumers (the downstream firm). The grocery store faces an inverse demand curve of  $P_D = 200 - Q$  from consumers. The marginal cost of manufacturing one pizza is  $MC = 40$ .

- (a) If the two firms are separate, find the quantity of frozen pizza produced, the price charged by the pizza manufacturer, and the price charged by the grocery store.

**Solution.** Start with the grocery store, since we know its inverse demand curve.

$$TR_D = (200 - Q)Q = 200Q - Q^2 \quad \implies \quad MR_D = 200 - 2Q.$$

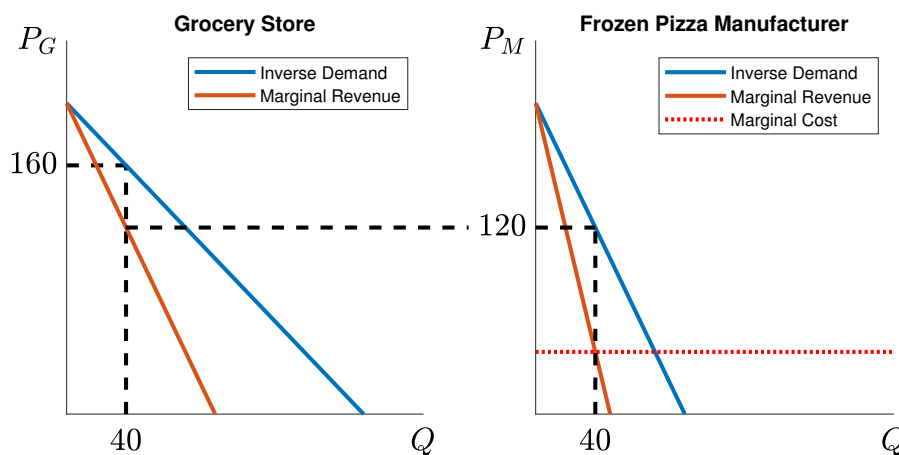
To maximize profit, it sets  $MR_D$  equal to its marginal cost. The first key insight is that the marginal cost of a frozen pizza for the grocery store is the price it pays to obtain a frozen pizza from the frozen pizza manufacturer,  $P_U$ . Therefore the profit maximizing condition is  $P_U = 200 - 2Q$ . The second key insight is that the preceding condition is the inverse demand curve for the upstream firm.

Now we can complete the upstream firm. It has total revenue of

$$\begin{aligned} TR_U &= (200 - 2Q)Q = 200Q - 2Q^2 \implies MR_U = 200 - 4Q := 40 \\ &\implies Q^* = 40, P_U^* = 120. \end{aligned}$$

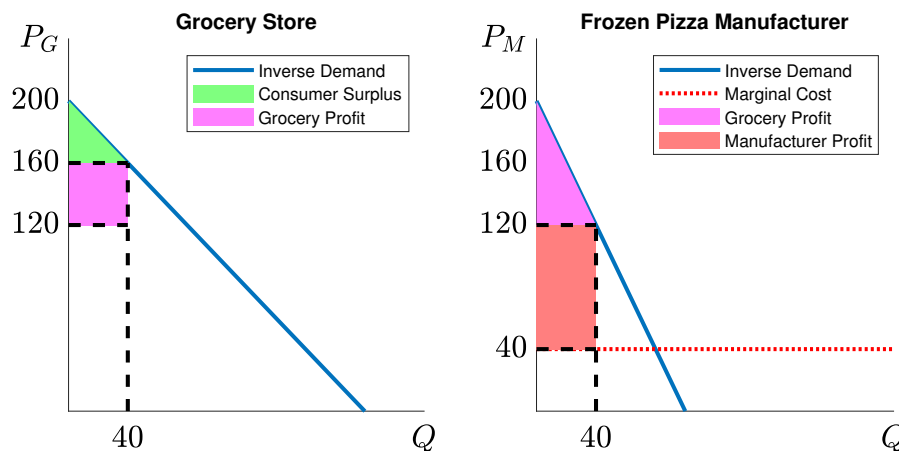
Notice that that pizza manufacturer sets its price 120 above its marginal cost of 40. This is one source of *marginalization*.

And now we can complete the downstream firm. The grocery store buys  $Q^* = 40$  frozen pizzas from the pizza manufacturer and sells them to the consumers at a downstream price of  $P_D^* = 200 - 40 = 160$ . Now notice that the grocery store sets its price 160 above its marginal cost of 120. This is the second source of marginalization. Point is, market power is being exercised in two separate points in the supply chain. That sounds bad for consumers, oui?



- (b) Pre-merger, calculate consumer surplus, producer surplus, and total welfare.

**Solution.** Visually the welfare components are as shown below.



The calculations are

$$\begin{aligned}
 CS &= 0.5(200 - 160)(40) = 800, \\
 PS_D &= (160 - 120)(40) = 1600, \\
 PS_U &= (120 - 40)(40) = 3200, \\
 TW &= CS + PS = 5600.
 \end{aligned}$$

- (c) If the two firms merge, find the quantity of frozen pizza produced, the price charged by the pizza manufacturer, and the price charged by the grocery store.

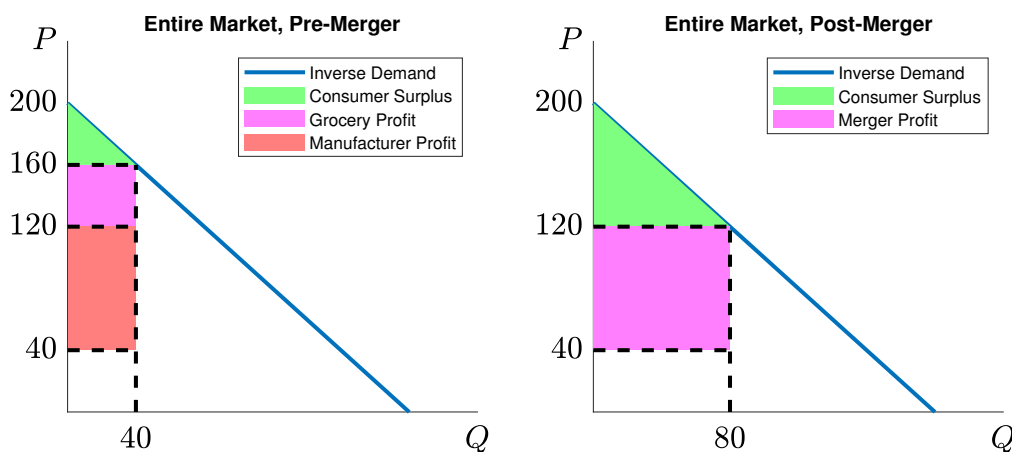
**Solution.** Now we just have a single firm facing the demand curve  $P = 200 - Q$ . Total revenue is

$$\begin{aligned}
 TR &= (200 - Q)Q = 200Q - Q^2 \implies MR = 200 - 2Q := 40 \\
 &\implies Q^* = 80, P^* = 120.
 \end{aligned}$$

After merging, the final price is lower and the quantity is higher. This is because now there is only one source of marginalization, since there is only one firm setting price above marginal cost. Sounds good for consumers, oui? But what about producers?

- (d) Post-merger, calculate consumer surplus, producer surplus, and total welfare.

**Solution.** Consider the two graphs below. The graph on the left shows welfare for the entire market pre-merger—basically part (b) consolidated into a single graph—whereas the graph on the right shows welfare for the entire market post-merger. It is clear that deadweight loss is smaller post-merger, consumer surplus is larger, and producer surplus is larger. Let's verify the former two.



The calculations are

$$CS = 0.5(200 - 120)(80) = 3200,$$

$$PS = (120 - 40)(80) = 6400,$$

$$TW = CS + PS = 9600.$$

Not only has consumer surplus increased, but producer surplus has also increased. A vertical merger of two monopolies therefore makes everyone better off by reducing double marginalization.

### Problem 3

Determine whether the following statements are true or false and explain why.

- (a) An upstream firm and downstream firm should be most likely to merge when each firms' investments only benefit itself.

**False.** Suppose Firm A undertakes a costly investment that benefits both Firm A and Firm B. Firm A is therefore only receiving *part* of the benefit that it is paying for *fully*, which mitigates the extent to which Firm A might invest. But if the firms merge, then the new merged firm fully benefits from the investment that it is paying for (i.e. it is a *residual claimant*), so it is more likely to invest heavily; this creates an incentive for the firms to merge.

- (b) If SANTOS and SAGASCO merged, then joint ownership of the Moomba processing plant would create a double marginalization problem.

**False.** First, we just showed that double marginalization is *solved* by joint ownership, not created by joint ownership.

Second, the big issue with the Moomba merger is that the Moomba processing plant is an *essential facility*: any firm must go through Moomba in order to reach the market, and therefore it forms a bottleneck in the market. The case packet says,

One possibility was a problem called vertical foreclosure: that other upstream companies might be denied access or sales to downstream customers or facilities. Other production companies might lose the opportunity of selling gas to SAGASCO's distribution company, for example, or might be dependent on the Moomba processing facility that the merged companies would control (pp. 7-8).

In other words, if the Moomba facility was owned and controlled by a single firm, but any firm must go through Moomba in order to reach the market... then it's pretty easy for the Moomba firm to just deny access to other firms, thereby killing off their competitors' business entirely.

- (c) A firm with positive accounting profits will always have positive economic profits.

**False.** Zero economic profit means the firm would do no better or worse by doing something else: it revolves around opportunity cost, not just how much money they make.

Suppose we live in the best of all possible worlds and there are only two markets: a market for donuts and a market for brownies. Donut firms generate accounting profit of \$500 and brownie firms generate accounting profit of \$400. Therefore both generate positive accounting profit. But brownie firms would do better by becoming a donut firm instead; therefore brownie firms have negative economic profit. And donut firms would do worse by becoming a brownie firm instead; therefore donut firms have positive economic profit. So brownie firms would become donut firms until the two types of firms earned the same accounting profit, thereby implying zero economic profit in equilibrium.

- (d) Two firms are regulated as natural monopolies. The capital asset pricing model implies that a regulator should ensure that a firm in a “risky” industry should earn higher economic profits than a firm in a “safe” industry.

**False.** The regulator should set both firms’ economics profit to zero. This requires that the regulator allow the “risky” firm to earn higher *accounting profit* than the “safe” firm (via higher required revenue) in order to accommodate the higher cost of capital the “risky” firm faces (e.g. risky firms have to pay a higher rate of interest to borrow).