MANAGERIAL ECONOMICS

Corrado Pasquali

UNITE

Firms with Market Power

Introduction

- ⇒ Consider a domestic steel manufacturing firm: the only manufacturer of steel in the country.
- ⇒ It produces and sells steel at $680 per ton, well above the world price of $375 per ton.
- ⇒ This firm is protected against foreign competition by incredibly high tariffs that effectively barred all imports.
- ⇒ There is no possibility that these tariffs would be dropped; our firm contributes heavily to both major political parties as well as several smaller parties.

Introduction

- ⇒ This firm never exported steel: Why export at \$375 per ton, when they sell steel at \$680 per ton domestically?
- ⇒ And, to clinch the argument that there was no reason to export steel, executives at the company noted that the average cost of manufacturing steel, which varied with the rate at which the firm produced steel, was at the time at \$405 and would never be below \$400 per ton.
- ⇒ This company simply could not make positive profits selling steel for \$375 per ton.
- ⇒ Notwithstanding everything just said, this firm could have increased profits by exporting steel. **Why?**

We will try and answer this question.

The simplest model of a profit maximizing firm

⇒ Imagine a firm that produces a single good for sale.

⇒ It has the power to vary its rate or level of production; we'll use the variable x to represent its production (output) level.

⇒ Corresponding to each x is a total cost to the firm of producing x, given by the function $TC(x)$.

The simplest model of a profit maximizing firm

- ⇒ This firm sells its output in some market.
- ⇒ Depending on what price it sets for its output, the amount it can sell changes: The higher the price it sets, the less it can sell.
- ⇒ We model this by using the variable p to denote the price the firm sets.
- ⇒ Then the demand function it faces, $D(p)$, tells the firm how many units of its product it can sell as a function of its price p.

Mkt power or competition?

- $\Rightarrow$ A firm that is not perfectly competitive has some wiggle room in the price it charges, with the relationship between price set and amount that can be sold given by the demand function $D(p)$.
- $\Rightarrow$ We say that a firm in this situation has market power.
- $\Rightarrow$ The amount of market power depends, in general, on how unique is its product, how important the product is to its customers, and how much competition it faces, all of which in this model is encapsulated in the demand function $D(p)$.

The Firm Chooses Its Price and Quantity to Maximize Its Profit

- ⇒ The simple model of a firm with market power, then, describes the firm by its total-cost function $TC(x)$ and the demand function $D(p)$ that it faces.
- ⇒ And the model concludes with how the firm chooses the price p it charges and, therefore, the amount $x = D(p)$ it produces and sells.
- ⇒ So: The firm chooses p and $x = D(p)$ to maximize its profit, where its profit is the difference between its total revenue from sales and its total cost of production.

Inverse Demand and Total Revenue

- $\Rightarrow$ Once we accept this model, if we know demand D and total cost TC, we can, in principle, discover the price the firm will choose.
- $\Rightarrow$ If the firm chooses price p , it sells $D(p)$ units, so its total revenue is $p \cdot D(p)$.
- $\Rightarrow$ The total cost of producing $D(p)$ is $TC(D(p))$. So the firm will choose p to maximize:

$$p \cdot D(p) - TC(D(p)) \tag{1}$$

Inverse Demand and Total Revenue

However, rather than looking at the problem as one of picking p, economists typically make the quantity produced x the driving variable.

- ⇒ To do so, we must turn the demand function "inside out".
- ⇒ Suppose we consider: $D(p) = 100 - 2p$
- ⇒ We ask: What price must be set by the firm, so that it can sell $x = 20$?
- ⇒ We're looking for the p that satisfies $D(p) = 20$, or $100 - 2p = 20$, or $p = 40$.
- ⇒ You can invert the relationship: $x = 100 - 2p$ to get:

$$p = \frac{100 - x}{2} \tag{2}$$

which allows you to put in any value of x and get p.

Inverse Demand and Total Revenue

We write this inverse of the demand function or, for short, inverse-demand function, as $P(x)$.

For this example, where demand is $D(p) = 100 - 2p$, inverse demand is $P(x) = (100 - x)/2$.

⇒ Then, if we have the inverse-demand function $P(x)$, we can write total revenue as a function of the production level x as $TR(x) = x \cdot P(x)$, and profit as a function of production level x as:

$$\pi(x) = TR(x) - TC(x) = x \cdot P(x) - TC(x) \tag{3}$$

Inverse Demand and Total Revenue

Taking the last mathematical step, we find the value of x that maximizes $\pi(x)$ by taking the derivative of $\pi(x)$ and setting it equal to zero.

And since $(x) = TR(x) - TC(x)$, this amounts to: (next ...)

Inverse Demand and Total Revenue

- ⇒ Take the derivative of the total-revenue function as a function of x , which economists call the marginal-revenue function, written $MR(x)$.
- ⇒ Take the derivative of the total-cost function as a function of x, which economists call the marginal-cost function, $MC(x)$.
- ⇒ The derivative of the profit function is the difference $MR(x) - MC(x)$, so the derivative of the profit function is zero, which is where profit is maximized, where $MR(x) - MC(x) = 0$, which is where $MR(x) = MC(x)$, or where marginal cost equals marginal revenue.

. . . which is quite a mouthful . . . . So, let's see an example.

Inverse Demand and Total Revenue

Imagine a firm with a total-cost function $TC(x) = 10 + 5x + x^2/4$, that faces demand function $D(p) = 100 - 2p$. What price and quantity pair maximizes its profit?

Inverse Demand and Total Revenue

- Turn demand $D(p)$ into inverse demand $P(x)$. We've already done this. It is $P(x) = (100 - x)/2$.

- Using inverse demand, compute the total - and marginal - revenue functions. Total revenue is $TR(x) = x \cdot P(x) = x(100 - x)/2 = (100x - x^2)/2 = 50x - x^2/2$, and marginal revenue is the derivative of this, or $MR(x) = 50x$.

- Find marginal cost by taking the derivative of total cost. Total cost is $TC(x) = 10 + 5x + x^2/4$, so marginal cost is $MC(x) = 5 + 2x/4 = 5 + x/2$.

- Equate marginal cost and marginal revenue, to find the profit-maximizing level of production. $MC = MR$ is

$$5 + \frac{x}{2} = 50 - x \text{ or } x = 30.$$

- Plug this value of x into inverse demand to find the optimal price to charge: $p = (100 - 30)/2 = 35$. Done.

Think Like an Economist: Think Margins!

What does MC = MR mean, intuitively? Begin with an analogy:

- ⇒ Imagine yourself standing on a hill in a dense fog. You cannot see more than one step in any direction. The question is, Are you on top of the hill?
- ⇒ You cannot tell for sure that you are on top, but you sometimes can tell that you are not. Ask yourself, Does the hill slope up on the margin in any direction? Can you get higher with a small step in any direction? When the answer is yes, then you aren't on top of the hill.

Local peaks, global peaks

- ⇒ This test can tell you only that you are not on top of the hill. It cannot assure you that you are on top.
- ⇒ On the surface of the Earth, Mount Everest is a global peak, while Mont Blanc is just a very impressive local peak.
- ⇒ If you were standing atop Mont Blanc and you ran the test Can I get higher in a single step? you would conclude that you could not. But that does not mean that you had reached the top of the highest mountain on Earth.

Local peaks, global peaks

- ⇒ This test of local maximization is, in part, why marginal is one of the most useful words in economics.
- ⇒ In economic models, we assume that entities - firms and consumers - purposefully strive to make themselves as well off as possible.
- ⇒ We model this purposeful behavior as the act of maximizing some numerical function of “well-offness.”
- ⇒ In the spirit of the top-of-the-hill test, we constantly ask whether the entities involved can improve their situation by making a small - marginal - change in their activities.
- ⇒ They haven’t maximized their situation until they have exhausted all possible marginal improvements.

Margins! Margins! Margins!

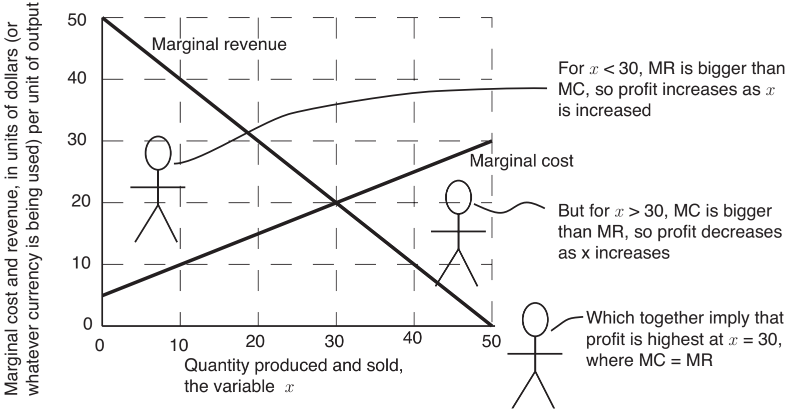
⇒ MC, or marginal cost, is the rate at which your total costs will increase per unit increase in your production level x. If you are at production level x and you move up to, say, $x + 0.1$ units, the change in your total costs will be $TC(x + 0.1) - TC(x)$ which is, approximately, $0.1 \cdot MC(x)$. And, $MC(x)$ is the rate at which total costs decline per unit decrease in production level.

Margins! Margins! Margins!

⇒ MR is the rate at which your total revenues will increase per unit increase in x, and it is the rate at which your total revenues will decrease per unit decrease in x.

Margins! Margins! Margins!

- ⇒ So suppose that, at your current level of production x, marginal revenue exceeds marginal cost; that is, $MR(x) > MC(x)$.
- ⇒ If you increase x by a bit, your revenues will go up faster than will your costs, so your profit will go up.
- ⇒ And if $MC(x) > MR(x)$, then by decreasing x a bit, total costs will go down faster than total revenues, increasing your profit. In other words, where $MC(x) = /MR(x)$, you can vary your production quantity a bit in one or the other direction and increase your profit. You aren't profit maximizing.


Marginal cost and revenue, in units of dollars (or whatever currency is being used) per unit of output
50
40
30
20
10
0
0
10
20
30
40
50
Marginal revenue
Marginal cost
Quantity produced and sold, the variable x
For $x < 30$, MR is bigger than MC, so profit increases as x is increased
But for $x > 30$, MC is bigger than MR, so profit decreases as x increases
Which together imply that profit is highest at $x = 30$, where MC = MR

Back to our story

⇒ Firm sells steel domestically at a price of $680 per ton, well above the global steel price of $375 per ton.

⇒ The average cost is presently $405 per ton and is never less than $400 per ton.

⇒ So, the story ends, it seems logical that this company should not bother selling steel in the global market.

Averages VS Margins

⇒ The problem with this logic is that it is based on a bunch of averages.

⇒ The domestic price per ton of $680 is the average price that the company gets.

⇒ And the cost figures of $400 and $405 per ton are explicitly average-cost figures.

⇒ To decide what is best for this company, we need to know its marginal cost of production and its domestic marginal revenue.

Averages VS Margins explained

- $\Rightarrow$ Domestic demand for steel is given by the demand function $D(p) = 250,000 - 250p$
- $\Rightarrow$ The total cost of producing x tons of steel by this company is $10,000,000 + 200x + x^2/1000$.
- $\Rightarrow$ So: Inverse domestic demand is $P(x) = 1000 - x/250$.
- $\Rightarrow$ The algebra is:

$$D(p) = 250.000 - 250p$$

so:

$$P(x) = (250.000 - x)/250$$

and finally:

$$P(x) = 1000 - x/250$$

Averages VS Margins explained

- ⇒ Hence total domestic revenue, if the company sells x tons domestically, is $TR(x) = 1000x - x^2/250$
- ⇒ And marginal revenue is $MR(x) = 1000 - x/125$.
- ⇒ Themarginal cost function is $MC(x) = 200 + x/500$.

Question

Question is: We're told that the company is not exporting. But is it maximizing domestic profit?

⇒ We know that the production quantity x for which this would be so is where $MC = MR$. That is:

$$200 + \frac{x}{500} = 1000 - \frac{x}{125}$$

so that:

$$x = 80.000 \ \text{tons.}$$

1. Starting equation:

$$200 + \frac{x}{500} = 1000 - \frac{x}{125}$$

2. Isolate the terms with x: Subtract 200 from both sides:

$$\frac{x}{500} = 1000 - 200 - \frac{x}{125}$$

$$\frac{x}{500} = 800 - \frac{x}{125}$$

3. Eliminate the denominators: Multiply both sides by 500 (the least common denominator of 500 and 125):

$$500 \cdot \frac{x}{500} = 500 \cdot 800 - 500 \cdot \frac{x}{125}$$

$$x = 500 \cdot 800 - 4x$$

$$x = 400000 - 4x$$

4. Solve for x: Move $4x$ to the left-hand side:

$$x + 4x = 400000$$

$$5x = 400000$$

Divide both sides by 5:

$$x = \frac{400000}{5}$$

$$x = 80000$$

Final result:

$$x = 80000$$

Checking the price

⇒ Plug $x = 80,000$ into the domestic inverse demand function, and you see that the price that corresponds to domestic sales of 80,000 tons is: $P(80.000) = 1000 - \frac{80.000}{250} = 1000 - 320 = \$680$

. . . just as in the original story.

Checking the cost

⇒ We might as well check that cost figure of \$405: Total cost at $x = 80,000$ is:

$$10,000,000 + 200 \cdot 80.000 + \frac{80.000^2}{1000} = \$32,400,000$$

So that the average cost is \$405.

Now to the point

⇒ The average domestic revenue of \$680, and the average cost of \$405, are not the relevant numbers (to an economist).

⇒ We need to know the marginal cost and the domestic marginal revenue.

⇒ So we plug 80,000 into the MC and MR functions and we learn that:

$$MC(80.000) = 200 + \frac{80.000}{500} = \$360 = MR(80.000) = 1.000 - \frac{80.000}{125}$$

Our question answered

- ⇒ These numbers tell the tale: When we say that the global price of steel is \$375, we are saying that the our steel manufacturer is a price-taker (or is competitive) in the global market.
- ⇒ It can sell all the steel it chooses to at this price; it can?t sell any at a higher price.
- ⇒ Hence its export total revenue, if it exports y tons of steel, is $375 \cdot y$, and so its export marginal revenue is \$375.
- ⇒ On the margin, it gets \$375 for the first ton of steel it sells into the global market, and on the margin, one more ton of steel costs it an addition \$360.
- ⇒ There is profit to be made by exporting!

Put it in another way

- ⇒ The last ton of steel it manufactured and sold domestically (of the 80,000) brought in a marginal $360 in revenues.
- ⇒ It could instead sell 79,999 tons domestically and export that last ton.
- ⇒ It loses $360 in domestic revenues, but gets $375 for the exported ton, putting it ahead by $15.

So, what is the best production plan for this company?

⇒ If domestic marginal revenue is below the export price of $375, it can't be that the firm is maximizing profit.

⇒ Without changing its total costs, it could export one more ton of steel, sell one less ton domestically, and be ahead (in profit) by the amount that $375 exceeds domestic marginal revenue.

⇒ Conversely, if domestic marginal revenue exceeds $375 and if the firm is doing any exporting, it would be better off exporting one ton less and selling that ton domestically.

So, what is the best production plan for this company?

$\Rightarrow$ So there are two possibilities:

1. If the firm is exporting steel, to be maximizing its profit, domestic marginal revenue must equal \$375,
2. if domestic marginal revenue is above \$375, but the firm is not exporting at all, it is okay.

And . . .

So, what is the best production plan for this company?

$\Rightarrow$ ... And the total level of production, which I'll denote by X and which is just $x + y$, should be at the level where the marginal cost of production is \$375.

So, what is the best production plan for this company?

- $\Rightarrow$ We know that, when the firm maximizes domestic profit without exporting, its domestic marginal revenue is less than \$375.
- $\Rightarrow$ So we know that the firm wants to export.
- $\Rightarrow$ Which means it should be producing at the level X where $MC(X) = 375$. Or:

$$MC(X) = 200 + \frac{X}{500} = 375 \quad \text{which is} \quad X = 87.500$$

And ...

So, what is the best production plan for this company?

. . . And

- ⇒ its domestic marginal revenue should equal \$375, which is $1000 - x/125 = 375$, or $x = (625)(125) = 78,125$.
- ⇒ Exports should be the difference between total production $X = 87,500$ and domestic sales of $78,125$, so exports should equal $87,500 - 78,125 = 9375$ tons.

So, what is the best production plan for this company?

The important part is the economic intuition: The firm wants marginal domestic revenue to equal marginal export revenue? which, since the firm is a price-taker globally, is just the global market price?and both of these should equal overall marginal cost.

If you understand why this is where the optimal plan is found, and why it is marginal cost and marginal revenues that matter, we're done.

Wrap Up!

⇒ Thinking like an economist in many cases means thinking about the marginal impact of decisions being made. Think margins, not averages!

Wrap Up!

⇒ The pieces of the basic model of a single-product firm with market power are

1. the demand function the firm faces, typically denoted D(p),
2. the total-cost function TC(x),
3. the assumption that the firm will select the price it charges/quantity it produces and sells to maximize its profit, or revenue less total cost.

Wrap Up!

To find the profit-maximizing price-quantity pair:

1. If necessary, invert the demand function to find the inverse demand function $P(x)$.
2. Construct the total revenue function $TR(x) = xP(x)$ and find its derivative, the marginal cost function $MR(x)$.
3. Find the derivative of the total cost function, the marginal cost function $MC(x)$.
4. Find the level of production at which marginal cost equals marginal revenue.
5. Plug this level of production into inverse demand to find the profit-maximizing price to set.