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Market Power and the Lerner Index: A Classroom Experiment

Christian Rojas

Abstract

We describe a classroom experiment that illustrates the concepts of market power and the Lerner Index. Students are organized in groups, each making a decision for a monopolist. Monopolists face different (unknown) demand curves, each with a different (constant) elasticity. Through repetition, students discover the profit maximizing solution and find that different monopolies have different mark-ups. The experimenter then reveals the unknown demand curves and illustrates how different elasticities are graphically and numerically connected to mark-ups and the Lerner index. The experiment can be used in a wide variety of courses including principles of economics, intermediate microeconomics, industrial organization, international trade, managerial economics and MBA classes. The experimental design is flexible: it can accommodate different class sizes (ranging from 10 to 100+ students) as well as different demand parameterizations. Finally, to reinforce the economic concept of profit maximization (MR=MC) in this setting, we also suggest and describe the implementation of an exercise based on the experimental design.

KEYWORDS: Market power, Lerner index, teaching, economic experiments, monopoly, demand elasticity

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1. Introduction

Market power (or firms' ability to price above marginal cost) is a fundamental concept in economics because it illustrates whether (and by how much) imperfectly competitive markets depart from the perfect competition benchmark; as such, this concept arises in many economic courses, especially those with a microeconomics focus. A popular measure of market power is the Lerner index (Lerner, 1934), a number located in the unit interval that has an inverse relationship with (the absolute value of) demand price elasticity. The Lerner index is appealing because it shows: a) where a firm's market power is located between perfect competition (zero) and maximal market power (one), and b) the role that demand elasticity plays in determining a firm's mark-up. As a consequence, the Lerner index (and extensions) is one of the most commonly taught concepts in industrial organization textbooks at both the graduate and undergraduate level (see, for example, Waldman and Jensen, 2007; Tirole, 1988), and it is often employed in other fields (i.e. international trade and macroeconomics).

While students can usually grasp the general idea that market power means greater control over price (and therefore greater mark-ups), our pedagogical experience is that they tend to have a difficult time understanding how the concept is related to the shape of demand. For example, when presented with the Lerner index formula (or its derivation), most students prefer to memorize the equation(s) rather than to make an effort to understand the intuition for the relationship between market power and demand elasticity. Using different intuitive examples for why this relationship holds seems to help some students, but many seem as they could benefit from additional illustration.

This paper describes a simple classroom experiment designed to illustrate the concepts of market power and the Lerner index in the context of monopoly and a constant elasticity demand schedule. Students are organized in groups (with a size that can vary depending on class size), each making an output decision for a hypothetical monopolist.[1] Monopolists have the same marginal cost but face different (unknown) demand curves with varying degrees of elasticity. Monopolists make an output decision that is recorded on a spreadsheet which contains formulas that compute the corresponding price and profits. Through repetition, students discover the profit maximizing output (and price) for each monopoly in the classroom and find that different monopolies have different equilibrium prices (and mark-ups) as well as different profit levels. At the end of

[1] Allowing more than one student to be the decision-making unit gives flexibility to the experiment and it eases its implementation. This is particularly important when class size grows large and the instructor wants to keep the number of hypothetical monopolies manageable. We discuss more details later.

the experiment, the different unknown demand curves are graphically revealed to students with an explanation of how they vary in shape and elasticity.

The results of the profit maximizing output and price decisions discovered by the students can then be easily related to the different elasticity levels. The instructor can ask the class to compute the mark-up (price-marginal cost) and to think for themselves about its connection with demand elasticity. Instructors can move on to calculate the Lerner Index and show that indeed (price-marginal cost)/(price) equals $1/|\varepsilon|$ (where ε is the price elasticity of demand).

An important feature of the experiment is its flexibility. Different class sizes can be accommodated by changing the number of demand schedules as well as by forming groups with varying numbers of participants. The experiment can be conducted before or after a lecture where the concepts are formally taught and the follow-up discussion can be modified to suit different course levels or foci. Another feature of the experiment is its simplicity: preparation time is minimal and implementation (instructions and procedures) is straightforward.

While we find this exercise to be useful for illustrating the Lerner Index definition through the relationship between elasticity and the mark-up (price – marginal cost), some instructors may find that it could abstract somehow from the underlying economic concept of profit maximization (marginal cost should equal marginal revenue). To highlight the importance of this concept in this setting, we suggest and describe the implementation of an exercise, based on the experimental design, which is assigned to students after the experiment. The interesting feature of this exercise is that students can connect their participation in the experiment to their work as they go through the assignment.

Surprisingly, to the best of our knowledge, there are no previous teaching experiments that specifically illustrate the concept of market power as intended here. Popular sources for classroom experiments such as Veconlab (http://veconlab.econ.virginia.edu/) or the comprehensive list of classroom experiments listed by Delemeester and Brauer in the Journal of Economic Education link for classroom experiments (http://www.marietta.edu/~delemeeg/games/), contain monopoly or oligopoly experiments demonstrating concepts such as price discrimination, entry, product differentiation, mergers, vertical integration or market efficiency; while these experiments are, to varying degrees, related to the issue of market power, they do not illustrate the concept as it is taught in many economic courses.

Section 2 describes the procedures of the experiment. Results of a session and suggested discussion formats, including an exercise that reinforces the economic rationale for profit maximization, are presented in section 3. Section 4 provides a discussion and possible further extensions. The appendix contains instructions and other material needed to conduct the experiment, as well as the suggested exercise.

2. Procedures and Implementation

2.1 Parameters and Overall Structure of the Game

Demand has a constant-elasticity functional form (only known to the instructor before the experiment) with an inverse demand function given by:

(1) $$p = aq^{c_i}$$

where p denotes price, q is quantity, a is a constant term and c is the inverse of demand elasticity (i.e. $c = 1/\varepsilon$). The instructor can choose as many elasticity parameters (c's) as desired; here we illustrate the experiment with three values: $c_1 = -0.38$, $c_2 = -0.45$ and $c_3 = -0.60$, which correspond to three demand elasticity levels: "high" ($\varepsilon_1 = -2.63$), "medium" ($\varepsilon_2 = -2.22$) and "low" ($\varepsilon_3 = -1.67$); we set $a = 7.4$ or $ln(a)=2$.

Students are assigned to a group. The instructor has flexibility as to how many students to assign to a group, but our experience is that groups of up to 4 or 5 students can generate discussion that includes all participants. Since there will typically be more groups than demand schedules, several groups need to be lumped together into "worlds", each world with a different demand schedule (i.e. different elasticity). Participants are not told whether there is a difference between groups or worlds nor that there are different demand schedules being considered. This is revealed to them at the end of the experiment.

Students are told that each group will behave as a monopolist that is looking for a single production decision (output) that maximizes profit (given an unknown demand curve) and that all groups are facing a constant average cost of production (in the example below this is set equal to 2); therefore, all participants in the group will have to discuss the problem and reach a consensus. We instruct students to choose quantities from the set $q=\{1,2,\ldots,10\}$, although this need not be the case (see section 4).

Once a decision within a group is reached, each group has to write their decision on their record sheet. Once all groups have decided on the output, the instructor records all production decisions in a spreadsheet that is displayed to the entire class. The spreadsheet contains built-in formulas that compute the price that corresponds to each quantity (q) decision (i.e. $p = aq^{c_i}$, where i denotes the corresponding demand schedule), as well as the corresponding revenue, total cost and total profit (see next section for details). Students are able to see the results for their group as well as other groups.

This exercise is repeated for several rounds until the instructor observes convergence to the predicted profit maximizing outputs. As rounds progress, students quickly realize that different worlds must have different demand schedules but that groups within a world face the same demand function. The number of rounds needed for convergence increases with the number of groups in each world; observing the results of more groups with the same demand schedule allows participants to figure out the solution more quickly.

2.2 Implementation Details

Preparation for the experiment is straightforward and requires little time. First of all, instructors need to decide on how many elasticities, groups and worlds will be implemented; these will be a function of the number of students in the class. We recommend having at least: two groups per world, three worlds (elasticities), and 2 participants per group. Thus, the experiment can be implemented with as little as 12 students, but can easily be changed to accommodate larger class sizes. For example, a 36-student class can be accommodated by having twelve groups, each with three students, with four worlds in each elasticity treatment (or alternatively three worlds in each of four elasticity treatments). A 100-student class could be accommodated by having twenty groups, each with five students, with four worlds assigned to each of five different elasticity treatments. Odd number of students can be accommodated by having varying numbers of students per group. The flexibility of the experiment is particularly desirable when instructors can not anticipate the exact number of students that will attend class on any given day.

After assigning students to groups, the instructor distributes one record sheet per group (see the appendix for an example of a record sheet). The instructor then displays the instructions on the screen (instructions can be found in the appendix); the actual order of when instructions are presented is not too important, however (i.e. the instructor can start the experiment with the instructions before handing out the record sheets). After instructions are read, the instructor should clear up any doubts students may have about how to proceed. Once groups have been formed, record sheets have been distributed and instructions have been read, the spreadsheet on which each group's output decisions will be recorded is shown (using a projector) and explained to students (see the appendix for a screen shot of the spreadsheet); this spreadsheet contains five columns: quantity, price, revenue, cost and profits. To add realism and sharpen incentives, we ask students to think about profits in millions of dollars (this forces them to pay greater attention to decimal points). The time needed for organizing the class into groups (and worlds), reading the instructions, answering questions and distributing record sheets varies with class size. With large classes (60+), this can take from 25 to 35 minutes; smaller classes (20-30) can take as little as 15 minutes.

Once everyone is familiar with how results will be recorded on the spreadsheet, the instructor asks groups to start discussion for the first round's output choice. After a few minutes, every group is asked to voice their choice, which is then recorded on the spreadsheet for everyone to see. We suggest that decisions be recorded in a logical order: from the most price-sensitive world to the least-price sensitive world (or vice versa); but this is not critical. The instructor then gives students a few minutes to see the results from all worlds and moves on to the second round in the same fashion. In our experience, convergence to the optimal output can be seen by in as little as 3 rounds in large classes (60+) whereas it can take up to 6 rounds in smaller classes. One reason why convergence is observed quickly is that the experimental design constrains the choice set to 10 output levels; this feature is desirable for larger classes where the total amount of time needed to finish the experiment (administration and rounds) is greater (35-50 minutes) thereby leaving sufficient time for discussion. Section 4 presents a suggestion on how to relax this constrained choice set.

3. Discussion and a Follow-Up Exercise

Table 1 shows results of a 45-student session with 3 demand elasticities (worlds) and 4 groups in each world (except for world 1 which had 3 groups); as it can be seen, convergence was achieved between rounds 3 and 4. After such convergence is observed, we suggest to start discussion by pointing out to students how responses have reached certain (output, price and profit) levels and how these levels vary by worlds (and not groups). A good strategy is to ask students why they think there are differences in the optimal output levels across worlds (e.g. why do you think World 1 has a higher profit maximizing price than World 3?). Students quickly figure out that different demand curves must be responsible for the differences, and (with some help) they understand that different price sensitivities are playing an important role. To illustrate this point further, students are shown a graph of the three different demand curves associated with each of the three worlds (figure 1); the instructor can then explain how they differ in slope and elasticity (i.e. the steeper the demand curve, the lower the absolute value of elasticity).

The indirect relationship between (the absolute value of) demand elasticity and equilibrium price can then be easily illustrated by moving back and forth between the results of the experiment (table 1) and the demand shapes (figure 1). In addition, we have found it helpful to (hypothetically) label worlds 1, 2 and 3 with actual company names that may resemble the three types of elasticities (e.g. world 3 might be Microsoft for which there are few close substitutes, whereas world 1 may be a local restaurant for which there are several close substitutes).

The discussion proceeds by showing students a table containing a schedule of all output choices with their corresponding prices, revenue, marginal revenue, total cost, and profit levels (table 2); there are three panels (a,b and c), each representing one of the elasticity cases (High, Medium and Low).

Table 1: Results of the Experiment for Session with 45 Students

	World 1					**World 2**					**World 3**				
	Group A														
Round	Quant	Price	Revenue	Cost	Profit ($mill)	Quant	Price	Revenue	Cost	Profit ($mill)	Quant	Price	Revenue	Cost	Profit ($mill)
1	5	4.0	20.0	10	10.042	8	2.9	23.2	16	7.189	6	2.5	15.1	12	3.130
2	7	3.5	24.7	14	10.692	5	3.6	17.9	10	7.907	2	4.9	9.7	4	5.750
3	8	3.4	26.8	16	10.823	10	2.6	26.2	20	6.217	1	7.4	7.4	2	5.389
4	**9**	**3.2**	**28.9**	**18**	**10.855**	**5**	**3.6**	**17.9**	**10**	**7.907**	**2**	**4.9**	**9.7**	**4**	**5.750**
	Group B														
1	6	3.7	22.4	12	10.441	7	3.1	21.5	14	7.547	6	2.5	15.1	12	3.130
2	8	3.4	26.8	16	10.823	**5**	**3.6**	**17.9**	**10**	**7.907**	3	3.8	11.5	6	5.467
3	**9**	**3.2**	**28.9**	**18**	**10.855**	**5**	**3.6**	**17.9**	**10**	**7.907**	**2**	**4.9**	**9.7**	**4**	**5.750**
4	**9**	**3.2**	**28.9**	**18**	**10.855**	**5**	**3.6**	**17.9**	**10**	**7.907**	**2**	**4.9**	**9.7**	**4**	**5.750**
	Group C														
1	7	3.5	24.7	14	10.692	5	3.6	17.9	10	7.907	10	1.9	18.6	20	-1.440
2	5	4.0	20.0	10	10.042	1	7.4	7.4	2	5.389	4	3.2	12.9	8	4.865
3	**9**	**3.2**	**28.9**	**18**	**10.855**	**5**	**3.6**	**17.9**	**10**	**7.907**	5	2.8	14.1	10	4.066
4	**9**	**3.2**	**28.9**	**18**	**10.855**	**5**	**3.6**	**17.9**	**10**	**7.907**	**2**	**4.9**	**9.7**	**4**	**5.750**
	Group D														
1	N/A					4	4.0	15.8	8	7.839	5	2.8	14.1	10	4.066
2						5	3.6	17.9	10	7.907	2	4.9	9.7	4	5.750
3						6	3.3	19.8	12	7.796	6	2.5	15.1	12	3.130
4						**5**	**3.6**	**17.9**	**10**	**7.907**	**2**	**4.9**	**9.7**	**4**	**5.750**

Notes: Bold numbers denote rounds that have converged to profit maximizing levels.

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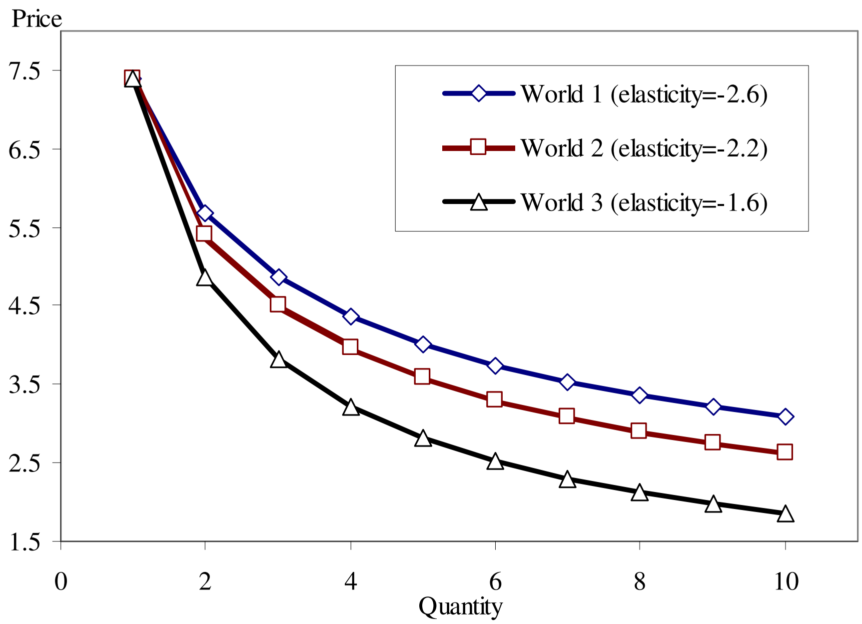
Figure 1: Demand Curves Associated with Each World



Notes: Demand function: $p = 7.4q^c$, were $c = 1/elasticity$.

Table 2 is useful for illustrating (in bold, for example) that the profit maximizing condition *MR*=*MC* holds almost exactly (at least in worlds 1 and 2). Discussion on how marginal revenue is computed and how the profit maximizing condition works can be made more extensive if the instructor wants to emphasize these concepts; this could be the case especially in a lower level class or if students need to have their memories refreshed (see below for a complementary exercise on this theme).[2] The last step of the discussion involves showing students how market power varies with elasticity (world); this can be done by having the instructor write down the usual definition of market power (P-MC) and calculating this difference for each of the three equilibrium prices (1.21, 1.58 and 2.87). Since MC is the same in all worlds, students automatically learn that a higher equilibrium price (and lower absolute demand elasticity) means more market power. The instructor can then introduce the definition of the Lerner index and its usual relationship with price elasticity:

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[2] We have found it useful to spend some time on explaining these concepts even at upper-level courses because many students find this approach more intuitive than what they have been exposed to in previous classes.

Table 2: Quantity, Prices, Revenue, Marginal Revenue, Total Cost and Profit Levels for Three Demand Elasticities.

Quantity	Price	Revenue	Marginal Revenue	Total Cost	Profit
1	7.39	7.39	7.39	2	5.39
2	5.68	11.36	3.97	4	7.36
3	4.87	14.60	3.25	6	8.60
4	4.36	17.45	2.85	8	9.45
5	4.01	20.04	2.59	10	10.04
6	3.74	22.44	2.40	12	10.44
7	3.53	24.69	2.25	14	10.69
8	3.35	26.82	2.13	16	10.82
9	**3.21**	**28.85**	**2.03**	**18**	**10.85**
10	3.08	30.80	1.95	20	10.80

2a: High Demand Elasticity Case: $\varepsilon = -2.6$, *a=7.4, MC=2*

Quantity	Price	Revenue	Marginal Revenue	Total Cost	Profit
1	7.39	7.39	7.39	2	5.39
2	5.41	10.82	3.43	4	6.82
3	4.51	13.52	2.70	6	7.52
4	3.96	15.84	2.32	8	7.84
5	**3.58**	**17.91**	**2.07**	**10**	**7.91**
6	3.30	19.80	1.89	12	7.80
7	3.08	21.55	1.75	14	7.55
8	2.90	23.19	1.64	16	7.19
9	2.75	24.74	1.55	18	6.74
10	2.62	26.22	1.48	20	6.22

2b: Medium Demand Elasticity Case: $\varepsilon = -2.2$, *a=7.4, MC=2*

Quantity	Price	Revenue	Marginal Revenue	Total Cost	Profit
1	7.39	7.39	7.39	2	5.39
2	**4.87**	**9.75**	**2.36**	**4**	**5.75**
3	3.82	11.47	1.72	6	5.47
4	3.22	12.87	1.40	8	4.87
5	2.81	14.07	1.20	10	4.07
6	2.52	15.13	1.06	12	3.13
7	2.30	16.09	0.96	14	2.09
8	2.12	16.98	0.88	16	0.98
9	1.98	17.79	0.82	18	-0.21
10	1.86	18.56	0.77	20	-1.44

2c: Low Demand Elasticity Case: $\varepsilon = -1.6$, *a=7.4, MC=2*

Notes: Demand function: Demand function: $p = 7.4q^c$, were $c = 1/elasticity$. Bold numbers denote the profit maximizing solution.

(2) $$\frac{P - MC}{P} = \frac{1}{|\varepsilon|}$$

Instructors of more advanced courses can spend some time in the derivation of this relationship (using the first order condition of the monopolist's profit maximizing problem) whereas other instructors can avoid the mathematical derivation altogether. In either case, a good approach is to ask students to compute both sides of (2) to confirm that the equality holds (with some rounding error) and that the corresponding Lerner indices are: 0.38, 0.45 and 0.60, respectively.[3]

The instructor can show the fact that (2) is an index that lies between the [0,1] interval by asking students to think about the maximum and minimum values that the left-hand side can take. This naturally leads to an illustration about how the lower bound of the index (zero) represents the perfectly competitive benchmark (i.e. P=MC) and its connection with the concept of infinitely elastic demand. Students can then be led to intuitively figure out why the Lerner index is an attractive measure to gauge a market's "distance" from the perfectly competitive benchmark.

A note of caution is in place. The parameterizations chosen show that the market with the highest mark-up is the least profitable (world 3 with $5.75 million), whereas the market with the smallest market power is the most profitable (world 1 with $10.85 million). This may puzzle some students, but one needs to point out that this not, in general, the case; the reason for a smaller profit in the market with the steepest (and least elastic) demand (world 3) is that this product is the "least popular" (i.e. the demand curve lies to the left of the other two demand curves).[4]

A Follow-Up Exercise to Illustrate the Importance of the Profit Maximization Rule (MR=MC)

While the above exercise is useful for illustrating the Lerner Index definition through the relationship between elasticity and the mark-up (price – marginal cost), it may abstract somehow from the underlying economic concept of profit maximization: at the optimum price, marginal cost should equal marginal revenue. To highlight the importance of this concept in this exercise, we suggest the following exercise.

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[3] Note that these values correspond to the (absolute value of) parameter *c* chosen by the instructor for each demand equation.

[4] An easy way to reverse this result is to define different intercepts for each demand curve (i.e. a bigger intercept for steeper demand curves). The formulas in our spreadsheets make this simple. See exercise below for an example of this variation.

To slightly increase the difficulty of the exercise (if so desired), instructors may want to use a different parameterization than the one used in the experiment. Table 3, below, considers one possible variation. The objective of the exercise is to ask students to work on their own (either in class or at home depending on time availability and the instructor's preferences)[5] to solve for the profit maximizing solution in all three worlds.

Table 3: Suggested Parameterization for Follow-Up Exercise

World	*a*	*c*	Elasticity
1	7.4	-0.18	-5.56
2	12.2	-0.35	-2.86
3	20.1	-0.61	-1.64

We present two variations of this exercise. The first one is a calculus-free version with three worksheets, each asking students to compute the price, revenue, marginal revenue, total cost and total profit that correspond to each of 12 different quantities (1 through 12). A worksheet (see a sample for world 1 in the appendix) provides the student with information about the function for the demand curve and the parameters (*a,c* and *MC*), and asks the student to draw the corresponding demand, MR and MC curves in a graph right below the worksheet table. Finally, students are asked to use the figure to pinpoint the profit maximizing solution; figure 2 below shows the graphical solution to this exercise for World 2 (the spreadsheet provided contains the spreadsheet and graphical solutions for all three worlds).

A calculus-based exercise (for more advanced courses) directly asks students to compute the profit maximizing solution (the appendix contains an example of how the exercise can be presented to students, and the spreadsheet provided contains the solution with formulas). The solution to this problem is given by: $MR = a(c+1)Q^c = MC$ which results in $Q^* = \left[\frac{MC}{a(c+1)}\right]^{1/c}$ and $P^* = \frac{MC}{c+1}$; students would be asked to fill out a table with their calculations. Table 4 presents such results.

[5] In our experience, there is no sufficient time for students to complete this exercise in class right after the experiment, unless it is an unusually small class (<15 students) or an unusually lengthy lecture (>1 hour and 15 minutes). Therefore, if the instructor prefers to have this exercise as an in-class activity, we recommend relegating it to the next lecture.

Figure 2: Graphical Solution for World 2, Calculus-Free Version

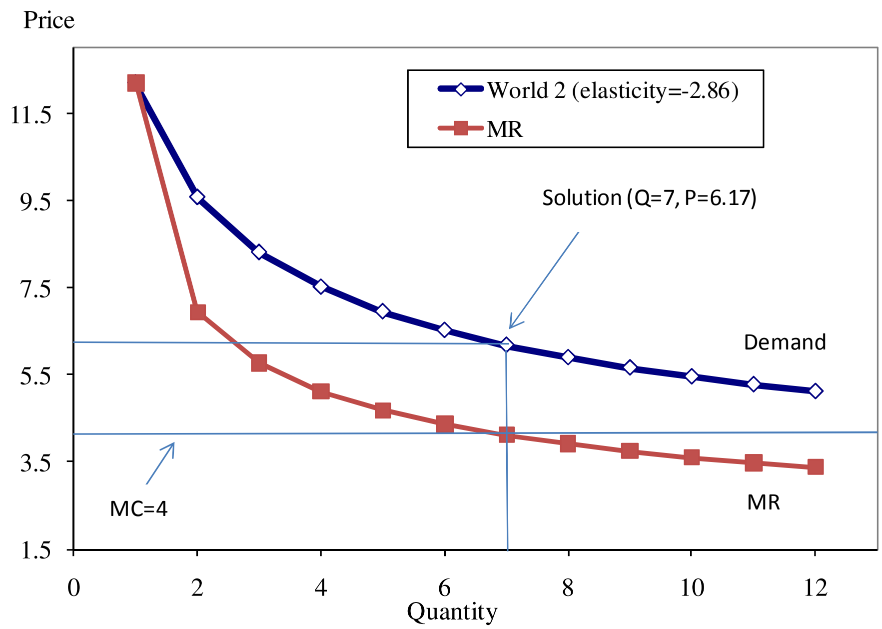

Table 4: Solution to Follow-Up Exercise, Calculus-Based Version

World	*a*	*c*	Elasticity	MC	Q*	P*	TR	MR	TC	Profit
1	7.4	-0.18	-5.56	4	10.13	4.88	49.40	4	40.51	8.89
2	12.2	-0.35	-2.86	4	7.07	6.15	43.48	4	28.26	15.22
3	20.1	-0.61	-1.64	4	3.01	10.26	30.90	4	12.05	18.85

To further reinforce the *MR=MC* rule in this setting and to connect it with the Lerner Index, the assignment (either calculus-free or calculus-based) can be followed up by a couple of questions that ask students to interpret and think about the results. We suggest the following:

- At the optimal levels of P and Q, is MC equal to MR? Why?
- What is the mark-up (P-MC) at the profit maximizing solution in each world?
- Is the mark-up that you just computed related in any way to the "steepness" (i.e. elasticity) of the demand curve? If so how? Confirm that, indeed, at the optimal solution, (P-MC)/P=1|elasticity|.
- Give the intuition for why three different hypothetical markets with identical cost structures can give rise to three different levels of market power. Provide examples of industries/markets that may reasonably resemble each of the three cases. Explain.

- Optional question for calculus-based exercise: using the first order condition of the profit function, show that (P-MC)/P=1|elasticity|.

4. Further Discussion and Possible Modifications

The experiment presented has wide applicability as it demonstrates concepts that are used in several economics and business courses of all levels. It can be used to reinforce basic economic concepts such as marginal revenue, marginal cost and profit maximization, as well as an intuitive tool for the mathematical derivation of the relationship between demand price elasticity and market power. Finally, it is easy to prepare, implement and adjust.

A central feature of the experiment is to highlight the connection between market power and demand elasticity. This can lead to a discussion about what factors students think can affect the value of demand elasticity. Our experience is that students will intuitively point out that advertising, innovation, research and development, and patents, among other factors, should be important in determining price elasticity and thus market power. Instructors can divert discussion into the factor(s) that are of more importance to the course.

The setup in the proposed experiment makes it easier to connect the concept of market power to other important topics. Instructors of industrial organization or managerial economics courses can naturally move on to a lecture on (third degree) price discrimination by asking students how a monopolist facing multiple demands (as shown in this experiment) should choose the optimal price in each market; a discussion of which conditions would be needed to effectively engage in price discrimination (e.g. no arbitrage) can follow. Alternatively, the instructor can use a price discrimination experiment as the one described by Basuchoudhary et al (2008).

Another important concept closely related to market power is double marginalization. An instructor wishing to illustrate how the inefficiency created by vertical separation increases with market power can use the proposed experiment before a lecture on vertical integration; the marginal revenue schedules (i.e. table 2) can then be used as the demand curves facing an upstream monopolist (with a cost schedule chosen by the instructor). It is then straightforward to show that when market power downstream is small, the double marginalization problem is minimal (and vice versa).

The experiment uses a constant elasticity demand function to ease the exposition of the intuitive notion that a curve's steepness is inversely related to (the absolute value of) elasticity; this also makes the illustration of (2) straightforward. But elasticity varies along the demand curve when other functional forms are employed. Instructors of more advanced courses may want to spend time explaining the differences between log-log demand v. linear demand (for example) and that while (2) should also hold in such cases, the right-hand side of the equation is not a constant (for a given demand curve).

Finally, the experiment can be made more interesting for smaller classes (or if the instructor wants to leave discussion for the next class period) by asking students to choose any quantity they like (including decimals) with no upper bound. In this case, convergence time will roughly double. The procedures for implementing the experiment can be kept identical, except that Table 2 is modified by inserting an additional row that shows the exact profit maximizing price and quantity.

Appendix

Sample Record Sheet for Experiment

World 1 Group A

Round	Quantity Chosen	Price	Revenue	Cost	Profit ($mill)
1					
2					
3					
4					
5					
6					

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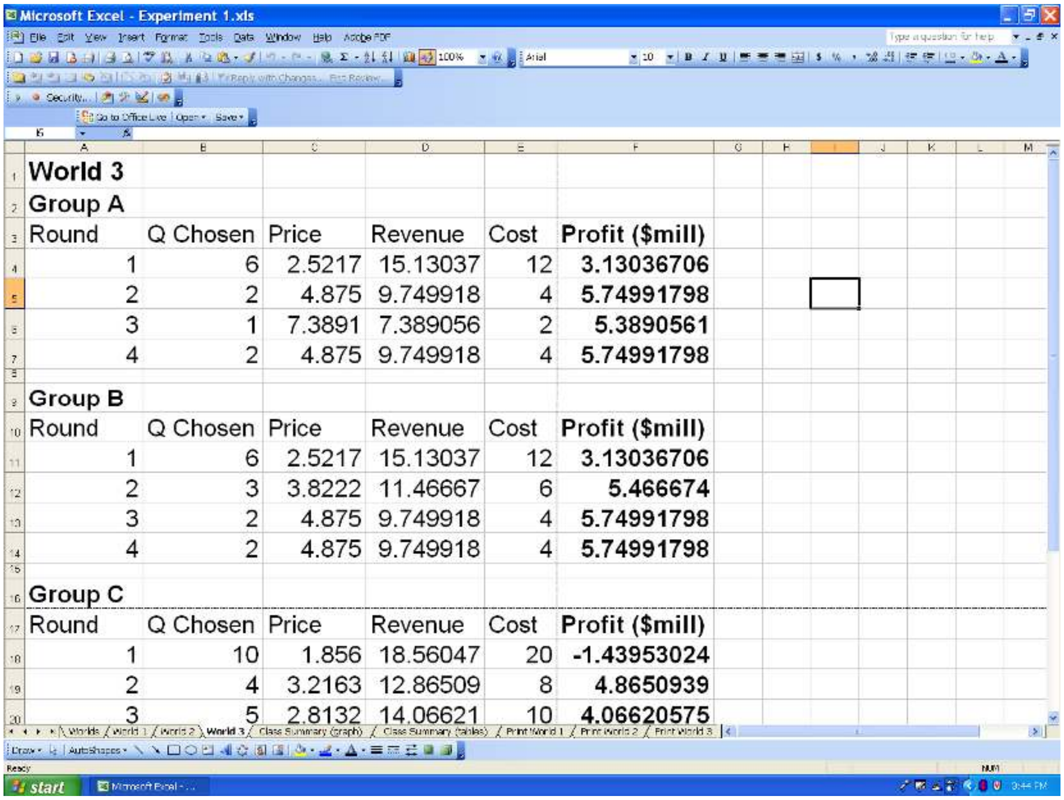
Instructions for Experiment, in presentation (bullet) style

- Please form groups of ~4 people
- Each group will be a monopolistic firm; there will be 9 monopolists in the classroom
- 3 firms will belong to "World 1", 3 firms to "World 2" and 3 firms to "World 3".
- Each firm will make a decision on a quantity to sell from the set: {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}. A firm's objective is to maximize profits.
- Each firm will make 3-4 quantity decisions ("rounds")
- The market price for the chosen quantity is determined by an "unknown" demand function that the computer will calculate for you.
- Each firm has MC=AC=2
- After each round, I will record each firm's quantity decision on a spreadsheet which will then be projected on the screen (you record your decision on the record sheet)
- Everyone will see the corresponding price and profit for their decision for that round (you record this on your on the record sheet)
- Next round starts.

Screen Shot of Experiment Spreadsheet (World 3)



World 3					
Group A					
Round	Q Chosen	Price	Revenue	Cost	**Profit ($mill)**
1	6	2.5217	15.13037	12	**3.13036706**
2	2	4.875	9.749918	4	**5.74991798**
3	1	7.3891	7.389056	2	**5.3890561**
4	2	4.875	9.749918	4	**5.74991798**
Group B					
Round	Q Chosen	Price	Revenue	Cost	**Profit ($mill)**
1	6	2.5217	15.13037	12	**3.13036706**
2	3	3.8222	11.46667	6	**5.466674**
3	2	4.875	9.749918	4	**5.74991798**
4	2	4.875	9.749918	4	**5.74991798**
Group C					
Round	Q Chosen	Price	Revenue	Cost	**Profit ($mill)**
1	10	1.856	18.56047	20	**-1.43953024**
2	4	3.2163	12.86509	8	**4.8650939**
3	5	2.8132	14.06621	10	**4.06620575**

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Calculus-Free Version Exercise, Worksheet for World 1

World 1
Demand: $p=a*q^c$

c=	-0.18
a=	7.4
Elasticity |1/*c*|=	5.56
MC =	4

Q	P	Revenue	MR	MC	Total Cost	Profit
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Below: Graph Demand Curve, Marginal Cost, Marginal Revenue and Indicate Optimal Solution

[followed by questions of instructor's choice, see text for suggestions]

Calculus-Based Version Exercise

Consider three different monopolies, all with a constant marginal cost of 4. Each monopolist faces the following demand curve: $p = aq^c$. The table below shows the different values of *a, c* and the corresponding elasticity (*1/c*) for each case.

World	*a*	*c*	Elasticity
1	7.4	-0.18	-5.56
2	12.2	-0.35	-2.86
3	20.1	-0.61	-1.64

For each monopoly, compute the equilibrium price and quantity. At these solutions, compute also the corresponding TR, MR, TC and Profit. Is MC equal to MR? Use the table below to record your results.

World	*a*	*c*	Elasticity	MC	Q*	P*	TR	MR	TC	Profit
1	7.4	-0.18	-5.56	4						
2	12.2	-0.35	-2.86	4						
3	20.1	-0.61	-1.64	4						

[followed by questions of instructor's choice, see text for suggestions]

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