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PRICE DISCRIMINATION AND RESALE: A CLASSROOM EXPERIMENT

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Abstract

This paper presents an experimental design that facilitates teaching third-degree price discrimination. By participating as buyers and sellers, students actively learn (1) how uniform pricing differs from group pricing, (2) why effective price discrimination requires limitations on resale, and (3) how discriminatory practices affect welfare. The exercise challenges sellers to set optimal prices against unknown demand curves, using a story of pricing a pharmaceutical product to American and Mexican consumers. By working through calculations for themselves, students eventually arrive at the optimal uniform price and the optimal pair of group prices, with and without resale.

The design proves successful in that prices converge fairly reliably to the theoretical predictions. Students find the exercise to be illuminating and interesting. Classroom discussion can focus on real-world examples of price discrimination, as well as regulatory policy questions in industrial organization and international trade. It can be used effectively in classes on principles of economics, intermediate microeconomics, industrial organization, and international trade, in class sizes ranging from nine students to hundreds of students.

Keywords: price discrimination, monopoly, no-dumping policy, classroom experiments

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I. INTRODUCTION

Price discrimination is commonplace in diverse consumer markets familiar to undergraduate students: pharmaceuticals, airlines, restaurants, computer software, and movies. The theory of price discrimination also figures in public-policy questions, such as the Robinson-Patman Act preventing anticompetitive price discrimination, no-dumping rules in international trade, and debates over international pharmaceutical pricing. Price discrimination thus represents a potentially exciting topic in undergraduate courses in economic principles, intermediate microeconomics, industrial organization, and international trade. However, it is also a relatively challenging topic for students.

Our interest in investigating the pedagogical aspect of price discrimination is motivated by both its broad applicability and the difficulty of teaching the concept. Typically, a discussion of price discrimination follows a discussion of monopoly power and its welfare reducing effects. Under the monopoly model, price discrimination may be welfare enhancing, which is often both interesting and confusing to the student.

Laboratory markets, on the other hand, can be structured to closely emulate theoretical models. Ignoring complexities of natural markets, pedagogically it allows the student to form a better understanding of the theory itself and to use it as an abstraction of real markets[1].

Previous classroom innovations (Zillante et al., *mimeo*; Hudson and Lusk, 2004[2]) for teaching price discrimination have mostly focused on second-degree price discrimination[3].

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[1] For a general introduction to using experiments in teaching, see Holt (1999) or Bergstrom and Miller (1999).
[2] Hudson and Lusk develop a Web-based experiment. Zillante et al. present a classroom experiment of second-degree price and a variation of third-degree price discrimination in the context of parking lot permits. Our experiment directly addresses the concept of third-degree price discrimination. Furthermore, their design is very context-specific, while our set-up is can easily be amended to accommodate changes in the context.
[3] Pigou (1920) was the first to detail the three different types of price discrimination (first, second and third) and made the conjecture that if output decreases welfare may also diminish. The term 'group-pricing' is due to Shapiro and Varian (1999). They also renamed first-degree price discrimination as 'personalized pricing' and second-degree as 'versioning' as the three types of price discrimination are not ranked in any conceivable way.

We develop a classroom experiment that illustrates the principle of third-degree price discrimination (group pricing). The experiment is placed in the context of the sale of pharmaceuticals by a firm to two countries with different demand schedules. The firm, the monopolist for this drug, first uses a single posted price auction to sell the drug to both countries at the same price (Treatment 1). Next, the market is segmented and the firm announces a different price to each country (Treatment 2), and finally resale between buyers of the two countries is allowed (Treatment 3).

The experiment runs successfully: the outcomes converge to their theoretical predictions within a few rounds. The welfare implications of price discrimination become evident once low-income purchasers are unable to benefit from lower prices in the resale treatment.[4] In our experience, the experiment proves effective in providing intuition behind third-degree price discrimination and stimulating discussion about discriminatory pricing, its welfare effects and possible applications.

The paper is organized as follows. Section II describes the design and procedures. The typical classroom results are shown in section III. Section IV provides suggestions for post-experimental class discussion and section V outlines possible extensions. Instructions and suggestions for implementation are compiled in the appendix.

II. EXPERIMENTAL DESIGN

OVERALL STRUCTURE

We set up one or more isolated (non-interacting) identical markets, which we call 'worlds'. In each 'world' there is one seller and eight buyers. All trade is in a single undifferentiated pharmaceutical.

[4] To make the experiment interesting, we set-up the model and its parameters so that price discrimination increases total welfare (see experimental design section).

There are three treatments in the experiment, corresponding to different market (pricing and trading) conditions, each of which is played for several rounds. In our experience, 3-4 rounds were sufficient to observe convergence to the equilibrium predictions. The pricing scheme options available to the seller are announced in the instructions to each treatment.

DEMAND AND COST STRUCTURE

The seller of each 'world' produces with a constant marginal cost of 2 (and no fixed cost). Consumers are given a unit demand schedule, which leads to a step-function aggregate demand. A set of cards must be prepared for each 'world'. Each set of cards consists of 4 red-backed cards with values 3, 4, 5, and 6 as well as 4 blue-backed cards of values 7, 8, 9, and 10. Each buyer is dealt a playing card. The face value of the card is player's private valuation of the pharmaceutical, which he keeps secret. For the purposes of price discrimination, the back color of the card will identify the country of the buyer. "Americans" are the blue cards, while "Mexicans" are the red cards. The significance of the colors is not communicated to students until the second treatment.

Buyers can buy at most one unit. However, they may choose to buy nothing at all. The difference between the face value of their card and the posted price is the measure of their consumer's surplus which they record as their earnings for that round.[5] The seller's profit is the difference between price and marginal cost times the number of units sold. The seller does not have capacity constraints and can hence sell all units demanded. At the end of each round, buyers and sellers record their earnings.

Demand schedules are not revealed to firms a priori. Clearly, the demand is effectively known by the sellers when they are not allowed to price discriminate. When discriminatory pricing becomes possible, the sellers learn the demand schedules as the trading rounds are

[5] The buyer's surplus is zero if they do not buy.

repeated. To enhance information acquisition, we publicly announce before the first round of second treatment that the economies are identical and then at the end of each round we publicly announce the outcomes from other markets. While this set-up does not exactly replicate the typical theoretical textbook example it has the standard equilibrium predictions.[6]

TREATMENTS

Treatment I (Uniform Pricing): The seller announces a single price for the good. Then, any buyers wishing to purchase at this price do so by raising their hands and earnings are recorded. This trading process is repeated over multiple periods until the profit-maximizing outcome is observed.

Treatment II (Price Discrimination): The instructor announces the meaning of the color backings. The seller is now allowed to charge a different price for each market. The seller begins each round by announcing two prices, one for red (Mexicans) and one for blue (Americans). Mexicans are then allowed to buy first and Americans second. Earnings are recorded and the game proceeds for several rounds until equilibrium is observed.

Treatment III (Resale): In this treatment resale between markets is permitted. The game proceeds as in Treatment II except that after the purchases of both countries, students can attempt to make trades among themselves (and this is known to all market participants before the start of Treatment III). Each buyer continues to be limited to purchase one unit from the seller (i.e. the monopolist).

At the end of each round in each treatment, the prices, quantities and profit of the seller are displayed to the whole classroom in a table (e.g. Table 3 below for the uniform pricing

[6] The typical textbook theoretical model of third-degree price discrimination assumes perfect knowledge of demand. Here, firms don't have any knowledge about demand, except the potential number of units that could be sold and the range of private valuations (since we are using playing cards). We deal with this lack of information by repeating the exercise for some rounds and making the information about the outcomes at different markets public.

treatment). In addition to enhancing learning the demand, this ensures that students who have the role of buyers remain focused on the experiment as they participate in profit calculations and observe other market outcomes.

PREDICTIONS

Table 1 present information regarding the demand schedule, the sellers' outcomes and welfare measures for the first and second treatment (part a and b, respectively).[7]

Table 1: Demand, Firm Outcomes and Consumer Welfare

a. Uniform Pricing

Price	*# of Units Demanded*	*Total Revenue*	*Marginal Revenue*	*Total Profit*	*Consumer Welfare*
10	1	10	10	8	0
9	2	18	8	14	1
8	3	24	6	18	3
7	**4**	**28**	**4**	**20**	**6**
6	**5**	**30**	**2**	**20**	**10**
5	6	30	0	18	15
4	7	28	-2	14	21
3	8	24	-4	8	28

b. Price Discrimination without Resale

	Price	*# of Units Demanded*	*Total Revenue*	*Marginal Revenue*	*Total Profit*	*Consumer Welfare*
USA	10	1	10	10	8	0
	9	2	18	8	14	1
	8	3	24	6	18	3
	7	**4**	**28**	**4**	**20**	**6**
Mex	6	1	6	6	4	0
	5	**2**	**10**	**4**	**6**	**1**
	4	**3**	**12**	**2**	**6**	**3**
	3	4	12	0	4	6

Notes: Values in bold denote profit-maximizing outcomes.

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Given our parameters, the profit-maximizing price in the first treatment is the monopoly price of either 7 (or 6), which gives a profit of 20 with 4 (or 5) units sold. In the second treatment, the profit-maximizing price for the U.S. is 7 and 5 (or 4) for Mexico, giving a total

[7] Since the equilibrium prediction of the third treatment (resale) is identical to the uniform pricing option (treatment I) we only present tables for the first two treatments.

profit of 26 with 6 (or 7) units sold. In the third treatment, the resale option drives the monopolist to charge a unique price equal to the monopoly price[8].

While in general third-degree price discrimination has uncertain welfare effects, with our demand specification welfare increases. Classroom discussion may (and should) explain why with discriminatory pricing it is possible that only one market will be served in equilibrium (changing the demand parameters to run this case in an extra round is straightforward).

III. CLASSROOM EXPERIENCES[9]

In general, we have observed consistent results and little variability across classes with the typical outcomes as follows. In Treatment I, the price converges to the monopoly level after two to four rounds. In Treatment II, the sellers recognize quickly that they should charge different prices to the two markets. After the sellers have learned about the differences in demands between the two markets, the prices eventually converge toward the optimal levels (typically in three to four rounds). In Treatment III, it is now both the buyers and sellers who have to learn. After some rounds in which the buyers learn to make deals and change their initial demand, the seller eventually realizes that it is optimal to charge the

[8] Depending on a class level, this case can be explained to students both intuitively and formally solving for the subgame-perfect Nash equilibrium. Here we suggest one informal and quick argument. First, the students should notice that with the resale option and the valuations we chose, the monopolist will sell at most 4 units (each unit bought by a Mexican buyer will be re-sold to an American buyer; and adding the number of Americans still willing to buy will give at most 4). It is straightforward to see that selling lees than four units cannot be optimal. Setting a price for Mexicans below 7 would make them all buy and re-sell to Americans. A price greater than 6 would only attract Americans. Both cases lead to the conclusion that under price discrimination with resale possibilities the profit maximizing decision for the monopolist is to set a unique (or uniform) price equal to the profit-maximizing price under no price discrimination.

[9] We designed an Excell spreadsheet that facilitates recording the data and presenting results to students. It can be accessed at http://www.econ.jhu.edu/People/Metcalf/PD.xls.

same (non-discriminatory) price to both markets. Table 2 illustrates the outcomes of a typical session for the uniform pricing treatment.[10]

Table 2: Typical Convergence to the Equilibrium (Uniform Pricing)

Round	*Market*	*Price*	*Quantity*	*Profit*
1	A	\$10	0	\$0
	B	\$6	5	\$20
2	A	\$7	4	\$20
	B	\$5	6	\$18
3	A	\$6	5	\$20
	B	\$6	5	\$20

IV. POST-EXPERIMENTAL CLASS DISCUSSION

The main thrusts of the discussion to follow this experiment are (1) formal details of (third-degree) price discrimination (definition, necessary conditions for price discrimination to be possible[11], comparison with other types of price discrimination, total and group welfare effects, using different pricing schemes such as a two-part tariff), (2) policy implications and (3) applications, e.g. current issues in international pharmaceutical trade. It has been our experience that having a specific real-world application makes the students significantly more willing (and able) to gain an understanding of the theory.

In discussing the welfare effects of price discrimination, a leading question of whether price discrimination was welfare improving or, put differently, whether it was "right" to price differently to poor and rich, can begin the discussion. At first, the connotations of the word

[10] This was a small classroom of 20 undergraduate students at Virginia Tech. Although the number of students was relatively small, convergence to the equilibrium was achieved quickly in the third round. With more students (and hence markets), the flow of information is significantly greater and so is the speed of convergence.

[11] For instance, the ability to tell each person's type, which in our application is represented by the card color; why reselling must not be possible, as illustrated by the change from Treatment II to Treatment III.

discrimination will start some students thinking of welfare diminishing effects. However, a discussion of what actually happened to Mexican consumers after each treatment will clarify the welfare improving aspects for most students (i.e. Mexicans go from either no purchases, or zero total consumer surplus, to some units purchased and positive consumer surplus). Then, a direct computation of the surplus will rigorously show the total welfare improvement.

There is additional welfare issues not brought out by the game. One is the ability of the government to regulate the existence of monopolies, if price discrimination is not feasible, particularity because of resale, then the loss of welfare may be so great that the government may break the monopoly all together[12]. In more advanced classes, one may raise an issue of dynamic efficiency in the context of risky and costly innovation. The ability to price discriminate increases returns to innovation, and this can improve welfare since it increases incentives to invest in research.

Contrasting the good of breaking the monopoly with its bad dynamic effects on research is a good way to show the importance and difficulty of economic analyses. A related dynamic point is that in the EU, which specifically authorizes the resale or "parallel trade" of pharmaceuticals, the launching of new drugs is often much delayed for the poorer EU members, who could be expected to resell to their richer neighbors (Danzon, Wang, and Wang, 2003). Another related welfare issue is that welfare could be further increased by additional third-degree price discrimination within the current categories. This is a proposal for *refining* of price discrimination categories, *within* as well as between countries, to benefit

[12] Although few countries have explicitly rejected patent laws, large countries like India, Brazil and South Africa, in negotiating for lower prices, have worked out deals to allow for local production of their own generic versions of anti-retroviral AIDS drugs. Canada is said to be considering a similar program. This local-generic approach is supported by the World Health Organization and *Medecins Sans Frontiers* (in press).

the lower income groups within single countries. This already takes place within the US and other countries to some degree, with Medicare (seniors) and Medicaid (poor) patients getting access to cheaper drugs.[13] One solution to reselling is quantity limits, which would relate to a version of this game where people could buy more than one unit.[14, 15] In fact, quantity limits to Canada have started to take place in the pharmaceutical market (MacDonald, in press). An interesting discussion question would thus be to ask students what they think will happen if buyers are allowed to purchase multiple units.

A discussion of empirical findings on price discrimination could further enforce the real world aspects of this topic[16].

V. EXTENSIONS

The design we presented is flexible enough to accommodate all classroom sizes (see Appendix) as well as other variations the instructor may be interested in (e.g. unambiguous welfare effects, using different pricing schemes, allowing for multiple-unit resale, changing the context). The cost of running the experiment is virtually none.

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[13] Another problem is related to information about others' deals, when different international prices are well known, national governments can use "external referencing" to negotiate lower prices for themselves. External referencing is used in formal drug purchase agreements by Canada, Italy, Greece, and the Netherlands, and is probably used informally by many others.

[14] Another related point is that a price discrimination policy can include confidential rebate agreements between the drug company and individual countries. A single price could then be put forward, equal to the highest price (e.g., that in the richest country) that would have been charged under optimal between-country price discrimination. Secret negotiations would then be pursued with each individual country to determine their rebate amount. In equilibrium the after-rebate price should be identical to the optimal between-country price discrimination price for each country. The lump-sum nature of the rebate, however, should discourage parallel trade.

[15] We have run the experiment with this variation and the results are essentially the same, i.e. uniform pricing sets in when resale is allowed.

[16] Danzon and Towse (2003) point out that resale, or "parallel trade" as it is called in policy discussions, is not the only problem. Given these problems of parallel trade and external referencing, it is not surprising to find evidence of price convergence. Maskus (2001) shows only a weak positive correlation between per-capita incomes and international drug prices, and Scherer and Watal (2001) shows that the average price of AIDS anti-retroviral drugs in 19 countries was only 15% lower than the US list price. Danzon, Wang and Wang (2003) survey the evidence of a narrowing price band, but with delayed launch times within poorer countries.

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APPENDIX

INSTRUCTIONS AND SUGGESTIONS FOR THE INSTRUCTOR

PREPARATION BEFORE CLASS

To identify the high and low demand buyers, you will need at least two decks of cards of different colors, for example red and blue. If you have other colors, make sure you modify instructions accordingly. Separate from the red deck four sets of cards, each with the numbers 3, 4, 5 and 6. Separate from the blue deck four sets of cards, each with the numbers 7, 8, 9 and 10. With these cards, create four different sets of cards containing the numbers 3 through 10. Each of these four sets will then have four red cards (with numbers 3 through 6) and four blue cards (with numbers 7 through 10). Each of these four sets will be the reservation values of the buyers in each economy.

Two decks of cards should hence allow you to create four economies, each with eight buyers (with numbers 3 through 10) and one seller. To allow more students to be sellers, or to fit to your class size, you can group two or three students as a single seller and let them together come up with the price decision each round. In case you have a bigger class, you can add more decks. Assistants can help distribute instructions or collect information. A simple formula to figure out the set-up of a given class is class size divided by 9 then to distribute the remainder to be in the seller firms. The experiment is flexible enough to accommodate different class sizes. For example, if you have 66 students in a class you can have by our formula: 7 economies, with 3 economies having 2 students in the seller or you could have 6 economies with every seller having 3 students in it.

To show the results of each market in every round, we recommend you use a computer in a classroom that allows you to project the computer's screen so that everyone in the class can see the outcomes. We have developed a spreadsheet that allows you to register prices, quantities and sellers' profits in each market. This spreadsheet has built-in formulas that automatically calculate the sellers' profits. In addition, the spreadsheet creates tables and graphs that can be used for later class discussion (more on this in the discussion section). To ease instruction giving in class, we provide a PowerPoint presentation with relevant instructions laid out in slides.

RUNNING THE EXPERIMENT

The experiment can be run in approximately 40 minutes. Depending on the length of the class, discussion can either be conducted after the experiment or it can be delayed for the next session. Separate the economies (groups), and assign students the roles of buyers, sellers or assistants. Read the instructions for Part I of both buyers and sellers. Make sure that everyone has understood the exercise and ask if anyone has questions at this moment. Next, deal a card to each of the buyers of each market. At this point, do not mention the fact that some cards are red and some are blue and, if asked, say that the colors do not matter at this point in the game. Begin the first round of trading according to the instructions. At the end of each round, record the outcome (prices, quantities and profits) of each economy and make sure everyone in the class notices what they were and then begin the next round. For each treatment, read aloud the instructions for sellers and buyers for that treatment. Then proceed through the rounds of that treatment until prices converge or 5 rounds, which ever comes first. Since buyers who get cards with a number 3 or 4 have limited interaction ability, we recommend that at the beginning of each treatment you reshuffle the cards in each market. Also, make sure that sellers do not interact with buyers and display the results of all markets only after every group has finished trading.

INSTRUCTIONS

We are going to set up a market in which some people will be buyers of pharmaceuticals, and others will be sellers. Buyers are organized into separate groups of 8. Therefore, the total group of buyers must be a multiple of 8 (8, 16, 24, *etc.*).

Buyers: Each buyer will be given a numbered playing card. Please hold your card so that others do not see the number. The number on each card represents the dollar value of the utility (in dollars) that you receive if you purchase a unit of the product. You are only allowed to buy one unit. The dollar amount that you earn from each unit purchased is the face value of your card minus the price at which you purchase. You have the option of not purchasing, but then you will have earnings of zero. The game will be played for several rounds, please record your earnings for each round.

Sellers: To each group of buyers, there should be assigned one group of sellers, referred to hereafter as "The Seller," consisting of 1 to 3 people. The seller acts as a single unit selling to a group of buyers, so that the exact number of people in the seller group is not important. Individuals in the seller group should come to a consensus on the price at which they wish to sell. You are asked to provide a price with whole dollars (no cents).

The seller may sell as many units as are requested by consumers. The seller will be required to sell at a price that is no lower than Marginal Cost, which is $2. Earnings on the sale of each unit are calculated as the difference between the price negotiated and $2. The seller should record earnings for each round.

One seller and a group of 8 buyers represent an independent 'world'.

FIRST GAME

First, the seller announces one price at which the buyers in that world may purchase. Then, each buyer wishing to purchase at that price should raise his/her hand and record the purchase price and his/her earnings at that price (price - card number). If you are a buyer, and the quoted price is above your card number you MUST purchase the unit.

The seller should count and record the number of buyers purchasing at the quoted price, and then calculate its profits. This is done for a number of rounds.

SECOND GAME

Now we are going to set up a market in which some people will be Mexican buyers of pharmaceuticals, and others will be US buyers. Buyers with red cards are residents of Mexico, and buyers with blue cards are residents of the US. The game proceeds as before, except that now the seller announces two prices (one for each nation) and Mexican buyers will be given the opportunity to purchase first. After Mexican buyers have made their purchases US buyers are given the opportunity to raise their hands and purchase. Buyers and sellers will then record their earnings. Again, this is played for a few rounds. NOTE: Sellers' should record in the bottom table of their record sheets. If you are a buyer, and the quoted price is above your card number you MUST purchase the unit.

THIRD GAME

Proceed as in the second game, with the difference that now buyers have the option of reselling their unit to other buyers after the seller has concluded transactions with both the Mexicans and the Americans (remember Mexicans buy first, then Americans). If a buyer buys a unit from the seller and resells his/her unit to another buyer, earnings are calculated as the difference between the two prices (price sold – seller price). Otherwise, earnings are calculated as before: the difference between the price at which unit was purchased (whether it was from seller or another buyer) and the card number. To summarize this game:

a. Seller quotes two prices
b. Mexicans buy, Americans buy
c. Americans and Mexicans trade units (if desired)
d. Buyers and seller record earnings.

NOTE: as a buyer you are no longer required to buy if the quoted price is below your card number. Moreover, you may purchase a unit even if the quoted price is higher than your card number (if you can not resell the unit at a higher price you will incur in a loss).

BUYER'S RECORD SHEETS

GAMES 1 AND 2

Round	**Price**	**Earnings** (Card # - Price)
1		
2		
3		
4		
5		
6		
7		
8		

GAME 3

Round	**Price** (either from seller or from other buyer)	**Earnings** (Card # – Price) if did not resell (Price sold – Seller price) if resold
9		
10		
11		
12		
TOTAL		

SELLER'S RECORD SHEETS

GAME 1

Round	**Price**	**Quantity Sold**	**Revenue**	**Unit Cost**	**Total Cost**	**Profit**
1				2		
2				2		
3				2		
4				2		

GAME 2

Round	**U.S. Price**	**U.S. Quantity**	**Mexico Price**	**Mexico Quantity**	**Total Revenue**	**Unit Cost**	**Total Cost**	**Profit**
5						2		
6						2		
7						2		
8						2		

GAME 3

9						2		
10						2		
11						2		
12						2		
TOTAL								