*Journal of Industrial Organization
Education*

Manuscript 1040

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Block Pricing: A Refinement

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Abstract

In many textbooks, an important assumption difference between the standard picture for block pricing and the intuitive discussions on this pricing scheme is often ignored. This practice leads the students to misunderstand this picture as an illustration for price discrimination against heterogeneous buyers. In this article, I analyze how some textbook narratives can lead to this misinterpretation. Then, I provide a simple example that shows how block pricing discriminates buyers with heterogeneous demands. A real life example as applied to the transportation rates of natural gas for block pricing is also provided and discussed.

KEYWORDS: block pricing, heterogeneous demands

Author Notes: The author would like to thank the anonymous referee, James A. Dearden (the editor), Harold Winter and Rosemary Rossiter for helpful comments and discussions. All errors are my own.

1. Introduction

Block pricing is a widely used example of second degree price discrimination in Microeconomics and Industrial Organization textbooks.¹ It is a pricing scheme that is easy to explain to students because there are ample real life examples and its graphical illustration is closely tied to the first degree price discrimination on consumer surplus extraction. For these reasons, it is probably the most vivid example of second degree price discrimination that an undergraduate student will remember after studying various pricing schemes with monopoly power. The standard graph of the block pricing, however, does not sufficiently illustrate the discrimination aspect of block pricing as it is commonly understood since it assumes homogeneous demands. When the practice of price discrimination using block pricing is discussed after introducing the standard graph, students can be easily misled to believe that this graph actually shows the price discrimination against heterogeneous buyers from block pricing, which is a significant disservice to students. In this paper, I will first discuss the reasons of this misunderstanding created by some of the current textbook treatments of block pricing. Then I provide a graphical example that illustrates the price discrimination of block pricing under heterogeneous demands and discuss its merits. Finally, I discuss a real life example of block pricing for the transportation rates of natural gas.

2. The Standard Graphical Illustration

The standard graphical illustration for block pricing assumes that all buyers in the market have the same demand curve. As a result, the monopolist can use block pricing to extract more consumer surplus than uniform pricing at marginal cost but less than first degree price discrimination. For simplicity, Figure 1 applies only 2 blocks and two pricing points to present this standard illustration. In Figure 1, the monopolist sets the price for quantity purchased between zero and Q_1 at P_1 and quantity beyond Q_1 at P_2 . Given the demand curve D , each consumer will purchase the product up to Q_2 , where consumer's marginal valuation on the product meets P_2 . The marginal cost is assumed to be constant and is represented by the flat line marked as MC . Comparing with the uniform marginal cost pricing under perfect competition, the monopolist extracts additional consumer surplus,

¹ There are several other forms of second degree price discrimination. A classical example is the creation of different classes of flight tickets. Varian (2009) uses optimal packages as an example. Furthermore, some authors, such as Pindyck and Rubinfeld (2009) and Varian (2009) make a distinction between block pricing and quantity discount, where quantity discount is defined as optimal packages. Indeed, the practice of block pricing is often seen in the utility industry and the quantity discount or optimal packages are usually seen for groceries.

represented by the areas of rectangular d , e and f . When comparing with first degree price discrimination, where the monopolist charges prices for each additional unit exactly according to the marginal valuation on the demand curve D , block pricing in Figure 1 extracts less consumer surplus by the area of triangles a , b and c . Triangle c also represents the dead weight loss in this example.

Figure 1: Standard Graphical Illustration for Block Pricing.

Two textbooks, Thomas and Maurice (2011) and Brickley, Smith and Zimmerman (2009), provide the most accurate description of this standard illustration. The authors of both textbook first clearly point out that the demand curve as illustrated in Figure 1 is assumed to be the same for all consumers. They also conclude that all consumers will purchase the same quantity, which is a direct consequence of the homogeneous demands assumption. Even though the different units of goods purchased in Figure 1 have different prices, both the total expenditure on this product and the total quantity purchased are the same for all the buyers. This is contrary to the popular intuition that, under this pricing scheme, buyers with low demands pay higher average prices and purchase small quantities and buyers with high demands pay lower average prices and purchase large quantities. Many authors include the discussion of this idea in their textbooks, as documented below.

As modern textbooks become more and more readable and accessible to students, some authors discuss the standard illustration above without a clear

statement of the homogeneous demands assumption.² However, together with this kind of incomplete discussions, the same authors often also discuss the price discrimination using block pricing under the assumption of heterogeneous demands without explicitly stating the change of the assumption on the demand side. For example, Baye (2009, page 406) explained the merit of block pricing as

In effect, consumers purchasing small quantities (or alternatively, those having higher marginal valuations) pay higher prices than those who purchase in bulk.

Clearly, this statement implies heterogeneous demands; otherwise the purchased quantities would have to be the same for all customers as described in Thomas and Maurice (2011). Brickley, Smith and Zimmerman (2009, page 215) note that a necessary condition for buyer discrimination is to have heterogeneous demands, even though these authors do not go further to offer any graphical illustration of that idea.

There is a reason why it is easy for the authors to fall into this trap of a silent switch of assumptions. The graph for the first degree price discrimination is suitable for both homogeneous demands and heterogeneous demands. But the standard graph for block pricing is only suitable for homogeneous demands especially when its focus is the comparison with first degree price discrimination. Unless the switch between assumptions is made explicit, students who read the discussion of price discrimination using block pricing after studying the standard illustration may very well be misled to believe that this picture actually shows how price discrimination against heterogeneous buyers is done effectively using block pricing.

Can authors or instructors simply avoid the discussion of price discrimination of different consumer types for block pricing so as to avoid the possible misinterpretation? In my opinion, it is not a good option. If the instructor only presents the standard illustration, a question the students may ask is why the monopolist does not apply finer and finer blocks to extract more and more consumer surplus, which ultimately implies two-part pricing under homogeneous demands. After all, once the first block is determined and purchase behavior has been observed, it should not be very hard for the monopolist to figure out the rest of the demand curve especially if it is linear as shown in Figure 1. It is easier for an instructor to supply a satisfactory answer once the assumption of heterogeneous demands is introduced. Under heterogeneous

² For examples, see Allen, Doherty, Weigelt and Mansfield (2005), Baye (2009), Pindyck and Rubinfeld (2009) and Salvatore (2007). Some other textbook authors skip the standard illustration of block pricing all together. For examples, see Kreps (2004), Hirschey (2009), Samulson and Marks (2006), Keat and Young (2009), Keating and Keating (2009), and McGuigan, Moyer and Harris (2008). Varian (2009) only provides a graphical illustration for quantity discount as an example for second degree price discrimination and mentions block pricing without a graph.

demands, the monopolist has to design the blocks so that profit can be maximized given the mix of buyers in the market.

Also, when introducing various price discrimination schemes, Thomas and Maurice (2011) provide an extensive discussion on how pricing schemes can extract the information of heterogeneous demands. Using an optimized block pricing scheme, the monopolist can effectively let the buyers self-select into purchasing different quantities at different average prices without explicitly identifying different buyer groups. The exact optimization problem and its solution, however, are beyond the scope of this paper. When discussing the second degree price discrimination, Kreps (2004) noted

The practice of setting nonlinear pricing schemes is, in general, very complex. No hard and fast rules describe the structure of optimal schemes.

In the next section, we will have a look at how we can enhance the presentation of block pricing when heterogeneous demand curves are incorporated.

3. Block Pricing with Heterogeneous Demands

In this section, I will discuss a simple example that shows how block pricing can generate higher profits than uniform monopoly pricing under heterogeneous demands. In this example, there are two groups of buyers with two different levels of demands, high and low. The buyers with high level of demand will purchase more units beyond the initial block at a lower price. The profits for the monopolist under uniform pricing and block pricing can be easily compared in this example and block pricing clearly has an advantage. Figure 2 shows this example.

In Panel A of Figure 2, the demand curve for the low level group is marked by D_1 and the high level, D_2 . In this figure, we assume that each curve represents the demand of a single representative buyer from each group. The horizontal sum of the two demand curves then constitute the market demand curve, D_T in Panel B. The market marginal revenue curve MR_T and the marginal cost curve for the monopolist MC determine the profit maximizing uniform price P_1 , which leads to the total quantity purchased by the two buyers, Q_T . In Panel A of Figure 2, we can see that the low demand buyer will purchase Q_1 units and the high demand buyer will purchase Q_2 units under the single price P_1 .

If the monopolist wants to increase profits by adopting block pricing, a simple implementation can be set up by creating a block beyond Q_2 at a lower price. Let us assume that the monopolist tries to determine the optimal single price given the portion of the demand curve starting from point G and moving

downward along D_2 , the demand curve for the high demand buyer in Panel A. The marginal revenue curve for this portion is MR_2 , and it crosses the marginal cost curve MC at point D. Point D determines the price for the second block at P_2 . Notice that there is no need to consider the demand curve for the low demand buyer since Q_2 is higher than $\bar{Q}_1$, where the low demand buyer has zero marginal valuation on the product. Under this block pricing scheme, the high demand buyer will purchase up to Q_3 and the monopolist can make additional profits marked by the area ABCD comparing with the profits gained under uniform pricing. In Panel B, the profit under uniform pricing is marked with the dotted squares and the additional profit from block pricing is marked with solid squares (the same shape as the area ABCD). Also notice that in Panel B, the total quantity purchased is $Q_1 + Q_3$, which does not fully extend to the market quantity demanded on D_T at P_2 . This is due to the fact that the low demand buyer (D_1) has not purchased enough quantity so as to qualify for purchasing any quantity at P_2 under the block pricing scheme.

There are several advantages of this illustration for block pricing. First, the average price, P_1 , paid by low demand buyers is higher than the average price paid by high demand buyers, which is a weighted average of P_1 and P_2 . In this sense, the block pricing scheme can effectively discriminate against buyers with different demand levels. The insight for second degree price discrimination in general is the self-selection function in block pricing. In Figure 2, the monopolist uses a two-block pricing schedule to induce the buyers to self-select into purchasing different quantities and extract more consumer surplus. In particular, the size of the initial block Q_2 is large enough to prevent low demand buyers from buying a small additional amount at the lower price. In addition, the second block at lower price serves to extract more consumer surplus from the high demand buyer. In general, this choice of large initial block makes sense if there are much more high demand buyers than the low demand ones.

The second obvious advantage for Figure 2 is that the gain in profits from block pricing comparing with uniform monopoly pricing is clearly illustrated in Panel B. The additional profit is captured by lowering the price to P_2 on the block beyond Q_2 .

Additional welfare implications of block pricing Figure 2 may also be an interesting topic to discuss with the students. For example, it is fairly easy to compare Panel B in Figure 2 to an appropriate standard illustration of block pricing and show that the scenario in Panel B results in heavier deadweight loss. This is another result of excluding low demand buyers from enjoying the lower price on the second block by setting the initial block size large enough.

Figure 2: An Example of Block Pricing under Heterogeneous Demands

Students also practice the monopoly uniform pricing technique under different circumstances in the development of Figure 2. Furthermore, as an in-class exercise, it is straightforward for the instructor to ask the students how to setup another block using the same technique (hint: starting from point B in Panel A of Figure 2).

A clear limitation of Figure 2 is that it is a not necessarily an optimal design of the block pricing scheme with two blocks. As discussed before, searching for the optimal block pricing scheme is a complicated problem beyond the scope of the current paper. The differences in consumer demands and the relative weights of different groups of consumers matter to the optimal solution as discussed above. The complexity of the problem will increase with the desired number of blocks and total number of different kinds of buyers in the market. However, I do believe that the gains on economic insights for the students from this example will outweigh this limitation. The example in Figure 2 actually brings our theory closer to reality. It is also fine to mention the difficulties involved with the optimization problem to the students since they should also be exposed to the complexity of the real life problem.

4. A Real Life Example of Block Pricing

The use of block pricing by the public utilities industries is the most common example used by major textbooks. So I provide one such real life example below. Table 1 shows the GENERAL SALES RATES on natural gas transportation service charged by Columbia Gas of Ohio.³

Table 1: Transportation Rate Charged by Columbia Gas of Ohio (P.U.C.O. No.2, 2010*)	
General Sales Rates	
First 25 Mcf per account per month	\$1.7183 per Mcf
Next 75 Mcf per account per month	\$1.3000 per Mcf
Over 100Mcf per account per month	\$1.0325 per Mcf
Note: 1 Mcf = 1000 Cubic Feet = 10 Ccf.	
*This document can be found at http://www.columbiagasohio.com/en/about-us/tariff-information.aspx	

³ These rates are approved by the Public Utilities Commission of Ohio (P.U.C.O.), which regulates the pricing of utilities by private companies in Ohio. Notice that these rates are not the cost of natural gas, which is determined by the market for natural gas. Furthermore, there are different tariff schedules for different types of customers. The total price for natural gas consumption will include the cost of natural gas, various fixed fees and taxes, on top of the transportation service fee shown in Table 1. The pricing practice in electricity is similar.

From Table 1, we can see a clear example of declining block pricing. The range of the first block is from 0 Mcf to 25 Mcf, the second block from 25 Mcf to 100 Mcf and the third block beyond 100 Mcf. If customer A consumes less than 25 Mcf of natural gas in a month, the price is \$1.7183 per Mcf for the transportation of natural gas. If customer B uses 80 Mcf of natural gas in a month, the transportation charge will be \$42.96 (25×1.7183) for the first 25 Mcf and the remaining 55 Mcf will be charged at \$1.3 per Mcf. If customer C uses 120 Mcf of natural gas in a month, the transportation charge will be \$153.34 ($42.96 + 75 \times 1.3$) for the first 100 Mcf and the rest 20 Mcf will be charged at \$1.0325 per Mcf. Since the maximum consumption capacities of each customer are likely different from one another and these constraints usually will not change easily and frequently, the demands of different customers are naturally heterogeneous.

5. Conclusions and Discussions

In this paper, I first review the current treatment of block pricing in popular Microeconomic and Industrial Organization textbooks at intermediate level. The examination shows that the standard graphical illustration for block pricing is not sufficient in describing the discrimination aspect of this pricing tool. The elegant way that the standard graphical illustration can demonstrate surplus extraction often distracts authors and students alike from its restrictive assumption of homogeneous demands, which contradicts the assumption in the intuitive discussions of block pricing. Then I provide a new graphical example that demonstrates the implementation of price discrimination using block pricing under heterogeneous demands and I discuss the benefits and limitations of these graphs. An example of real life applications of block pricing in the natural gas industry is also provided. Both the new graphs and the real life examples for block pricing can help students to better understand how price discrimination techniques are used to increase profits and render them vivid impression on the distinctions and connections between different pricing schemes.

In teaching various price discrimination schemes, whether the consumers are homogeneous sometimes plays an important role. Under the context of first degree price discrimination, continuous price schedule and two-part pricing are straight forward to analyze under either consumer homogeneity or heterogeneity. But when using block pricing as an example for second degree price discrimination, different assumptions of consumer homogeneity require different analyses, as is emphasized in this paper. Furthermore, there are many other examples of second degree price discrimination that an instructor can choose from. Multiple classes of seats on an airplane, the use of coupons and take-it-or-leave-it

packages are just a few. Since the optimal solution to the second-degree price discrimination packages is well understood, it might be a better choice for instructors who prefer give a perfect answer to an economic problem. In addition, the profits from price discriminating packages can also be easily shown to dominate uniform pricing. Nonetheless, the analysis of block pricing under heterogeneous demands offered in this paper provides the instructors a better way to connect the theories of block pricing to its economic intuitions.

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