DEMAND SHIFTS IN MONOPOLY MARKETS

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Abstract

This paper introduces two exercises on shifts in simple non-linear demands within a monopoly market. These exercises aim to address a common misconception among undergraduate economics students: the mistaken belief that the comparative static effects of shifts in demand in monopoly and perfect competition are qualitatively identical. To illustrate that these comparative static results may diverge, we present examples in which an increase in demand—a shift to the right in the demand curve—leads to a higher price in a competitive market but results in a lower price in a monopoly market. Additionally, these exercises reinforce fundamental concepts such as marginal reasoning, profit calculation, and the significance of demand level and elasticity in monopoly pricing. Furthermore, they underscore the role of assumptions in economics. Our activities are tailored for undergraduate students enrolled in principles and intermediate-level economics, microeconomics, and industrial organization courses.

Keywords: monopoly pricing; comparative static; demand shifts

JEL Classification: A00, A20, D41, D42, L00, L12

Introduction

Economic principles and intermediate microeconomics courses introduce students to the analysis of market functioning under different market structures. Based on our experience teaching these courses, along with various other microeconomic-related classes, to diverse audiences over the years, students typically develop a solid understanding of the comparative statics effects of changes in demand under perfect competition. However, when we assess students' understanding of comparative statics under monopoly, the results are considerably less satisfactory. Specifically, while most students respond correctly to questions concerning demand shifts in competitive markets, their performance is less consistent when addressing questions related to the effects of demand shifts under monopoly. For example, consider the following multiple-choice question extracted from a final exam in intermediate microeconomics:

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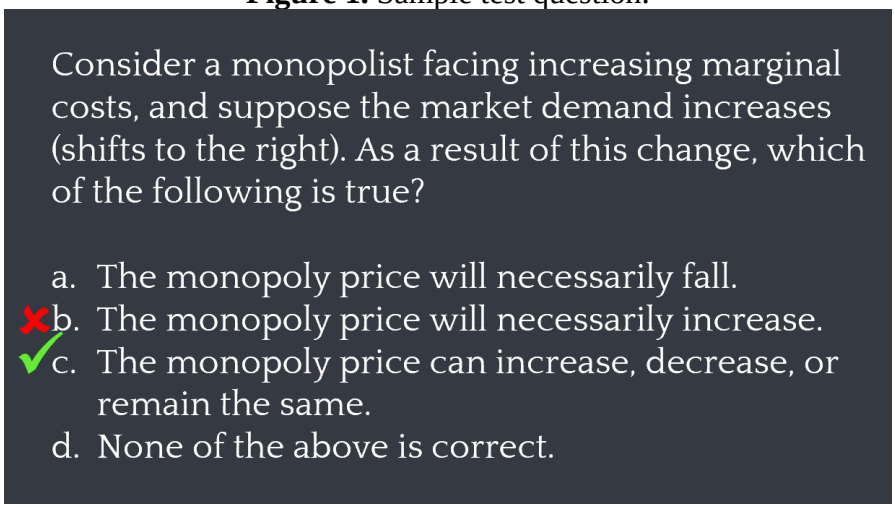
Figure 1. Sample test question.



In our experience, when students respond to a question like in Figure 1 without proper in-class discussion of the effects of demand shifts under monopoly, they are likely to select the incorrect option stating that the market price will necessarily increase, instead of the correct option that the effect on the equilibrium price may be an increase, a decrease, or no change. Anecdotal evidence suggests that this misunderstanding stems from incorrectly extrapolating the effects of demand shifts under perfect competition. Hence, we argue it is imperative to illustrate in class that the impacts of demand shifts under competitive markets do not necessarily carry over to other market structures.

To illustrate that the effects of demand shifts in a competitive market and a monopoly may differ, we propose two simple exercises. In these exercises, an increase in demand, which leads to a higher price in a competitive market, actually results in a lower price under monopoly. Moreover, these exercises allow us to demonstrate to students that price determination under market power involves more complexity compared to perfect competition. Introducing students to our exercises, either during class or in homework assignments, serves multiple (non-mutually exclusive) indirect purposes. First, it closes an instructional gap by adding to the discussion of demand shifts under competitive markets its counterpart under monopoly. Second, it benefits students by showing how the same demand and supply curves lead to different resource allocation results under two alternative market structures. Lastly, it engages students by offering a counter-intuitive (or seemingly paradoxical) result; a demand increase causes the monopoly price to fall. We find that discussing counter-intuitive results like this in class serves as a great eye-opener and increases class participation.

The analysis of the effects of demand shifts in monopoly is not new to the literature. Duncan (1942) showed that barring linear demands, neither the monopoly price nor its quantity needs to increase following an increase in demand. Surprisingly, we only found some reference to this observation in two graduate-level textbooks.[3] Undergraduate textbooks generally limit their attention to linear demands and are, therefore, unable to generate examples where the results of demand shifts in monopoly and perfect competition differ.[4] While the use of a linear demand to analyze competitive markets is a convenient simplifying assumption, its use under monopoly is

[3] Refer to Mas-Colell et al. (1995) exercises 12.B.2 and 12.B.3 and Tirole (1988) exercise 1.1.
[4] For a list of the reviewed textbooks, see Table 3 in the appendix.

not innocuous. Under linear demands and increasing marginal cost, an increase in demand invariably leads to a higher monopoly price. Consequently, by limiting the analysis of monopoly to linear demands, undergraduate textbooks reinforce an erroneous belief—that the qualitative results mirror those of perfect competition. To address this limitation, our exercises involve shifts of two simple nonlinear demand curves.

Our paper contributes to the literature in economic education that, in recent years, has explored ways to expand or supplement the content of principles and intermediate-level textbooks to assist instructors in integrating analytically complex models or new theoretical results into their teaching methods while ensuring student accessibility. Articles in this literature often introduce simplified versions of general models, simple numerical problems, in-class experiments, games, or other engaging activities. Examples in the fields of microeconomics and industrial organization include topics in competition with differentiated products (Nguyen & Gilbert, 2019), competition involving quality-differentiated demands (Adams, 2020), deadweight loss arising from imperfect information (Elwood, 2023), the Coase theorem (Gourley, 2018), market design (Nungsari & Flanders, 2020), and third-degree price discrimination (Coleff & Rubbini, 2023; Chao & Nahata, 2021).[5]

We organize the rest of the paper as follows: Section 2 introduces our exercises. Section 3 provides a real-world application to motivate the exercises, and Section 4 offers a brief overview of the pedagogical advantages of our exercises and concludes.

Two Exercises on Demand Shifts

This section presents two exercises to illustrate and compare the effects of demand shifts on the equilibrium price in both a monopoly and a competitive market. To facilitate the comparison between the two market structures, we make two common assumptions: first, that the monopoly produces under increasing marginal costs, and second, that its marginal cost curve coincides with the market supply curve under perfect competition. These assumptions serve to provide a clear basis for comparison.

To demonstrate that a shift in demand may lead to changes in opposite directions in monopoly and competitive prices, we construct examples in which an increase in demand leads to a decrease in the monopoly price and an increase in the competitive price. As previously mentioned, to obtain results like these, we must depart from commonly used linear demand models.

For expositional purposes, our exercises provide a direct comparison between the monopoly and competitive cases. However, the instructor may use the functional forms suggested to discuss the effects of demand shifts in competition and monopoly independently. The first exercise is suitable for any course on economics principles or intermediate microeconomics. The second one involves elementary calculus concepts and can be covered in intermediate microeconomics courses, making it particularly valuable for any industrial organization course.

Exercise 1: Discrete Demand

Consider a market for a product with four unit-demand consumers. Each consumer *i* has a known valuation of v_i dollars for the product and demands one unit if the posted price is less than

[5] The recent literature identifying omissions or limitations in standard principles and intermediate textbooks spans beyond microeconomics and industrial organization. For instance, see Johnson, Kovzik, & Burnett (2022) in principles of macroeconomics, Wai (2023) in econometrics, Cook & Pantuosco (2022) in international trade, and Berik & Rodgers (2023) in development.

or equal to her valuation v_i and zero otherwise. In other words, consumers' valuations v_i represent their willingness to pay for a unit of the product. The product is sold by a monopolist who supplies the product under increasing marginal costs. Assume that the first unit's marginal cost is 1, the second unit's marginal cost is 2, and the third and fourth units' marginal costs are 3 and 4, respectively.

Initially, assume that valuations are $(v_1^0, v_2^0, v_3^0, v_4^0) = (\$9, \$5, \$3, \$1)$. A single-price monopolist sets a price $p_M^0 = \$9$ to sell only a unit to consumer one. To illustrate how to find the monopoly price, instructors can start by constructing a table containing the information reported in the first five columns in Table 1 below. Subsequently, they can use this data to identify the price and quantity that maximize the firm's profit given the consumers' valuations. The first column (q) indicates the quantity produced and sold, the second column (p) is the maximum price the firm can charge for each of the corresponding quantities, the third column (R) is the revenue, the fourth column (C(q)) is the total cost of producing the corresponding quantities, and the fifth column (Profit) is the firm's profit.

The initial challenge in monopoly pricing is to capture the role of the maximum price given valuations. The instructor can guide students in understanding the second column by noting that if the monopoly sells one unit, the maximum price it can charge for this unit is $9. If the monopoly sells two units, the maximum price it can charge for each of these units is $5. In the same way, the maximum price the monopolist can charge for each unit if it sells three and four units is $3 and $1, respectively. The revenue shown in column three results from multiplying the quantity by its corresponding price (columns one and two). To calculate the cost in the fourth column, consider the marginal cost for the first, second, third, and fourth units, which are $1, $2, $3, and $4 respectively. Assuming for simplicity that the fixed cost of production is zero, the total cost of producing one unit is $1, the total cost of producing two units is $1 + $2 = $3, the total cost of producing three units is $3 + $3 = $6, and the total cost of producing four units is $6 + $4 = $10. Finally, the profit in column five is the difference between revenue and cost (columns three and four). Hence, the monopoly maximizes profit when the firm sells one unit for $9.

Table 1. Monopoly's Revenue, Cost, and Profit.

q	p_0	R_0	$C(q)$	$Profit_0$	p_1	R_1	$Profit_1$
(1)	(2)	(3) = (1) x (2)	(4)	(5) = (3) – (4)	(6)	(7) = (1) x (6)	(8) = (7) – (4)
1	9	9	1	8	12	12	11
2	5	10	3	7	8	16	13
3	3	9	6	3	6	18	12
4	1	4	10	-6	4	16	6

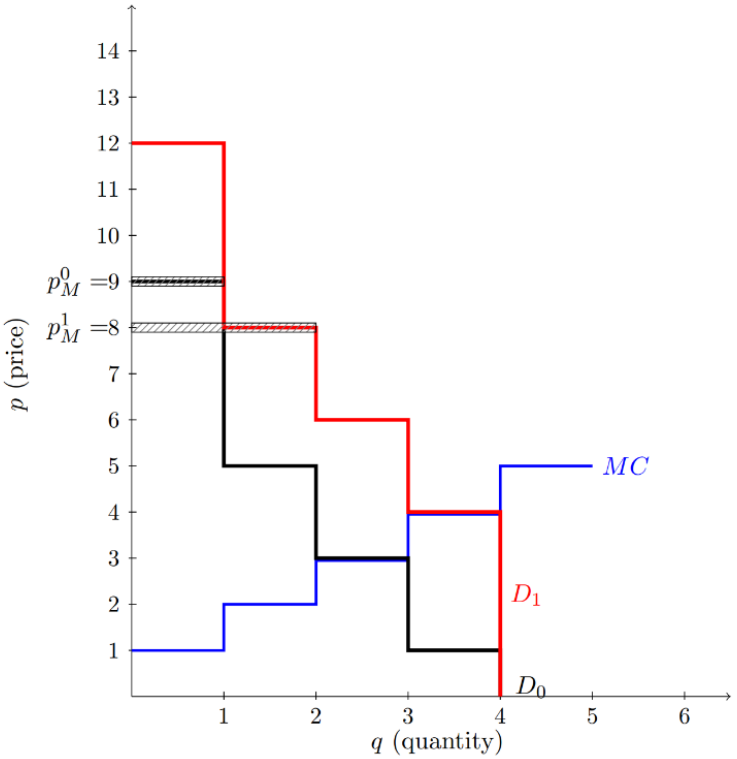
Instructors may also use the exercise to reinforce marginal thinking. For this, they can calculate the marginal revenue in the third column of Table 2 below and argue that the firm will not sell more than one unit as the marginal cost of the second unit exceeds the marginal revenue of this unit.

Table 2. Monopoly's Marginal Cost and Marginal Revenue.

q	MC	MR_0	MR_1
(1)	(2)	(3)	(4)
1	1	9	12
2	2	1	4
3	3	-1	2
4	4	-5	-2

Starting from the initial equilibrium where valuations are $(v_1^0, v_2^0, v_3^0, v_4^0) = (\$9, \$5, \$3, \$1)$ and monopoly price $p_M^0 = \$9$, suppose that each consumer's valuation increases by three dollars, such that $(v_1^1, v_2^1, v_3^1, v_4^1) = (\$12, \$8, \$6, \$4)$. This change represents a shift to the right of the demand curve. In this new situation, the monopolist sets a price $p_M^1 = \$8$ to sell two units; one to consumer one, and one to consumer two. Hence, the increase in demand leads to a decrease in the (monopoly) market price. Instructors can show how to determine this monopoly price in the same way as before using columns (6) and (8) in Table 1 or columns (2) and (4) in Table 2. The monopoly's equilibrium before and after the change is illustrated in Figure 2 below.

Figure 2. Discrete Demand.



It is straightforward to verify that the opposite is true in a competitive market; marginal cost pricing leads to a competitive market price $p_C^0 = \$3$ under the original demand and $p_C^1 = \$4$ under the increased demand. To illustrate these results, instructors can refer to columns (2) and (6) in Table 1 and column (2) in Table 2. In sum, in our simple numerical example, an increase in market demand leads to a decrease in the market price under monopoly and an increase under perfect competition.

A few practical observations are worth noting. First, in the example above, consumers' valuations increase in the same magnitude. It is simple to construct examples in which some valuations increase more than others, while qualitative results remain the same. Second, in each of our competitive equilibria, there is indifference between two quantities: two and three units in the original demand and three and four units in the increased demand. Instructors who wish to avoid these indifferences can modify valuations of consumers three and four appropriately. For example, if the original valuations of consumers three and four are \$3.20 and \$1.20, and if their increased valuations are \$6.20 and \$4.20 respectively, the competitive quantities become unambiguously three with the original demand, and four with the increased demand. In this case, marginal cost pricing leads to a competitive price of \$3 with the original demand and \$4 with the increased demand.

Finally, we presented different versions and variations of this exercise in economic principles and intermediate microeconomics classes. We typically supplement the discussion with appropriate tables or graphs. The in-class discussion takes us approximately 10-15 minutes.

Exercise 2: Continuous Demand

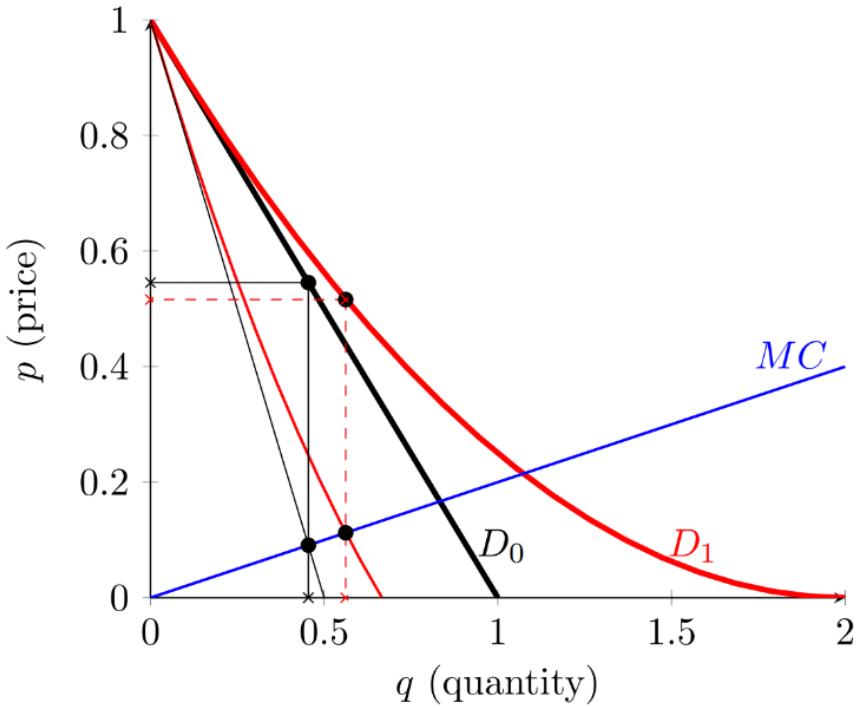
Consider a monopoly market facing a demand represented by the function $q_0(p) = 1 - p$ for $p \in [0,1]$. Let us assume that the cost function is $c(q) = 0.1q^2$ such that marginal cost $c(q) = 0.2q$ is a linear function of the quantity sold. Solving the monopoly's profit maximization problem $Max_p \Pi(p) = Max_p \, \mathrm{q(p)p} - \mathrm{c(q(p))}$ using the first-order conditions or the marginal-revenue-equal-to-marginal-cost condition, we verify that the monopoly sets a price $p_M^0 = \$0.545$ and sells $q_M^0 = 0.455$ units.

Suppose that starting from this original equilibrium, the demand curve shifts to the right, so the increased demand is $q_1(p) = 2\left(1 - \sqrt{p}\right)$ for $p \in [0,1]$. With this new demand, the monopoly price falls to $p_M^1 = \$0.516$ and the quantity sold increases to $q_M^1 = 0.562$ units. Figure 3 below represents the monopoly's equilibria.[6]

As in our previous exercise, an increase in the market's demand leads to a decrease in the monopoly price. This result contrasts with the commonly observed result under perfect competition, where an increase in demand leads to an increase in the market price. Indeed, under our demand and cost functions, it is straightforward to verify that marginal cost and price equalization leads to a competitive price of $p_C^0 = \$0.167$ under the original demand and $p_C^1 = \$0.215$ under the increased demand, with competitive quantities $q_C^0 = 0.833$ and $q_C^1 = 1.07$, respectively.

[6] We construct this example using demands within a family of demands with the structure $q(p,\alpha) = \alpha\left(1 - p^{1/\alpha}\right)$ for $p \in [0,1]$ and for $\alpha \in [0,+\infty)$. In our example, we restrict to $\alpha \in \{1,2\}$. We cannot use a linear demand to show that under an increasing marginal cost, a shift to the right in the demand curve (i.e., an increase in demand) may lead to a decrease in the monopoly price. To see this, consider a general inverse linear demand function given by $p = a - bq$ and, for example, a quadratic total cost $c(q) = cq^2$ (such that the marginal cost is $MC = 2cq$). Then, the monopoly price is given by $p_M = \frac{a(b+2c)}{2(b+c)}$. Notice that demand shifts upwards when "a" increases or/and "b" decreases, and, thus, the monopoly price p_M increases in "a" and decreases in "b". Formally, $\frac{\partial p_M}{\partial a} = \frac{(b+2c)}{2(b+c)} > 0$, and $\frac{\partial p_M}{\partial b} = \frac{-ac}{2(b+c)^2} < 0$.

Figure 3. Continuous Demand.



Beyond illustrating how the comparative static results differ under monopoly and perfect competition, the instructor can use this exercise to discuss other important topics pertaining to equilibria in a monopoly market. First, the instructor can bring to the students' attention that our demand shift increases the quantity demanded at each price (demand level) as well as the price elasticity of demand at each price. Note that the price elasticity for the original demand $\varepsilon^0 = \frac{p}{1-p}$ is less than the price elasticity for the increased demand $\varepsilon^1 = \frac{\sqrt{p}}{2(1-\sqrt{p})}$, for any price $p \in [0,1]$. The Lerner's index can be used to explain that an increase in demand elasticity induces a reduction in the (marginal) markup, which may lead to a price reduction.

Additionally, the instructor can use the example to argue that profits must have increased following the increase in demand; since the firm can charge a higher price for the original quantity while keeping the same total cost, then profits must be larger if the monopoly voluntarily chooses to reduce its price. Alternatively, the example allows the exact calculation of profits before and after the demand shift.

We presented different versions of this exercise in intermediate microeconomics and industrial organization classes. The in-class discussion takes approximately 15-20 minutes, but this time shortens when the instructor previously introduces students to the suggested demand in the context of perfect competition.

Application

In this article, we present exercises designed for students enrolled in principles, intermediate microeconomics, and industrial organization classes. These exercises focus on a key observation: unlike in competitive markets, a monopoly may lower prices in response to an increase in the demand curve. In one example, consumers' valuations increase by a fixed amount

($3 for each consumer). In the other, consumers' valuations increase, but this increment is heterogeneous among consumers.

A common pattern observed in these exercises is that demand becomes flatter after the shift. In the case of continuous demand, price elasticity increases at each price level when the demand curve shifts upward. To provide intuition for this type of demand increase, consider any action, investment, or shock that increases the valuation (or willingness to pay) of consumers with lower valuations more than that of those with higher valuations. In such scenarios, demand elasticity may substantially increase, as lowering the product's price encourages many new purchases. This increase in demand primarily occurs when consumers with relatively lower valuations are now willing to pay significantly more than before. To capitalize on this opportunity, the monopolist reduces the price, resulting in a significant boost in the quantity demanded.

To illustrate this phenomenon with a real-world example, let's consider the market for museum tickets, where numerous visitors are awestruck by exceptional artworks and historical artifacts. However, it is likely that some "amateurs" (individuals with limited knowledge about the exhibits) ascribe a lower value compared to well-informed "professionals" who recognize the significance of specific pieces. In cases like these, the introduction of QR code scanning with information about the artwork could impact amateurs differently from professionals. Occasionally, appending captivating information to a painting or attraction that non-professionals or amateurs would not be aware of in advance could elevate the amateurs' valuation more than that of experienced consumers or professional artists. Consequently, demand for museum tickets may rise unevenly, with a greater impact on amateurs than professionals, thereby enhancing the price elasticity of demand for museum tickets and potentially leading to a price reduction.

Examples like the increased demand for museum tickets through QR code scanning for special attractions can be valuable for in-class discussions. Tirole (1988) alludes to an instance of concert halls distributing booklets explaining the music and introducing the conductor, which enhances the valuation of consumers with lower willingness to pay.

In advanced courses, instructors can also establish a connection between these cases and the seminal paper by Spence (1975), which examines how product quality influences consumers' valuation (and thus demand). In Spence (1975), a specific scenario is analyzed where an investment that increases quality particularly enhances the valuation of consumers with relatively lower valuations.

Conclusion

In this paper, we have introduced two simple exercises aimed at addressing a common misconception among undergraduate students in principles and intermediate microeconomics courses – the mistaken belief that the comparative static effects of demand shifts in monopoly and perfect competition are qualitatively the same.

These exercises serve additional purposes. First, they provide students with the opportunity to practice marginal reasoning and profit calculation while working through the problems. Second, they lay the foundation for a more in-depth exploration of demand shifts and the role of elasticity in monopoly pricing. Despite undergraduate textbooks extensively covering the marginal-revenue-equal-to-marginal-cost condition and the markup expression tied to price elasticity of demand (Lerner's Index), some students form only a vague understanding of the essential variables influencing price determination in a monopoly. Our exercises help instructors to emphasize the critical distinction between price elasticity of demand and demand level as determining factors for prices in a monopoly market. While omitting the analysis of demand shifts under monopoly might

not pose a significant issue for economics majors, given that instructors cover this topic in more advanced courses, it's important to remember that many students in principles and intermediate classes do not major in economics and are therefore unlikely to explore this issue further in advanced courses.

Lastly, from a modeling perspective, the inclusion of examples with non-linear demand functions offers an excellent opportunity to engage in a meaningful discussion about the role of assumptions in economics. In competitive markets, the negative slope of demand is sufficient to demonstrate the effects of demand shifts on market price and quantity. As a result, a downward-sloping linear demand serves as a convenient simplification that does not sacrifice generality. In contrast, comparing the results of our exercises to those under linear demands demonstrates that the law of demand alone is insufficient to derive general comparative statics outcomes concerning demand shifts under monopoly.

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Appendix

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Acemoglu, D., Laibson, D., & List, J.A.	Microeconomics, 2nd.
Baumol, W.J., & Blinder, A.S.	Economics: principles & policy, 11th.
Case, K.E., Fair, R.C., & Oster S.M.	Principles of Economics, 10th.
Colander, D.C.	Microeconomics, 11th.
Cowell, F.	Microeconomics: principles and analysis, 1st.
Cowen, T., & Tabarrok, A.	Modern Principles of Economics, 3rd.
Frank, R.H.	Microeconomics and Behavior, 7th.
Frank, R.H., Bernanke, B.S., Antonovics, K., & Heffetz, O.	Principles of Economics, 7th.
Goolsbee, A., Levitt, S., & Syverson	Microeconomics, 2nd.
Greenlaw, S.A., Shapiro, D., & Taylor, T.	Principles of Economics, 2nd.
Hubbard, R.G., & O'Brien, A.P.	Microeconomics, 5th.
Krugman, P., & Wells, R.	Microeconomics, 5th.
Mankiw, N.G.	Principles of Economics, 9th.
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McConnell, C.R., Brue, S.L., & Flynn, S.M.	Microeconomics: principles, problems, and policies, 21st.
Miller, R.L.	Economics Today: the micro view, 17th.
Nicholson, W., & Snyder, C.	Intermediate Microeconomics and its Applications, 11th.
Parkin, M.	Microeconomics, 10th.
Perloff, J.	Microeconomics, 8th.
Pindyck, R.S., & Rubinfeld, D.L.	Microeconomics, 9th.
Varian, H.R.	Intermediate Microeconomics: a modern approach, 8th.