Chapter 2
The Firm at Home and Abroad

Monopoly at Two Places

(Greenhut–Manne Problem)

A monopolist sells a product at home and remote places. There is a cost to ship the product to the remote place or, alternatively, to build a second factory there. In Model 2A, a monopolist with one factory sells its product only at the home place. In Model 2B (localization), the firm also supplies the remote place from the same factory. In Model 2C (no localization), the firm builds a second factory at the remote place and serves customers at each place from their own factory. Model 2D considers a monopolist choosing whether to build one factory or two. Where the number of customers is sufficiently large—which in turn may require that the two places be sufficiently close together—there will be at least one factory and it will be located at the place with the larger demand. If the unit shipping cost is sufficiently low, there will be localization (i.e., one factory serves both places), and soap will be priced differently at the two places (partial freight absorption). Model 2E shows how one might think about entry deterrence at the remote place. If unit shipping cost is sufficiently high, and the smaller place has enough customers, the firm builds a second factory there and prices will be the same at the two places. In this chapter, localization and prices (one for each place) are joint outcomes of profit-maximizing behavior.

2.1 The Greenhut–Manne Problem

This book looks at the localization of firms in geographic space. This chapter begins with a model of a firm that serves customers at up to two places and has to decide whether to serve (1) one or both places from one factory or (2) each place from its own factory. The models presented in this chapter are adapted from Markusen (2002, Chap. 2). There is an extensive literature in this area that goes back to Manne (1967) in operations research and to Greenhut (1956) in Economics; hence, I call it the Greenhut–Manne problem. In the first of these alternatives, all production is localized in one factory; in the second alternative, production is spread across two distinct places. Since this model is concerned with just one firm, it allows us to look at localization of production rather than localization of firms. Nonetheless, it is a useful starting point for thinking about why concentration of production arises. I start the book with this model because it builds on the stuff of a first course.
in microeconomics so familiar to students whose only background is a first-year undergraduate course in Economics.

To begin, I review a conventional *non-spatial* microeconomic *model* of a monopolist who maximizes *profit*.¹ Is it strange to begin a book on competition and location with the case of a firm that is both non-spatial and a monopolist? After all, you might ask, “is not a monopolist *uncompetitive* by definition?” or “why *non-spatial* when we are interested in geography?” In part, the problem here is with the interpretation of monopolist in popular literature as opposed to Economics. Popularly, monopolist is taken to mean an industry with just one firm while, to an economist, it means simply that the firm can affect the price it receives or pays for a commodity. In this book, I use the economic interpretation and envisage the possibility of competitors. Even a firm that is alone in its industry faces competition to the extent a potential customer can forego the firm’s product in favor of substitutes. To me, such a firm is *non-spatial*²; it sells its product—which I hereinafter will call soap for ease of exposition—only at an adjacent (local) *place*³ (Place 1). For the firm, Place 1 is its *home market*. Throughout the book, I use “place” and “customer point” interchangeably. More narrowly, suppose Place 1 is an *isolated market*.⁴ I want to ignore shipping costs for the moment. Please be patient here. I begin with a non-spatial firm because I want to use it—later in this chapter—to contrast with a firm in a spatial setting otherwise similar.

A final note is in order as we get underway. In Chapter 1, I distinguish between *competitive location theory* (the subject of this book) and optimal location theory (not the subject of this book). However, cannot this chapter also be construed as a set of models in optimal location theory? After all, we are looking at a firm that maximizes profit. I agree, but my focus is different. What I do in this book is to use such models to address questions related to the consequences of competition.

### 2.2 Model 2A: Non-spatial Monopolist

I begin with the notion of a firm which I take to be a person or group of persons engaged in the production of soap for the purpose of earning a profit. For the moment, I don’t distinguish between a firm and the narrower concept of an *establishment*; that is, a branch of the firm that carries on business at a particular site. I don’t address here how the firm is organized (e.g., in terms of research, development, production, distribution, finance, and marketing) or about vertical integration and outsourcing because what the firm does and how it does it may

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¹The amount by which a firm’s revenue for a period exceeds its costs inclusive of a normal return on any unpriced factors such as owner equity or management skill. Also known as excess profit.
²A feature of a model wherein geography plays no role. Typically, shipping cost and/or commuting costs are assumed zero or are otherwise ignored.
³A market sufficiently small in area that we can ignore shipping costs on shipments of the good within that market.
⁴For this good, local producers and demanders transact in this and only this market. No one else transacts product there: e.g., no one purchases there for the purpose of reselling elsewhere or resells there a good purchased elsewhere.
2.2 Model 2A: Non-spatial Monopolist

depend on where it locates its chosen activities. Put another way, in the perspective of Coase (1937), any firm can be thought to use a combination of market prices for outputs and inputs together with some hierarchical (command) allocation and the balancing of these, in the context of location, is at the heart of this book. However, I ignore such balancing at this early stage of the book.

Assume the firm operates in a (paper) fiat money economy and plans to build a factory at Place 1 for which $K$ dollars of capital are needed. Assume this factory will last forever with regular annual maintenance. Suppose the annual opportunity cost of capital is a yield rate $r$. In this case, the opportunity cost of the firm’s investment is the profit that normally could otherwise be earned on this capital: $rK$. I use a period of 1 year here, but the analysis would be similar if I used say a month, a week, or a day. Note that $rK$ (the opportunity cost of capital) is a fixed cost; the firm incurs it regardless of the level of production. I assume here that the other possible investments by the firm all have a comparable level of risk—an assumption made to avoid the complexities of comparing investments with different yields and risks. For simplicity, assume the firm has no other fixed costs. As well, assume the firm has no choice as to the size of factory. The model does not permit the firm to build either a smaller factory (presumably at less cost) or a larger factory (presumably at higher cost). In this sense, I can imagine an indivisibility in scale of factory.

In making its investment decision, I imagine the firm in two distinct scenarios. In the capital-constrained scenario, the firm has a fixed amount of capital available, say $K$, and chooses where or how to invest it. In the unconstrained scenario, the firm can obtain as much capital as it wants at a given opportunity cost of $r$ annually per dollar invested. These scenarios are similar in that a profit-maximizing firm

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5 Ritter (1995, p. 134–135) describes the emergence of paper (fiat) money economies in the twentieth century and its relationship to seigniorage (the profit earned by a government on the difference between the nominal value of a coin and the cost of minting it). I assume here that the paper money supply is maintained by an authority (central bank) to ensure that the currency is a good store of value (or, equivalently, that the level of inflation is low).

6 Economists might prefer to measure capital physically (e.g., number of machines) rather than in dollars. Capital—measured in dollars—is a given physical amount of capital times the price per unit of capital. In turn, the price of a unit of capital can be thought to be determined in a market for plant and equipment where suppliers of capital commodities interact with demanders including our firm. A problem with using dollars, as done here, is that a change the price of a capital asset will have no direct effect on the amount of output that can be produced, say daily, from a given physical amount of capital. However, such productivity concerns are not relevant in this model since, as I comment below, the model assumes an unlimited wellspring of production once the factory is built.

7 The return on the best alternative investment opportunity available to the firm at a similar level of risk.

8 A caveat is in order here. Later in the chapter, I argue that the market clears. Depending on the nature of the production technology, that might be difficult to ensure if the period were very short, say one second to the next.

9 A cost incurred by the firm for a period of operation that does not depend on the quantity of output produced.

10 An attribute of a production process such that production cannot be replicated at a smaller scale with the same efficiency.
would seek to use capital efficiently. However, looking at the two scenarios gives us complementary perspectives on the behavior of the firm.

Assume the marginal cost is a constant \( C \) dollars per unit of soap produced. There is no congestion here. The marginal cost curve\(^{11}\)—the schedule of unit cost arrayed by quantity produced—is a horizontal line: see DF in Fig. 2.1. This includes the cost of manufacturing (e.g., commodity inputs, labor, and energy), the regular maintenance required to offset the wear and tear of production, advertising and promotion, and normal profit.\(^{12}\) The notion of a constant marginal cost is easiest to envision if I assume, over the relevant range of output considered, the firm has a Leontief technology\(^{13}\) (and therefore a linear expansion path),\(^{14}\) purchases its inputs in competitive markets (so the purchase price of each unit of an input is the same), regardless of the number of units purchased, and experiences no constraints on capacity,\(^{15}\) no congestion in its factory (that causes unit cost to rise as the scale of output is increased), and no economies of scale. Put differently, having invested \( K \) to construct the factory, and thereby incurring a fixed annual opportunity cost \( rK \), the firm finds itself with an unlimited wellspring of production\(^{16}\) at a constant marginal cost of production\(^{17}\) \( (C) \).

Assume here the firm is a price taker\(^{18}\) in markets for its inputs. As far as the firm is concerned, \( r \) and \( C \) are each simply a fixed expenditure required (per unit of \( K \) and \( Q \), respectively) that reduce profit. At the same time, \( r \) and \( C \) reflect the prices of inputs. In purchasing them, the firm competes in markets for inputs along with

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\(^{11}\)A schedule showing the marginal (additional) cost incurred by the firm (usually over the short run wherein capital invested is held constant) as a function of the quantity to be supplied.

\(^{12}\)The profit attributable to an unpriced factor of production such as entrepreneurial skill or owner equity.

\(^{13}\)A production technology characterized by the fact that each unit of output produced requires exactly the same amount of an input regardless of the relative prices of inputs. In other words, there is no substitutability among inputs in production. Put differently, a doubling of output requires a doubling of each and every input used in production. It is named after Wassily Leontief, an American Economist and Nobel Laureate (1973), whose main area of research was input–output analysis.

\(^{14}\)As used here, a condition of a production function wherein, if as firm expenditure (output) is increased by a fixed proportion holding prices of inputs constant, the efficient firm purchases the same proportion more of each input.

\(^{15}\)The amount of output that can be produced by a given factory over a stated period of time. In a simple case, we imagine that the unit variable cost of production is fixed per unit for any quantity up to capacity (marginal cost of production is a horizontal line up to capacity). To allow for the concept that no quantity greater than capacity is possible, we typically assume the marginal cost curve then becomes vertical. In other words, no matter how much the firm might want to further increase quantity, it cannot produce a quantity in excess of capacity.

\(^{16}\)In effect, \( rK \) is akin to a lump-sum licensing fee paid annually by the firm that gives it authority to produce as much of the commodity as it wants during that period.

\(^{17}\)The increment to the firm’s total cost incurred by the last unit produced.

\(^{18}\)A condition under which a market participant (supplier or demander) is unable to affect the price they receive or pay for a unit of the product by varying the quantity that they supply or demand. The supplier (demander) sees the demand (supply) for its product as horizontal: i.e., infinitely elastic at the given market price.
2.2 Model 2A: Non-spatial Monopolist

Model 2A: Monopoly price at one place
- AB Aggregate inverse demand curve: see (2.1.4)
- AC Marginal revenue curve: see (2.1.5)
- AN Elastic segment of the aggregate inverse demand curve
- DF Marginal cost curve
- DMHE Fixed cost ($K$)
- GHI Average cost curve: see (2.1.2)
- LAKL Consumer surplus: see (2.1.12)
- MLKH Excess profit due to monopoly: see (2.1.8)
- NB Inelastic segment of the aggregate inverse demand curve
- OA Intercept of inverse demand curve ($a$)
- OAKJO Consumer benefit: see (2.1.10)
- OD Marginal cost ($C$)
- OJ Profit-maximizing output ($Q_1$): see (2.1.7)
- OL Profit-maximizing price ($P_1$): see (2.1.6)
- OM Average cost
- OMHJO Producer cost including fixed cost: see (2.1.11)

Fig. 2.1 Model 2A: monopolist located and selling at Place 1 only.

Note: $a = 15$; $\beta = 1$; $C = 3$; $K = 50,000$; $N_1 = 200$; $r = 0.05$. To maximize profit, firm sets $P_1 = 9$ and $Q_1 = 1200$. Horizontal axis scaled from 0 to 4,000; vertical from 0 to 16

others demanding those inputs. To the extent it affects the price of $r$ or the prices of other inputs making up $C$, such competition may affect the location of our firm.

Suppose the firm plans to produce quantity $Q_1$ annually with this factory. Since I assume that markets clear throughout this book, I use $Q_1$ to refer interchangeably to the quantity produced by the firm and the quantity demanded by customers. Therefore, inventory is zero (ignored). The firm’s total cost and average cost, both inclusive of the opportunity cost of capital, are now given by (2.1.1) and (2.1.2). See Table 2.1, wherein I summarize the equations, assumptions, notation, and rationale for localization in Model 2A. Average cost is the sum of marginal cost (assumed constant above) and average fixed cost (which drops the greater the quantity of soap over which to spread the total fixed cost, here only $rK$). This firm has a declining average cost; the greater the output, the lower the average cost of units produced. See the average cost curve and marginal cost curve: labeled GHI and DF, respectively, in Fig. 2.1.

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19 For a firm, the sum of variable and fixed costs of production inclusive of any unpriced resources such as entrepreneurial talent.
20 For a firm, total cost divided by the amount produced.
Table 2.1 Model 2A: monopolist located and selling at local Place 1 only

<table>
<thead>
<tr>
<th>Equation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$rK + CQ_1$</td>
<td>Total cost</td>
</tr>
<tr>
<td>$rK/Q_1 + C$</td>
<td>Average cost</td>
</tr>
<tr>
<td>$P = \alpha - \beta q$</td>
<td>Individual inverse demand curve</td>
</tr>
<tr>
<td>$P_1 = \alpha - \beta Q_1/N_1$</td>
<td>Aggregate inverse demand curve</td>
</tr>
<tr>
<td>$\alpha - 2\beta Q_1/N_1$</td>
<td>Marginal revenue</td>
</tr>
<tr>
<td>$P_1 = 0.5(\alpha + C)$</td>
<td>Profit-maximizing price, assuming $\alpha &gt; C$</td>
</tr>
<tr>
<td>$Q_1 = 0.5N_1(\alpha - C)/\beta$</td>
<td>Profit-maximizing quantity</td>
</tr>
<tr>
<td>$0.25(\alpha - C)^2N_1/\beta - rK$</td>
<td>Monopoly excess profit (MP)</td>
</tr>
<tr>
<td>$N_1^* \geq 4\beta rK/(\alpha - C)^2$</td>
<td>Minimum number of customers required</td>
</tr>
<tr>
<td>$0.25(1.5\alpha + 0.5C)(\alpha - C)N_1/\beta$</td>
<td>Consumer benefit (CB)</td>
</tr>
<tr>
<td>$rK + 0.5(\alpha - C)CN_1/\beta$</td>
<td>Producer cost including fixed costs (PC)</td>
</tr>
<tr>
<td>$0.125(\alpha - C)^2N_1/\beta$</td>
<td>Consumer surplus (CS)</td>
</tr>
<tr>
<td>$0$</td>
<td>Producer surplus (PS)</td>
</tr>
<tr>
<td>$0.375(\alpha - C)^2N_1/\beta - rK$</td>
<td>Social welfare (SW): $SW = CS + PS + MP$ or $SW = CB - PC$</td>
</tr>
<tr>
<td>$\varepsilon_{11} = -(P_1/Q_1)(dQ_1/dP_1) = (\alpha + C)/(\alpha - C)$</td>
<td>Price elasticity of demand at Place 1</td>
</tr>
</tbody>
</table>

Notes: Rationale for localization (see Appendix A): Z1—Presence of a fixed cost; Given (parameter or exogenous): $a$—Intercept of individual linear inverse demand curve: maximum price; $b$—Negative of slope of individual linear inverse demand curve: marginal effect of quantity on price received; $C$—Marginal unit production cost; $K$—Capital required to build factory; $N_1$—Number of consumers at Place 1; $r$—Opportunity cost of capital. Outcomes (endogenous): $N_1^*$—Minimum number of consumers required; $P_1$—Price of unit of soap at Place 1; $q$—Per capita consumption of soap; $Q_1$—Quantity of soap supplied to Place 1; $\varepsilon_{11}$—Price elasticity at Place 1 at market equilibrium.
I implicitly assume this is an efficient firm. This should not be surprising given I have assumed that the firm maximizes profit. However, let me illustrate the pervasiveness of the concept of efficiency here by focusing on four assumptions I make. First, there is no other way of building this production facility at Place 1 that would require less than $K$ units of capital. Second, the lowest possible opportunity cost of capital is $r$ annually per dollar invested assuming the firm draws capital away from its worst (more correctly the least-best) performing investment of similar risk and that the latter is nonetheless better than any other investment at that level of risk that the firm might make. Third, there is no other production technology more efficient than that which underlies the fixed marginal cost $C$. Fourth, the average cost given by (2.1.2) is the least cost possible for any given level of output. Throughout the book, I assume firms are efficient in all respects. In reality—as any business manager might be quick to point out—a firm will typically have to make much effort simply to get to this stage. As far as the economist is concerned, the firm can be thought to have already done a kind of economic due diligence.

Assume $N_1$ identical individuals at Place 1 who each purchase soap for their own consumption. Assume unit shipping cost is zero; hence effective price is simply price. Put differently, the home market customer is assumed to bear no costs related to search and information gathering, negotiation, and acquisition (including freight and transfer, storage and inventory, agency and brokerage fees, credit, cost of insurance and other loss risks, installation and removal, warranty and service, and taxes and tariffs). For simplicity of analysis, I assume such costs—where they occur—are borne by the firm and therefore included in the marginal cost of production, $C$, per unit of soap produced.

Assume as well each customer has the same individual linear inverse demand curve for the firm’s product where $P$ is price, $q$ is individual quantity consumed over the year, $\alpha$ is the intercept (i.e., the price above which a customer demands zero), and $\beta$ is the slope (the amount by which the price the customer is willing to pay drops for each unit of soap the firm wants to sell to the customer in the time period under consideration). In responding to this demand, the firm agrees to exchange units of soap for money. Why does it want to do this? In large part, the answer is that—to the extent inflation is low—money is what economists call “a store of value” that the firm can then use to pay its suppliers and to distribute

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21 An efficient firm (1) incurs the least possible cost in achieving its desired output and (2) seeks the maximum revenue possible from that output. It adopts an organizational structure that enables it to be efficient. It has a production function which shows, for each combination of inputs, the maximum possible output that can be produced with those inputs. The firm also has a cost function which shows, for each level of output ($Q$), the minimum possible cost of achieving that $Q$. Finally, the firm knows the demand for its product and exploits that information along with the knowledge of its cost and production functions to maximize its own profit.

22 See (2.1.3). A demand function is generally expressed as a schedule of quantity demanded ($Q$) at various prices ($P$): i.e., $Q = f(P)$. An inverse demand function rearranges this as the price consumers are willing to pay as a function of the quantity supplied to the market: that is, $P = f^{-1}(Q)$. 

profits to its owners. More generally, we can think of money as just another desirable commodity used by the firm (1) to barter with suppliers or (2) for whatever other purpose ownership of that commodity might be used.

What kinds of assumptions are implicit in Equation (2.1.3)?

- There is no multiyear setting here. The customer demands $q$ units each year unless something (i.e., $P$, $\alpha$, or $\beta$) changes from 1 year to the next. This is consistent with the idea that the individual starts the year with no inventory of soap and consumes all $q$ units by the end of the year. Implicitly, soap is therefore perishable—perhaps because it has a “best before” date—and cannot itself serve as a store of value.\(^{23}\)

\[
\begin{array}{|c|c|}
\hline
\text{Person} & \text{Demand} \\
\hline
1 & q = \alpha/\beta - P/\beta \\
2 & q = \alpha/\beta - P/\beta \\
\cdots & \cdots \\
N & q = \alpha/\beta - P/\beta \\
\text{All} & Nq = N\alpha/\beta - NP/\beta \\
\hline
\end{array}
\]

- The demand curve tells us nothing about how frequently the customer shops for soap during the year or how much is purchased at a time. A commodity may be consumed on the spot at time of purchase (e.g., an ice cream cone). In other situations (e.g., a bar of soap), the commodity might be brought home and consumed slowly over time. In the latter case, the customer maintains a stock (e.g., a partial bar of soap), but I presume this disappears by the end of the year.

- Equation (2.1.3) is a particularly simple demand curve; it ignores income and the prices of complements and substitutes. Where does a demand curve come from? I find it helpful to think that (1) the customer is simultaneously participating in markets for commodities, (2) these commodities are, to varying degrees, pair-wise substitutable or complementary, and (3) the demand for any one product is downward sloping in price in part because of diminishing marginal utility and in part because of substitution effects.\(^{24}\)

\(^{23}\)A commodity would be a store of value if it was nonperishable and could be readily resold in the future: i.e., either converted back to cash at a low transaction cost or offer the possibility of capital gains.

\(^{24}\)Economists in general moved away the notion of diminishing marginal utility of commodities because it was seen to be based on a cardinal measurement of utility. Instead, the ordinal assumption of a diminishing marginal rate of substitution between commodities was invoked. In this book, I retain the use of diminishing marginal utility because students find it helpful. Where it becomes problematic (e.g., in Chapter 9), I will discuss the matter further.
subject to a budget constraint. By explicitly ignoring income and the prices of other commodities, (2.1.3) subsumes them into $\alpha$ and $\beta$.

I assume here that the firm knows—and is able to exploit—the individual demand curve. The firm is not a price taker in the market for soap (as is assumed in a perfectly competitive market); by varying the quantity supplied, the firm can affect price. After all, that is what makes it a monopolist. The intercept may be interpreted as a maximum price; the price paid rises to $\alpha$ as quantity supplied to the customer annually approaches zero. This corresponds to OA in Fig. 2.1. The customer views soap as an expendable commodity; it would sooner go without soap at all than pay a price in excess of $\alpha$. In a corresponding sense and with apologies to economists who may take affront with my casual usage here, I think of the marginal cost, $C$, as like a minimum price; a firm presumably could not sustain selling at a price below marginal cost indefinitely. Rewrite this as a demand curve $(q = \alpha/\beta - P/\beta)$ once for each customer in a list as shown above. Summing both sides of this set of individual demand equations, I get an aggregate demand equation: $N_1q - N_1(\alpha/\beta) - N_1P/\beta$. Aggregate demand is $Q = N_1q$. Because demand depends on the number of customers at Place 1, this is best envisaged strictly as a local demand, that is, assuming no demand (consumption) by non-residents. After substitution and rearrangement, I get the aggregate linear inverse demand curve (2.1.4): see curve AB in Fig. 2.1. Of course, since all customers are identical, $q = Q_1/N_1$ is simply consumption per customer. Here, the intercept ($\alpha$) and slope ($-\beta/N_1$) are the parameters of this aggregate demand curve. By definition, the larger the market ($N_1$), the less quickly price drops for a given increase in

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25 A skeptical reader here might well ask how a firm can know the demand curve of its customer when in fact it can, at best, try varying the price it charges to see how much of the good is demanded. This raises more generally the problem of whether economic agents ever have the full information about the market that is presumed by economists in these models. For an important paper on this topic, see Alchian (1950, pp. 220–221) on the famous adoption-versus-adaptation argument.

26 In a linear inverse demand curve, maximum price is the Y-intercept: the price at and above which the quantity demanded is zero.

27 An attribute of consumer demand for a product such that there is a price above which the consumer demands none of it. The opposite of an expendable good is an indispensable good: i.e., a good which must be consumed in some quantity, however small, even when its price is high.

28 The lowest price at which a profit-maximizing firm would participate in the market. Revenue just covers the variable cost of production. Minimum price is not sustainable over the longer run because fixed costs of production are not covered.

29 In a region, this is the demand for a product by consumers for local consumption and firms for local production. Specifically, local demand does not include demand by arbitrageurs for resale in another region. Marshall (1907, p. 112) invokes a similar notion when he refers to those who buy for their own consumption, and not for the purposes of trade. Larch (2007) uses a similar approach to local demand in international trade theory. In practice, there is no generally accepted standard in Economics for measuring local demand. In empirical practice, local demand is often taken to mean simply that the quantity demanded varies from one location to the next: see, for example, Megdal (1984) and Justman (1994).
quantity. As \( N_1 \) becomes large, the aggregate inverse demand curve approaches a horizontal line regardless of the slope of the individual inverse demand curve. If the firm supplies a small quantity for this market, customers are willing to pay a price approaching \( \alpha \); as quantity supplied rises, price drops.

Before making use of this aggregate inverse demand curve, let me add a caveat. I assumed above that all customers at Place 1 are identical. Specifically—thinking of the customer as consumer—each consumer has the same individual demand curve and each pays the same price. In this non-spatial model, the latter assumption is consistent with the view that unit shipping cost is zero. If instead customers at Place 1 were spread out over a geographic area and incurred a shipping cost for each unit of soap consumed, customers further from the firm would have a higher effective price—compared to customers closer to the firm—and therefore demand less. For the moment, I continue to ignore the complexities that arise in demand aggregation in a spatial economy because of shipping cost.

At this point, let me also juxtapose the firm’s demand curve beside its decision to invest capital in the construction of a plant. The demand curve shows the quantity the firm expects to sell in a period of time as a function of price. However, \( K \) is the money amount that has to be invested now to produce a quantity of soap each period from now until forever. Our model is so simple that it does not envisage a termination date for production or a scrap value at that time for the investment. How does a firm know what the demand will be for soap next year or at some other future period? Is not the firm somehow balancing the risk of a future downturn in demand against the return (profit) that it hopes to make in future years? To ease our way into location theory, I ignore such considerations in this chapter. My preference here is to think that the firm has some advantage over its competitors—e.g., better management, a process innovation, a good reputation in the industry, or social, political, and economic ties built up over the years—that it expects will enable it to adapt and survive in the future. To accountants, this corresponds to the value of goodwill; the amount a firm might be sold for over and above the value of its physical assets net of liabilities. To me, goodwill is a form of capital that the firm accumulates over time through investments of time (effort) and money. As such, it is different from the capital invested to build a factory in a particular location. In this chapter, I assume that the returns to this capital are part of the normal profit included in \( C \). Put differently, the firm invests in goodwill as a means of ensuring that its demand curve in future years will correspond to (2.1.4).

I assume the firm maximizes total profit (net of the opportunity cost of capital): \( PQ - CQ - rk \). We can imagine the firm, starting from an output of zero, increases \( Q \) until the additional revenue generated from the last unit of soap (marginal revenue) is no larger than the additional cost incurred (marginal cost). Marginal cost is easy to calculate here: it is just \( C \). The marginal revenue\(^{30} \) (MR) curve shows how

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\(^{30}\)The addition to the firm’s total revenue created by the last unit supplied by the firm to the market. If the firm’s demand curve is horizontal, it is a price taker (i.e., in a perfectly competitive market) and therefore its marginal revenue is simply the price. On the other hand, if the firm’s demand curve is downward sloping, marginal revenue is the price of the last unit sold minus the revenue
much total revenue increases for the last unit produced at different levels of output: 
\[ MR = \frac{d(PQ)}{dQ} = P + Q\frac{dP}{dQ} \]. See curve AC in Fig. 2.1. Because the aggregate inverse demand curve (2.1.4) is linear in quantity in this model, application of calculus shows us that marginal revenue is also linear in quantity and has the same Y-intercept (\( \alpha \)) and a slope twice as steep (\( -\frac{2\beta}{N_1} \)) as the demand curve.\(^\text{31}\)

As the firm increases quantity supplied, its \textit{semi-net revenue},\(^\text{32}\) continues to increase as long as price stays above marginal cost. In Fig. 2.1, semi-net revenue is the rectangle DLKED,\(^\text{33}\) To maximize \textit{excess profit} (semi-net revenue minus fixed cost), the firm chooses the quantity where marginal revenue equals marginal cost.\(^\text{35}\) As is well known to Economics students, the firm does \textit{not} maximize profit by setting price as high as possible (i.e., \( P = \alpha \)); instead, the firm takes into account how profit is also affected by the quantity sold. Note here also that excess profit will be larger when \( C \) is smaller; to the firm, \( C \) is a drain on profit. In Fig. 2.1, total revenue of the firm is the rectangle OLKJO, and excess profit is the rectangle MLKHM at the profit-maximizing quantity \( Q \).

From another perspective, excess profit arises because competitors for some reason cannot or do not produce the same commodity. If enough competitors were to produce the same commodity, the firm’s own demand curve would become horizontal and excess profit would disappear as new firms enter the market. Why does a firm have such an advantage? Often, the advantage can be tied to an input. It might be attributable, for example, to a technology not available to other firms (because of a patent for instance) or to a managerial skill unique to the owner of that firm. In such cases, the excess profit can be thought to be a \textit{Ricardian Rent},\(^\text{36}\) associated with that advantageous input.

As a consequence of assuming the aggregate inverse demand curve is linear in quantity, the profit-maximizing price (OL in Fig. 2.1) is halfway between the minimum price (\( C \)) and the maximum price (\( \alpha \)); OD and OA, respectively, in Fig. 2.1. Since \( C \), \( \alpha \), and \( P \) can be measured in dollars, (2.1.6) has the desirable feature that

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\(^{31}\)See (2.1.5). For ease of exposition throughout this book, I do not discuss the second-order conditions for profit maximization.

\(^{32}\)For a firm, revenue minus variable cost. In this book, variable cost includes both production and shipment. The firm’s net revenue (profit) is semi-net revenue minus fixed cost.

\(^{33}\)Throughout this book, I use the convention that variables (algebraic labels), equations, and expressions are italicized while other figure labels (representing points, lines, and areas) are not. All figures are labeled by their vertexes, and I indicate a polygon by repeating the first vertex again at the end of the label.

\(^{34}\)Revenue of the firm in excess of all costs, including normal profit on unpriced inputs like the firm’s capital and entrepreneurial skill.

\(^{35}\)See (2.1.6) and (2.1.7) and the corresponding excess profit (2.1.8). For those readers whose microeconomics is rusty, to the left of \( Q \) in Fig. 2.1, the firm finds that increasing \( Q \) also increases semi-net revenue. To the right of \( Q \), semi-net revenue falls if we further increase \( Q \).

\(^{36}\)An excess profit that arises because of an asset or market situation unique to a firm that prevents competitors from entering the market and/or earning the same profit.
there is no money illusion.\textsuperscript{37} Also, price is the same for every customer (since they are all identical and the marginal cost curve is the same for every one of them); it is unaffected therefore by size of market. In turn, the profit-maximizing quantity is positive as long as maximum price ($\alpha$) is higher than minimum price ($C$). This implies soap is expendable when $P_1$ exceeds $\alpha$ in that, if price is or above $\alpha$, customers at Place 1 would eschew soap. This itself is a consequence of the linearity of demand: i.e., because the demand curve crosses the Y-axis. Note also that although the number of customers at Place 1 ($N_1$) does not affect the profit-maximizing price (2.1.6), it does affect aggregate quantity demanded (2.1.7) and profit (2.1.8). Finally, as is well known to students of Economics, the monopolist always chooses a point (price and quantity) along the aggregate demand curve where the price elasticity of demand is larger than one (along segment AN in Fig. 2.1): i.e., where demand is price elastic.\textsuperscript{38}

Here, in thinking about the behavior of the firm, I distinguish between the short and long term. To survive in the short term, the firm must usually sell its product at a price sufficient to cover the variable cost\textsuperscript{39} of production. In other words, $P_1$ is greater than or equal to $C$. However, to be profitable over the long term, the firm must also recoup its fixed costs (that is, the opportunity cost of capital): i.e., $(P_1 - C)Q_1 - rK \geq 0$. There is an implication here for size of market. If the minimum required level of excess profit in (2.1.8) is zero, then the minimum number of customers ($N_1^*$) needed to achieve this is given by (2.1.9). Put differently, satisfying (2.1.9) creates a kind of home market effect in the sense that the market is large enough to enable production at Place 1.

Given a demand curve and a supply curve for a market, we know that as we hold the supply curve constant and shift the demand curve up or down, the equilibrium market outcomes ($P_1$ and $Q_1$) change in a way that has the effect of tracing out the supply curve. Now, imagine a thought experiment in which we alter the intercept of the demand curve ($\alpha$) in Model 2A. As we do, we know from (2.1.6) that $P_1$ will be higher if $\alpha$ is made larger. We also know from (2.1.7) that $Q_1$ will also be higher if $\alpha$ is made larger. In Fig. 2.2, I show—as curve A3DEFC—the locus of price and quantity that result from different values for $\alpha$. In this sense, we can think of curve A3DEFC as a quasi supply curve. To be clear, however, curve A3DEFC is upward sloped not because the firm’s unit costs are increasing with the scale of output (if anything, they are decreasing); instead, this supply curve is upward sloped because the monopolist captures the higher price now profitable because of the increase in $\alpha$.

More generally, in this model, there are six givens ($\alpha$, $\beta$, $C$, $K$, $N_1$, and $r$) and three outcomes ($P_1$, $Q_1$, and $N_1^*$). How would the outcomes change here were the

\textsuperscript{37}In a demand model, “no money illusion” means that price is relative to the units in which other money variables are measured. Put differently, if money quantities were all to double, quantity demanded would be unchanged.

\textsuperscript{38}See (2.1.15).

\textsuperscript{39}A cost incurred by the firm for a period of operation that varies with the quantity of output produced.
Model 2A: Tracing a local supply curve

A3C Local supply curve

D Profit-maximizing $Q_1$ and $P_1$ at $\alpha = 9$

E Profit-maximizing $Q_1$ and $P_1$ at $\alpha = 15$

F Profit-maximizing $Q_1$ and $P_1$ at $\alpha = 21$

**Fig. 2.2** Model 2A: tracing out a local supply curve by varying $\alpha$.

*Note:* $\beta = 1; C = 3; K = 50,000; N_1 = 200$ $r = 0.05$. Here, $\alpha$ is set to 3, 9, 15, or 21. Curve $A_3DEFC$ is the local supply curve: i.e., the locus of combinations of $P_1$ and $Q_1$ that maximize profit as $\alpha$ is varied. *Horizontal axis* scaled from 0 to 4,500; *vertical* from 0 to 25.

Given different? In Economics, such questions are the stuff of *comparative statics*. In this model, comparative statics can be derived from inspection of (2.1.6), (2.1.7), and (2.1.9): see Table 2.2.

- **$C$** If $C$ is increased, the firm’s profit margin is squeezed. The firm increases its price $P_1$; however, $Q_1$ decreases. Because each customer is purchasing less, $N_1^*$ must become larger.

- **$K$** If $K$ is increased, $P_1$ and $Q_1$ are unchanged. However, $N_1^*$ increases because the firm needs more customers to make enough net revenue to cover the opportunity cost of capital.

- **$N_1$** When $N_1$ is increased, the aggregate demand curve becomes flatter; that is, sweeps counterclockwise about $(0, \alpha)$. $P_1$ is unaffected, but $Q_1$ increases. $N_1^*$ is unchanged.

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40 A comparison of outcomes (endogenous values) predicted by a model when a given (exogenous variable or parameter) is changed by a small amount. Some models describe market equilibrium; here comparative statics details the changes in equilibrium when a given is changed by a small amount. In other cases, models describe optimal outcomes; here comparative statics details changes in optimal outcome when a given is changed.
Table 2.2  Model 2A: comparative statics of an increase in exogenous variable

<table>
<thead>
<tr>
<th>Given</th>
<th>$P_1$</th>
<th>$Q_1$</th>
<th>$N_1^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C$</td>
<td>+</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>$K$</td>
<td>0</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>$N_1$</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>$r$</td>
<td>0</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>+</td>
<td>+</td>
<td>−</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0</td>
<td>−</td>
<td>+</td>
</tr>
</tbody>
</table>

Notes: See also Table 2.1; +, Effect on outcome of change in given is positive; −, Effect on outcome of change in given is negative; 0, Change in given has no effect on outcome.

When $r$ is increased, $P_1$ and $Q_1$ are unchanged. However, $N_1^*$ increases because the firm once again needs more customers to make enough net revenue to cover the opportunity cost of capital.

If $\alpha$ is increased, the demand curve shifts upward and the price-quantity combination runs up the supply curve. Price rises: so too does the quantity transacted. Because customers individually purchase more than before, $N_1^*$ becomes smaller.

If $\beta$ is increased, the individual inverse demand curve sweeps clockwise about $(0, \alpha)$ and the price-quantity combination runs down the supply curve. At any price below $\alpha$, consumer demand is now lower than it was before. For the profit-maximizing firm, $P_1$ is unaffected but $Q_1$ decreases. Because each customer is purchasing less, $N_1^*$ must become larger.

Before leaving this model, let me add four thoughts.

First, the market here clears. On the supply side, the firm starts the year with no stock and retains no stock at year-end; in fact, there is no incentive to accumulate stock any time during the year. It sells all that it produces during the course of the year; there is no profit to be earned by producing more than the market demands over the year. On the demand side, customers demand exactly the quantity given by (2.1.7) when market price is (2.1.6); there is no unmet demand.

Second, I have said nothing so far about how the firm sells soap to customers at Place 1. Does it, for example, sell to a retailer who then operates a store selling soap to the customer? Costs are incurred in retailing: e.g., advertising and promotion, inventory and sales, and service and warranty replacement. In my view, it is easiest here to assume that (1) the factory operates a retail outlet on-site, (2) the unit cost $C$ includes the costs of retailing, and (3) customers purchase soap there. If instead I assume a separate retail establishment that sells soap, I need to consider the
wholesale price received by the factory, the markup used by the retail establishment, and its inventory holding.\footnote{See, for example, Hsu and Tan (1999).}

Third, the firm earns its semi-net revenue by producing at unit cost \( C \) a commodity that it then sells at a price \( P_1 \). Put differently, it earns a profit to the extent the prices of its inputs are low relative to the price at which it sells soap. In general, therefore, the firm—indeed any firm—can be thought to engage in a kind of \textit{arbitrage}: buying in (input) markets where prices are low for resale in a (output) market where price is high. What the firm does is transform inputs from low-priced markets into a commodity sold in a higher priced market.

Fourth, for some reason, the ability to produce soap at a marginal cost of \( C \) is restricted to just the firm or a small number of rival firms. This might be, for instance, because of proprietary knowledge, a particular managerial skill, purchasing power, or some economy of scale or \textit{division of labor} possible in production. Assume, instead, \( K = 0 \) and every customer at Place 1 could produce soap themselves at the same unit cost, \( C \), as the firm. I label this home production. Faced with paying a price \( P_1 \) in excess of \( C \) to acquire soap why would not customers simply produce soap themselves? In this case, the competition confronting the firm is home production. Of course, in the real world, the firm may have any of the advantages listed above that make it more efficient than home production. However, this idea gives us an interesting way (though not the only way) to think about \( \alpha \). Since \( \alpha \) is the maximum price, presumably it might correspond to the unit total cost (i.e., \( C \) plus unit capital cost) customers incur in home production. Suppose the firm sets its price just below \( \alpha \). On the assumption customers have diminishing marginal productivity in the activities in which they allocate their time, capital, and other household resources, they will give up some home production in favor of product purchased from the firm. If the firm were to further lower its price, the customer might give up more home production (a production substitution effect) as well as consume more of the commodity in total (a price substitution effect and an income effect). Presumably, such changes are reflected in the shape (slope) of the individual’s inverse demand curve.

\section*{2.3 Model 2B: Monopolist Selling at Two Places; Factory at Place 1 Only}

Now, suppose this same firm has the possibility of selling soap at a remote customer point (Place 2) with a common currency and no restrictions on the shipment of commodities other than a unit shipping cost. Other than for the possibility that the firm sells in both Places 1 and 2, assume Place 2 is also isolated. Let \( Q_1 \) and \( Q_2 \) be the amounts the firm supplies annually to Places 1 and 2, respectively, from its factory at Place 1 where \( Q_2 = 0 \) if the firm does not sell there.
Suppose the distance from Place 1 to Place 2 is \(x\) km. Let \(s\) be the (constant by assumption) cost per unit of soap shipped 1 km; hereinafter, I call \(s\) the unit shipping rate. In total, therefore, it costs \(sx\) to ship one unit from the factory at Place 1 to a customer at Place 2. In Chapter 1, I introduced the notion of a unit shipping cost. There, I defined it to be “transaction costs paid by the purchaser related to search, negotiation, and acquisition (including freight and transfer, storage and inventory, agency and brokerage fees, credit, cost of insurance and other loss risks, installation and removal, warranty and service, and taxes and tariffs) with respect to the commodity”. As noted in Chapter 1, there are two ways to think about \(sx\). One is that \(sx\) is exogenous: simply a resource cost for overcoming distance: e.g., fuel consumption, storage, and or costs related to information gathering. The other is that \(sx\) is endogenous to a regional economy: it includes services provided by shippers, brokers, service agents, retailer, and others, as well as the prices of these. Assume here that the firm is a price taker in these input markets. In this model, as far as the firm is concerned, \(sx\) is simply an exogenous aggregate fixed expenditure required (per unit shipped) that reduces profit.42

Before proceeding, let us consider the components of unit shipping cost. Specifically, when might these be proportional to distance as assumed here?

**Search, information gathering, and negotiation:** These expenditures are usually thought to be greater, the further apart are vendor and purchaser. However, it is not clear that these need be strictly proportional to distance. Also, these expenditures might best be regarded as an investment, with the cost itself being the opportunity cost of the capital invested. In an extreme case—search once then purchase frequently and forever—the opportunity cost involved may be small.

**Freight, transfer, agency, brokerage, credit, and cost of insurance and other loss risks:** These expenditures are usually thought to have two components: one related to distance and the other related to time. The latter includes both travel time and time spent handling the commodity at either end of the trip, at transfer points along the way, and in administration.

**Storage and inventory:** This includes costs related to the space required to hold inventory as well as to the opportunity cost of capital tied up in the commodity being store. It includes costs incurred by the producer, the shipper, and the customer. In each case, there is typically a tradeoff between inventory cost and freight cost; each agent holds inventory to reduce overall cost. In that respect, storage and inventory costs may well increase with the length of the trip.

**Installation and removal:** This includes costs related to the installation of the commodity where it is to be used by the customer and the cost of removing and disposing of product that it replaces. To the extent that installers must

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42In assuming \(sx\) fixed, I ignore the possibility of congestion on transportation networks that might cause \(sx\) to vary with the level of shipments. In this book, except where otherwise noted, I also ignore the idea that unit shipping cost might somehow vary directly with price: see Azar (2008) for a model where consumers perceive unit shipping cost to be relative to price.
be deployed and recycling/waste hauled away, such costs may increase with distance shipped.

**Warranty and service:** This includes costs incurred by the vendor or purchaser related to warranty coverage and/or service. To the extent that service agents must be deployed and product must be shipped for repair or replacement, such costs may increase with distance.

**Taxes and tariffs:** This includes sales and import taxes paid by the customer on purchases of the commodity. These can be related to distance as, when, and where tax or tariff is *ad valorem* based on a selling price that includes the cost of shipping.

The dichotomization of geographic space that I use here usually is called *punctiform*. This is a commonly used abstraction of geographic space wherein economic activity is portrayed as clustered at distinct geographic points (places). Put differently, economic activities themselves do not use land or otherwise occupy space. In this abstraction, shipping between activities located at the same place incurs a negligible (zero) cost; shipping between activities at two different places incurs a nonzero cost that is invariant with respect to the number or volume of economic activities there.

Throughout this chapter, I assume that all costs are borne by the firm; customers at Places 1 and 2 incur no unit shipping costs. In this section, I assume that the incremental unit shipping cost to a customer at Place 2 (over and above the cost incurred in supplying a customer at Place 1) is strictly proportional to distance. I assume here that the firm absorbs the unit shipping cost; it is free to set a *delivered price*\(^{43}\) at each customer point. Put differently, the firm engages in *discriminatory pricing*.\(^{44}\) I assume also that there are no impediments to shipment (e.g., quotas) other than shipping cost. The total cost to the firm is now given by (2.3.1). See Table 2.3. At the same time, assume that the firm can charge a distinct *delivered price* at each place (here, \(P_1\) and \(P_2\)) without fearing an arbitrageur might purchase soap at the lower-price place for resale at the higher-price place. To the extent the firm sets a higher delivered price at remote Place 2, it can recoup some, all, or perhaps even more than all, of the cost of shipping incurred.\(^{45}\)

Suppose each customer at Place 2 has the same individual linear inverse demand curve as at Place 1. In other words, \(\alpha\) is the same at the two places: so too is \(\beta\). Assume here as well that transaction costs are zero so that effective price equals price. Place 2 differs only in the number of customers there (\(N_2\)). Its aggregate inverse demand curve is shown in (2.3.2). Here, once again, \(\alpha\) is the maximum price the firm could expect at Place 2; \(\beta/N_2\) is how much the price at Place 2 falls as the firm increases the amount supplied annually by one unit.

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\(^{43}\)Firm sets price for good delivered to customer; consumer does not pay a separate shipping charge.

\(^{44}\)A pricing scheme used by a monopolist to enhance profit that results in different prices for different markets or submarkets, it is sometimes called third-degree price discrimination.

\(^{45}\)Depending on local price elasticities, there is even the possibility that the firm could set a price in the remote market that is lower than the price in the home market.
**Table 2.3** Model 2B: monopolist also selling at remote Place 2

<table>
<thead>
<tr>
<th>Description</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost</td>
<td>( rK + CQ_1 + (C + sx)Q_2 ) (2.3.1)</td>
</tr>
<tr>
<td>Aggregate linear inverse demand curve at Place 2</td>
<td>( P_2 = \alpha - \beta Q_2/N_2 ) (2.3.2)</td>
</tr>
<tr>
<td>Marginal revenue at Place 2</td>
<td>( \alpha - 2\beta Q_2/N_2 ) (2.3.3)</td>
</tr>
<tr>
<td>Profit-maximizing price at Place 2, assuming ( \alpha &gt; C + sx )</td>
<td>( P_2 = 0.5(\alpha + (C + sx)) ) (2.3.4)</td>
</tr>
<tr>
<td>Profit-maximizing quantity at Place 2</td>
<td>( Q_2 = 0.5(\alpha - (C + sx))N_2/\beta ) (2.3.5)</td>
</tr>
<tr>
<td>Monopoly excess profit (MP)</td>
<td>( 0.25((\alpha - C)^2N_1 + (\alpha - C - sx)^2N_2)/\beta - rK ) (2.3.6)</td>
</tr>
<tr>
<td>Range</td>
<td>( X = (\alpha - C)/s ) (2.3.7)</td>
</tr>
<tr>
<td>Minimum number of customers at Place 2 needed given ( N_1 ) fails</td>
<td>( N_2^* \geq \left{4\beta rK/(\alpha - C)^2 - N_1\right}[\alpha - C]/(\alpha - C - sx)^2 ) (2.3.8)</td>
</tr>
<tr>
<td>Consumer benefit (CB)</td>
<td>( 0.25(1.5\alpha + 0.5C)(\alpha - C)N_1/\beta + 0.25(1.5\alpha + 0.5(C + sx))(\alpha - C - sx)N_2/\beta ) (2.3.9)</td>
</tr>
<tr>
<td>Producer cost (PC)</td>
<td>( 0.5((\alpha - C)CN_1 + (\alpha - C - sx))(C + sx)N_2)/\beta + vrK ) (2.3.10)</td>
</tr>
<tr>
<td>Consumer surplus (CS)</td>
<td>( 0.125((\alpha - C)^2N_1 + (\alpha - C - sx)^2N_2)/\beta ) (2.3.11)</td>
</tr>
<tr>
<td>Producer surplus (PS)</td>
<td>0 (2.3.12)</td>
</tr>
<tr>
<td>Social welfare (SW): ( SW = CS + PS + MP ) or ( SW = CB - PC )</td>
<td>( 0.375((\alpha - C)^2N_1/\beta + 0.375(\alpha - C - sx)^2N_2)/\beta - rK ) (2.3.13)</td>
</tr>
<tr>
<td>Price elasticity of demand at Place 2</td>
<td>( \varepsilon_{12} = -(P_2/Q_2)(dQ_2/dP_2) = (\alpha + C + sx)/(\alpha - C - sx) ) (2.3.14)</td>
</tr>
</tbody>
</table>

**Notes:** *Rationale for localization* (see Appendix A): Z1—Presence of a fixed cost; Z8—Limitation of shipping cost. *Givens* (parameter or exogenous): \( C \)—Marginal unit production cost; \( K \)—Capital required to build factory; \( N_i \)—Number of consumers at Place \( i \); \( r \)—Opportunity cost of capital; \( s \)—Cost of shipping one unit of product one km; \( x \)—Geographic distance from Place 1 to Place 2; \( a \)—Intercept of individual linear inverse demand curve: maximum price; \( b \)—Negative of slope of individual linear inverse demand curve: marginal effect of quantity on price received. *Outcomes* (endogenous): \( N_2^* \)—Minimum number of consumers required at Place 2; \( P_i \)—Price of unit of soap at Place \( i \); \( Q_i \)—Quantity of soap supplied to Place \( i \); \( X \)—Range of soap (kilometers); \( \varepsilon_{12} \)—Price elasticity at Place 2 at market equilibrium.
As at Place 1, the intercept here is assumed positive and the slope (here $\beta/N_2$) is negative.

Here I implicitly assume that the demands at Places 1 and 2 are separable; the firm can set quantity and price separately at the two places. For some reason, the firm does not have to worry whether a difference in price between the two places might lead customers at the place with the higher price to purchase soap instead where the price is lower. I return to this matter shortly.

Suppose the firm now chooses $Q_1$ and $Q_2$ to maximize excess profit. My assumption that marginal cost is the same regardless of the quantity supplied to either Place 1 or Place 2 makes the problem separable: I can solve for $Q_1$ without knowing $Q_2$ and vice versa. In this case, the solutions for $Q_1$ and hence $P_1$ remain as in Table 2.1. With respect to $Q_2$, the firm then simply equates marginal revenue (2.3.3) with marginal cost ($C + sx$) for customers at Place 2. The firm will find it profitable to ship to customers at Place 2 as long as the maximum price at Place 2 ($\alpha$) is larger than the marginal cost of serving a customer there ($C + sx$). The firm will not find it profitable to supply Place 2 if $C + sx > \alpha$. If profitable, Place 2 will be part of the market supplied by the firm with a profit-maximizing combination of price and quantity there and a corresponding semi-net revenue (or, equivalently, added excess profit) earned from customers there (2.3.6). This is in addition to the excess profit (2.1.8) earned from customers at Place 1. Finally, note that the price elasticity of demand is larger here compared to (2.1.15) because unit shipping cost pushes the firm higher up the demand curve (i.e., up segment AN in Fig. 2.1) where demand becomes more elastic.

Comparing profit-maximizing prices at the two places, (2.1.6) and (2.3.4), we see the two prices differ by half the cost of shipping one unit of product from local Place 1 to remote Place 2. This principle—termed the half-freight rule—arises as a special case because I assume linear individual demand curves at the two places. If I had used another demand function (e.g., $q = aP - P$), the half-freight rule would not hold. Nonetheless, the model illustrates an important principle. For a monopolist, the difference in selling price between two places is not necessarily equal to the difference in shipping cost involved.

Now, imagine a thought experiment in which Place 2 is pushed further away from Place 1 and soap thereby becomes more costly to ship. Eventually, given the linear demand curve at Place 2, there would come a distance $X$ at which the most profitable price ($P_2$) would equal the maximum price ($\alpha$), and hence annual demand

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46 See (2.3.4) and (2.3.5).
47 See (2.3.14).
48 A market outcome in which the prices at which a monopolist sells the same good in two markets differ by half the difference in shipping costs of shipping to the two markets. In general, this arises when consumers in the two markets are identical and have linear demand curves.
there would drop to zero.\footnote{See (2.3.7).} In the view of the firm, that distance would constitute what is called the range\footnote{For an expendable good sold at an f.o.b. price, the distance at which shipping cost is sufficiently high to cause demand to drop to zero.} of soap. Of course, not every commodity need have a range.\footnote{The starting point for this book is the firm producing a good or service. The book therefore ignores firms whose business is the construction of a network. De Fraja and Manenti (2003) study the extension of local telephone calling areas—within which long distance charges do not apply—as a strategic variable chosen to maximize the carrier’s profit.} Some commodities might be indispensable:\footnote{An expendable good is such that there is a price above which the consumer demands none of it. The opposite of an expendable good is an indispensable good: i.e., a good which must be consumed in some quantity, however small, even when its price is high.} that is, customers need them regardless of price. In that case, the linear demand curve used here would be inappropriate.

As indicated in (2.3.6), Place 2 may add to the profit of the factory built at Place 1. Since the firm maximizes profit, it will ignore the second place unless it adds to the total excess profit that would otherwise be earned from Place 1 alone. From (2.1.8) and (2.3.6), the ratio of the semi-net revenue generated by a customer at Place 1 to the semi-net revenue of a customer at Place 2 is \((\alpha - C)^2/(\alpha - C - sx)^2\); put differently this gives the number of Place 2 customers equivalent to one Place 1 customer. Given sufficient customers at Place 2, a firm would have built the factory at Place 1 even if Place 1 alone would not support a factory in the sense of (2.1.9). In (2.3.8), the minimum number of customers at Place 2 needed to do this is calculated. On the right-hand side of (2.3.8), the left-hand pair of \{\} braces enclose the amount by which \(N_1\) falls short of the requirement for profitability. The right-hand pair of \{\} braces enclose the Place 2 equivalent.

Important here too is the conclusion that the delivered price at Place 2 does not depend on the number of customers (\(N_2\)) there. If the number of customers is insufficient, the firm may choose not to build a factory at all. However, if it is profitable to build a factory, the price charged at each place is insensitive to the relative numbers of customers at the two places.

Are there circumstances in which there would be arbitrage? Would a trader have the incentive to purchase soap at Place 1 and resell it at Place 2? Comparison of (2.1.6) and (2.3.4) tells us the price difference the monopolist would choose is \(P_2 - P_1 = 0.5sx\). In this case, on the presumption that the unit cost of shipping for the arbitrageur is also \(sx\), there is no incentive to purchase at Place 1 for resale at Place 2.

I have already characterized Place 1 as the home market and Place 2 as the remote market. Potentially, there is a home market effect here. If the population of Place 1 were large enough to enable (2.1.9), the firm would build a plant there. If \(C + sx\) is smaller than \(\alpha\), the firm would also sell product at Place 2 that it had produced in its plant in the home market. If the population at Place 1 is not large enough to enable (2.1.9), the firm would nonetheless build a plant there to serve both the home and remote markets as long as the population at Place 2 is large enough to enable (2.3.8).
In this model, there are eight givens \((\alpha, \beta, C, K, N_1, N_2, r, \text{ and } s)\) and eight outcomes \((N_1^*, N_2^*, P_1, P_2, Q_1, Q_2, X)\). How would the outcomes change here were the givens to change? In this model, comparative statics are readily derived from inspection of (2.1.6), (2.1.7), (2.1.9), (2.3.4), (2.3.5), (2.3.7), and (2.3.8). See Table 2.4.

### Table 2.4 Model 2B: comparative statics of an increase in exogenous variable

<table>
<thead>
<tr>
<th>Given</th>
<th>(P_1)</th>
<th>(Q_1)</th>
<th>(N_1^*)</th>
<th>(P_2)</th>
<th>(Q_2)</th>
<th>(N_2^*)</th>
<th>(X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(C)</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>(K)</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>(N_1)</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>(N_2)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(r)</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>(s)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>(\alpha)</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>(\beta)</td>
<td>0</td>
<td>–</td>
<td>+</td>
<td>0</td>
<td>–</td>
<td>+</td>
<td>0</td>
</tr>
</tbody>
</table>

**Notes:** See also Table 2.3; +, Effect on outcome of change in given is positive; –, Effect on outcome of change in given is negative; 0, Change in given has no effect on outcome; ?, Effect on outcome of change in given is unknown.

- **\(C\)**: If \(C\) is increased, the firm’s profit margin is squeezed. The firm increases price; however, quantity decreases as a result at both customer points. Because each customer is purchasing less, \(N_1^*\) and \(N_2^*\) must become larger. Finally, \(X\) becomes smaller.

- **\(K\)**: If \(K\) is increased, price and quantity are unchanged at both customer points. However, \(N_1^*\) and \(N_2^*\) increase because the firm needs more customers to make enough net revenue to cover the opportunity cost of capital. \(X\) is unchanged.

- **\(N_1\)**: If \(N_1\) is increased, the aggregate demand curve at Place 1 becomes flatter, that is, sweeps counterclockwise about \((0, \alpha)\). \(P_1\) is unaffected, but \(Q_1\) increases. \(N_1^*\) is unchanged. \(P_2, Q_2,\) and \(N_2^*\) are unchanged. \(X\) is unchanged.

- **\(N_2\)**: If \(N_2\) is increased, the aggregate demand curve at Place 2 becomes flatter. \(P_2\) is unaffected, but \(Q_2\) increases. \(N_2^*\) is unchanged. \(P_1, Q_1,\) and \(N_1^*\) are unchanged. \(X\) is unchanged.

- **\(r\)**: If \(r\) is increased, price and quantity are unchanged at each location. However, \(N_1^*\) and \(N_2^*\) increase because the firm once again needs more customers to make enough net revenue to cover the opportunity cost of capital. \(X\) is unchanged.

- **\(s\)**: If \(s\) is increased, \(P_1, Q_1,\) and \(N_1^*\) are unchanged. However, at the remote Place 2, the firm will increase \(P_2\) and therefore see a drop in \(Q_2\). Therefore,
$N_2^*$ increases because the firm once again needs more customers there to make enough net revenue to cover the opportunity cost of capital. Finally, $X$ becomes smaller as $s$ is increased.

$\alpha$ If $\alpha$ is increased, the individual demand curve shifts upward. The firm now finds that consumers at both customer points are willing to pay more for any given quantity than before. Both price and quantity increase in each market. Because customers individually purchase more than before, both $N_1^*$ and $N_2^*$ become smaller. Finally, as $\alpha$ becomes larger, it becomes possible for Place 2 to be further away from the firm, that is, $X$ becomes larger.

$\beta$ If $\beta$ is increased, the individual inverse demand curve sweeps clockwise about $(0, \alpha)$. At any price below $\alpha$, customer demand is now lower than it was before at both customer points. For the profit-maximizing firm, price in each market is unaffected but quantity decreases. Because each customer is purchasing less, $N_1^*$ and $N_2^*$ must become larger. $X$ is unchanged.

In this model, how does the firm retail to a customer at Place 2? One strategy is to sell to both customers at Places 1 and 2 from the same retail outlet on-site at Place 1. A second strategy is to have a retailer at Place 2 sell soap there at an agreed-upon markup. In Model 2A, the firm’s marginal cost of production, $C$, presumably includes the cost of retailing per unit sold to a customer at local Place 1. In Model 2B, the unit shipping cost, $sx$, presumably includes any extra cost of retailing per unit sold to a customer at remote Place 2.

### 2.4 One Market or Two?

From the firm’s perspective, Places 1 and 2 can be said to constitute its market; they are the customers and places where the firm sells soap. To an economist however, a market is something else. In Chapter 1, I describe a market as a locus of buyers and sellers that facilitates efficient exchange of soap. Inherent in that conceptualization is a process (like auctioning) wherein a price gets established such that demand equals supply (i.e., a price that clears the market). The central idea is that a market process results in a single price in common to all suppliers and all demanders.\(^{53}\)

In practice, it is rare to find markets that operate exactly like this. Nonetheless, we commonly think of consumer commodities (e.g., for housing, automobiles, clothing, or bread) in a metropolitan area as each being provided in a market. How do such notion of markets diverge from the economic model? Two popular critiques come to mind. Let me now respond to each of these.

One critique is that consumer commodities are rarely auctioned in the way envisaged: i.e., in a process that clears a market. In the short run—from minute to

\(^{53}\)A similar point is made in McChesney, Shughart, and Haddock (2004).
minute for example—there may indeed be a divergence between demand and supply. However, this does not in itself negate the conceptualization of markets for consumer commodities. When supply exceeds demand in the short term, inventory accumulates in the hands of the supplier. When demand exceeds supply, inventory gets drawn down or demand goes unmet. Each of these possibilities—which can arise from the vagaries of demand and supply from minute to minute—imposes costs on the vendor: costs for maintaining inventory and opportunity costs of unmet demand. Auctioning too has its costs. Firms use strategies—from auctioning to price discounting to supplier and customer contracting—to maximize their profits. Put differently, firms use these strategies in a way that assists efficient clearing of markets even in the absence of a formal auction process.

A second critique—using the market for bread as an example—is that the price paid for a loaf will differ from white bread to whole wheat, from one neighborhood of the city to the next, and from one type of retail outlet (e.g., convenience store or supermarket) to the next. Doesn’t this mean that the market for white bread is different from the market for whole wheat, different from neighborhood to neighborhood, or different from one type of retail outlet to the next? Perhaps. However, another way to think about these is that they are submarkets within a larger market for bread. Submarkets are used to refer to the markets for commodities that are alike, substitutable for one another, and whose prices therefore tend to change similarly; when the price of one commodity increases, consumers tend to substitute for a less-expensive alternative, and thereby normally drive up the price of the substitute. Prices can differ among submarkets. After all, consumers might prefer whole wheat bread, or it might be more costly to produce. As such, there might be a price premium for whole wheat bread. However, the idea behind submarkets is that such premiums are thought to be relatively stable over time, and factors that cause the price of bread generally to rise or fall need not necessarily affect the price premium in a particular submarket.

In this chapter, we have only one supplier (the firm) and demanders at Places 1 and 2. Consider first the case where $s_x = 0$. In this case, the economist’s requirements for a market are met because there is a common price (since $P_1 = P_2$). Alternatively, suppose $s_x = 0$. Production and allocation appears to conform to a market process, but with one notable difference. Here, the firm sets different prices at Places 1 and 2. Does this difference in price mean that the two places are necessarily each in a market of their own? Note here though that the difference in price between the two markets (in other words, the price premium at remote Place 2) is a constant amount: in this case, half-freight. If $C$ were to rise by 1.00 for example, then $P_1$ and $P_2$ would each rise by 0.50. In this respect, Places 1 and 2 appear to be like two submarkets. At the same time, a profit-maximizing solution does not

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54 To me, a market for identical, or similar, commodities is said to be formed of submarkets when prices in the submarkets differ but are linked in some respect. In a strong version of submarkets, the price in one submarket is a fixed premium on the price in another submarket. In a weak version, a rise in price in one submarket causes the price in the other submarket to change, but there is no fixed premium.
concur with Marshall’s idea of a *common* market price wherein remote customers pay a special charge on account of delivery; here remote customers are paying only a half freight charge.

### 2.5 Pricing Strategies

Because this is a book about location theory, it is appropriate to begin with a model where the firm varies its price from one customer point to the next in response to differences in unit shipping cost. However, a skeptical reader might well point out that some monopolists in reality have other pricing practices in addition to discriminatory pricing. Four popular alternatives come to mind.

**F.o.b. price:** The monopolist sets the same price at the factory gate for all customers. Customers at Place 2 pay the same price as customers at Place 1 but then incur a shipping cost; the effective price is higher at Place 2, compared to Place 1, by the amount of the unit shipping cost. Put differently, the customer absorbs the unit shipping cost.

**Uniform pricing:** The monopolist makes the price the same for a unit of the commodity delivered at different customer points even though the marginal costs of serving customers there may vary. The firm absorbs the unit shipping cost. Here, the firm must set both a price and a maximum distance beyond which the customer is too costly to serve.

**Pickup or delivery pricing:** The monopolist sets two prices—an *f.o.b. price* and a delivered price—and allows the customer to choose between them. In this case, the unit shipping cost is absorbed either by the firm or by the customer depending on the option chosen by the customer. In the case of delivered price, the firm must set both the delivered price and a maximum distance beyond which the customer is too costly to serve.

**Basing point pricing:** The monopolist chooses some customer points (so-called “basing points”) and sets a delivered price at each of them. Customers elsewhere then pay the unit shipping cost to shipping home the commodity from the basing point. The firm in general here absorbs part of the unit shipping cost.

It is not difficult to show that, under simple assumptions, discriminatory pricing—use of the half-freight rule as shown above—maximizes profit compared

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55See Furlong and Slotsve (1983).
56Classic works in this field include Smithies (1942), Stigler (1949), and Machlup (1949). See also DeCanio (1984), Deutsch (1965), Faminow and Benson (1990), Gilligan (1992), Haddock (1982), Hughes and Barbezat (1996), Levy and Reitzes (1993), Lord and Farr (2003), Needham (1964), Soper, Norman, Greenhut, and Benson (1991), and Thisse and Vives (1992).
to the other options. Why then might a monopolist choose f.o.b. or some other pricing scheme and forego the extra profit possible with discriminatory pricing? Usually, the problem with discriminatory pricing is that it is difficult to enforce. Why, for example, wouldn’t customers at Place 2 purchase soap at Place 1 for the lower price and either consume it there or bring it back home with them? One might initially want to argue that such travel or shipment can be ignored because the firm, due to its scale of operation will already have found the least costly way to ship to Place 2 and that its price is higher at Place 2 by only one-half of that amount. However, this argument disregards the possibility customers might have to travel from Place 2 to Place 1 for another purpose and the effective price of purchasing soap at Place 1 for them is only \( P_1 \). Another aspect disregarded here is the relationship between inventory acquired by the traveling consumer and the unit cost of shipping. The customer who makes a trip to Place 1 to purchase soap can reduce the per unit cost of the trip by choosing to stock up on this trip: in effect, the customer trades off the opportunity cost of holding an inventory of soap at home against the cost of traveling to Place 1 to purchase it. I do not consider such inventory holding explicitly in this chapter.

### 2.6 Model 2C: Factory at Each Place

Now, suppose the firm has already built a factory at the larger Place 1 and is now considering an identical second factory (therefore, another establishment) at a smaller Place 2 to service customers there. Assume the opportunity cost of capital for this second factory is the same (\( r \)) as for the factory built at Place 1. Assume the capital cost here is also \( K \), and this new factory also has a marginal cost curve also constant at \( C \) dollars per unit soap. The total cost to the firm is now given by (2.5.1). See Table 2.5.

The second factory possibly gives the firm a more efficient way of supplying customers at Place 2 because it eliminates shipping cost. With the second factory, the firm would never ship soap from one place to the other; to do so would involve an unnecessary cost. Under these assumptions, the profit-maximizing price and quantity at Place 1 remain as in Table 2.1. However, the profit-maximizing price and quantity for Place 2 are now given by (2.5.2) and (2.5.3) in lieu of (2.3.4) and

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57 Among papers making the same argument, see Gee (1985).
58 See, for example, Ohta, Lin, and Naito (2005).
59 Also, in this chapter, I assume that all consumers are the same. Suppose however that consumers at Place 2 differed in that some regularly visited Place 1 and could stock up on the good, while others did not. The firm might then be able to use this information to better price discriminate between the two markets. See Anderson and Ginsberg (1999).
60 Because the model assumes no uncertainty, the firm does not need to think about the possibility of a breakdown, strike, or temporary reduction in the flow of inputs at one of its plants. If it did have such uncertainties, the firm might well ship output from one place to the other.
Table 2.5 Model 2C: monopolist with a factory at each place

<table>
<thead>
<tr>
<th>Description</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost</td>
<td>( 2rK + C(Q_1 + Q_2) )</td>
</tr>
<tr>
<td>Profit-maximizing price at Place 2</td>
<td>( P_2 = 0.5(\alpha + C) )</td>
</tr>
<tr>
<td>Profit-maximizing quantity at Place 2</td>
<td>( Q_2 = 0.5N_2(\alpha - C)/\beta )</td>
</tr>
<tr>
<td>Monopoly excess profit (MP)</td>
<td>( 0.25((\alpha - C)^2N_1 + (\alpha - C)^2N_2)/\beta - 2rK )</td>
</tr>
<tr>
<td>Condition for second factory at a smaller Place 2 to be more profitable</td>
<td>( N_2 \geq 4\beta rK/((\alpha - C)^2 - (\alpha - C - sx)^2) )</td>
</tr>
<tr>
<td>Consumer benefit (CB)</td>
<td>( 0.25(1.5\alpha + 0.5C)(\alpha - C)(N_1 + N_2)/\beta )</td>
</tr>
<tr>
<td>Producer cost (PC)</td>
<td>( 0.5(\alpha - C)C(N_1 + N_2)/\beta + 2rK )</td>
</tr>
<tr>
<td>Consumer surplus (CS)</td>
<td>( 0.125(\alpha - C)^2(N_1 + N_2)/\beta )</td>
</tr>
<tr>
<td>Producer surplus (PS)</td>
<td>0</td>
</tr>
<tr>
<td>Social welfare (SW): SW = CS+PS+MP or SW = CB-PC</td>
<td>( 0.375(\alpha - C)^2(N_1 + N_2)/\beta - 2rK )</td>
</tr>
<tr>
<td>Price elasticity of demand</td>
<td>( \varepsilon_{11} = - (P_1/Q_1)(dQ_1/dP_1) = (\alpha + C)/(\alpha - C) )</td>
</tr>
<tr>
<td></td>
<td>( \varepsilon_{22} = - (P_2/Q_2)(dQ_2/dP_2) = (\alpha + C)/(\alpha - C) )</td>
</tr>
</tbody>
</table>

Notes: Rationale for localization (see Appendix A): Z1—Presence of fixed cost. Givens (parameter or exogenous): C—Marginal unit production cost; K—Capital required to build each factory; \( N_i \)—Number of consumers at Place \( i \); \( r \)—Opportunity cost of capital; \( \alpha \)—Intercept of individual linear inverse demand curve: maximum price; \( \beta \)—Negative of slope of individual linear inverse demand curve: marginal effect of quantity on price received. Outcomes (endogenous): \( P_i \)—Price of unit of soap at Place \( i \); \( Q_i \)—Quantity of soap supplied to Place \( i \); \( \varepsilon_{11} \)—Price elasticity at Place 1 at market equilibrium; \( \varepsilon_{22} \)—Price elasticity at Place 2 at market equilibrium.

Comparing (2.5.2) with (2.3.4), the price at Place 2 will be lower than in the one-factory solution in Table 2.3. The elimination of the unit shipping cost allows the firm to lower its price at Place 2 and still further increase semi-net revenue since the quantity sold at Place 2 will be greater.

Further, assume demand at each place is constant from 1 year to the next; \( Q_1 \) and \( Q_2 \) do not change if \( P_1 \) and \( P_2 \) remain unchanged. Here, we can think the firm makes an investment now of \( K \) to build the second factory, the return for which is an improvement in semi-net revenue that arises partly because of (2.3.5), respectively. The contribution to firm profit arising from sales at Place 2 is shown in (2.5.4).
shipping cost savings and partly because the firm can increase its quantity sold at Place 2. The firm would find it profitable to build the factory at Place 2 where the gain in semi-net revenue from local production at Place 2 exceeds the opportunity cost of the capital required for the second factory: i.e., where (2.5.4) is non-negative. In part, this is driven by the number of customers at Place 2 (i.e., $N_2$) since the larger the market the larger the semi-net revenue. Equation (2.5.5) indicates that the larger the opportunity cost of capital ($rK$) or the price sensitivity of demand ($\beta$), or the smaller the shipping rate ($s_x$) the larger Place 2 must be to make the second factory profitable.

The comparative statics of Model 2C are the same as in Model 2B except for two implications that arise because shipments are no longer necessary. The first implication is that the notion of a range ($X$) is not relevant in Model 2C. The second is that variations in the unit shipping rate, $s$, will have no effect on price, quantity, or minimum size of market. See Table 2.6.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>$P_1$</th>
<th>$Q_1$</th>
<th>$N^*_1$</th>
<th>$P_2$</th>
<th>$Q_2$</th>
<th>$N^*_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C$</td>
<td>+</td>
<td>−</td>
<td>+</td>
<td>+</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>$K$</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>$N_1$</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$N_2$</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>$r$</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>$s$</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>−</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>+</td>
<td>+</td>
<td>−</td>
<td>+</td>
<td>+</td>
<td>−</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0</td>
<td>−</td>
<td>+</td>
<td>0</td>
<td>−</td>
<td>+</td>
</tr>
</tbody>
</table>

*Notes: See also Table 2.5; +, Effect on outcome of change in given is positive; −, Effect on outcome of change in given is negative; 0, Change in given has no effect on outcome; ?, Effect on outcome of change in given is unknown.*

In Model 2A and Model 2C, we might assume that the firm has an outlet counter at the front of its factory from which it sells product and that the marginal cost of production, $C$, includes the unit cost of retailing soap and servicing a customer there. In Model 2B, however, the firm needs to have a way of retailing to customer at Place 2. In this respect, Model 2C gives the firm a less-costly option for selling soap that is reflected in the absence of $s$ in Model 2C.

### 2.7 Model 2D: Choice of Sites and Localization

Finally, where, if at all, should the firm put a factory or factories? For example, rather than assuming that the first factory is at Place 1 and looking at whether to put a second factory at Place 2, how does our problem change if the firm has the option also of building one factory only and putting this factory at Place 2? In all, the firm has four options in the static world envisioned here: (i) build no factories, (ii) build
only one factory and put it at Place 1, (iii) build only one factory and put it at Place 2, or (iv) build one factory each at both Places 1 and 2. The excess profit that arises under each option is specified in Table 2.7. Here, $V_{ij}$ is the semi-net revenue from having the factory at Place $i$ supply customers at Place $j$ where feasible: i.e., where maximum price ($\alpha$) is higher than minimum price ($C$ plus any shipping cost). Of course, the do-nothing option i has a zero excess profit. Also shown in Table 2.7 is the rate of return for each of options ii, iii, and iv. In these, I have assumed symmetric shipping costs.\(^{61}\)

Using Table 2.7, I can now deduce whether and where the firm will build its factories. However, since this model contains 8 parameters—$\alpha, \beta, N_1, N_2, C, K, r$ and $sx$—it is easiest to envisage solutions if I make some simplifying assumptions.

**Table 2.7** Model 2D: the four options

<table>
<thead>
<tr>
<th>Option</th>
<th>Profit Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>i: No factories at all</td>
<td>0</td>
</tr>
<tr>
<td>ii: Place 1 only</td>
<td>$V_{11} + V_{12} - rK$</td>
</tr>
<tr>
<td>iii: Place 2 only</td>
<td>$V_{21} + V_{22} - rK$</td>
</tr>
<tr>
<td>iv: Place 1 and 2</td>
<td>$V_{11} + V_{22} - 2rK$</td>
</tr>
<tr>
<td>Rate of return ii</td>
<td>$(V_{11} + V_{12})/K$</td>
</tr>
<tr>
<td>Rate of return iii</td>
<td>$(V_{21} + V_{22})/K$</td>
</tr>
<tr>
<td>Rate of return iv</td>
<td>$(V_{11} + V_{22} - \text{Max}(V_{11} + V_{12}, V_{21} + V_{22}))/K$</td>
</tr>
</tbody>
</table>

where semi-net revenue of serving customers at $j$ from factory at $i$, $V_{ij}$, is given by the following

\[
V_{11} = 0.25N_1(\alpha - C)^2/\beta \text{ if } \alpha > C, \text{ else } 0
\]

\[
V_{12} = 0.25N_2(\alpha - C - sx)^2/\beta \text{ if } \alpha > C + sx, \text{ else } 0
\]

\[
V_{21} = 0.25N_1(\alpha - C - sx)^2/\beta \text{ if } \alpha > C + sx, \text{ else } 0
\]

\[
V_{22} = 0.25N_2(\alpha - C)^2/\beta \text{ if } \alpha > C, \text{ else } 0
\]

Notes: Rationale for localization (see Appendix A): Z1—Presence of fixed cost; Z8—Limitation of shipping cost. Givens (parameter or exogenous): $C$—Marginal unit production cost; $K$—Capital required to build factory; $N_i$—Number of consumers at Place i; $r$—Opportunity cost of capital; $s$—Cost of shipping one unit of product one km; $x$—Geographic distance from Place 1 to Place 2; $\alpha$—Intercept of individual linear inverse demand curve: maximum price; $\beta$—Negative of slope of individual linear inverse demand curve: marginal effect of quantity on price received. Outcomes (endogenous): $P_i$—Price of unit of soap at Place i; $Q_i$—Quantity of soap supplied to Place i; $V_{ij}$—Semi-net revenue from serving customers at Place $j$ from factory at Place $i$; $X$—Range of soap (kilometers).\(^{61}\)

\(^{61}\)A feature of shipping rates such that the cost of shipping a unit of product from Place $i$ to Place $j$ is the same as the cost of shipping a unit from $j$ to $i$. 
2.8 Two Markets Identical

To begin, assume the two markets are identical in size: i.e., \( N_1 = N_2 \). Assume also, for the moment, \( sx = 0 \). In this case, the firm would build at most one factory (because there is no shipping cost to be saved by building a second factory) and would be indifferent between putting it at Place 1 or Place 2.\(^{62}\) Without loss of generality, I presume the factory is at Place 1. However, if the rate of return were inadequate even here, the firm would choose option i: no factory at all. The firm would never choose option iv because that would be less profitable (i.e., generate less profit and a lower rate of return) than serving both places from the one factory at Place 1.

Suppose instead that \( sx \) is greater than zero. Assume initially that there is only one factory and it is at Place 1. Again, imagine a thought experiment in which \( sx \) is made progressively larger, perhaps because I imagine Place 2 further away from Place 1. As this happens, \( V_{11} \) remains constant, but \( V_{12} \) shrinks. Eventually as \( sx \) is increased still more, \( C + sx \) approaches \( \alpha \), \( V_{12} \) drops to zero, and the firm restricts itself to the home market. For \( sx \) still larger, \( V_{12} \) remains zero because the firm would no longer find it profitable to supply Place 2. Now assume there is a factory at each place. Here, the profit of option iv remains the same at every level of \( sx \) since the firm no longer incurs a shipping cost. The preferable option here depends on the magnitude of the shipping rate, \( sx \).

As an example, suppose \( \alpha = 15 \), \( \beta = 1 \), \( K = 50,000 \), \( C = 3 \), \( r = 0.05 \), \( N_1 = 200 \), and \( N_2 = 200 \). In this case, when \( sx \) is greater than 12 (in other words, \( \alpha - C \)), the firm’s marginal cost of supplying customers at Place 2 from a factory at Place 1 (\( C + sx \)) is greater than the maximum price customers there are willing to pay (\( \alpha \)). Curve AB in Fig. 2.3 shows the profit under option iii at various levels of shipping rate (\( sx \)); curve CD shows profit under option iv. I do not show option ii here because it has the same excess profit as option iii since \( N_1 = N_2 \). Starting from zero, as I increase \( sx \), the excess profit from option iii declines. At a stated unit shipping cost, draw a vertical line (line EG in Fig. 2.3) up to the higher of the profit schedules (in the case of EG, this is option iv) and read across to the y-axis to get the excess profit earned (OC in Fig. 2.3). For \( sx \) sufficiently low (below OH in Fig. 2.3), option iii—or equally option ii—becomes the most profitable choice.

The same example is displayed in Fig. 2.4 in terms of rate of return. Here it helps to think of two investment decisions in sequence. The first is to invest in the more profitable of either option ii or iii. Here, the two relevant rates of return are given by (2.7.5) and (2.7.6). The firm will choose option ii or iii if, at the stated unit shipping cost, curve AB lies above the opportunity cost of capital (see the horizontal line DE in Fig. 2.3). The second decision is whether to then add a factory at the other place; here I want to know if a second factory adds sufficient (incremental) profit to make the investment there worthwhile. The relevant rate of return here is (2.7.7) and is

\(^{62}\)In fact, if \( sx = 0 \), the firm is indifferent between having its factory at Place 1 and Place 2 even if \( N_1 \neq N_2 \).
Fig. 2.3 Model 2D: profit as a function of shipping rate.

Note: $\alpha = 15$, $\beta = 1$; $C = 3$; $K = 50,000$; $N_1 = 200$ $N_2 = 200$, $r = 0.05$, $sx = 4$. Profit is 7,900 under option iii; 9,400 under option iv. Critical unit shipping cost is 2.30. *Horizontal axis* scaled from 0 to 14; *vertical axis* from 0 to 14,000

shown as the curve OB in Fig. 2.4. The firm will choose option iv if, at the stated unit shipping cost, curve OB lies above DE. Where the stated unit shipping cost is OF in Fig. 2.4, the firm finds that the rate of return (FH) on the factory at one place is larger than the opportunity cost of capital (OD), as is the incremental rate of return (FG) on the factory at the other place.

Why does the rate of return on option iv take the shape of curve OB? To me, there are four points of interest about OB. First, when unit shipping cost is zero, the incremental rate of return on option iv is zero. In graphical terms, OB passes through the origin of Fig. 2.4. Why? When unit shipping cost is zero, there is no excess profit to be made by building a second factory. Second, the firm will always find either or both options ii and iii have a rate of return that, at every sx, is greater than or equal to the rate of return on the incremental investment in option iv. This is because the firm chooses first the *more* profitable of options ii and iii and therefore in option iv is looking at investing in a second factory, this time at the less profitable place. Third, whether the firm builds the second factory depends on the position of curve OB in relation to the line DE. As unit shipping cost becomes large enough, it is uneconomic to supply a remote market. The greater is sx, the more attractive it becomes to build a factory at the second place. Fourth, the rate of return on option iv converges with the rate of return on one plant: at sx sufficiently large, each plant serves only its local market.
2.9 Differing Markets

Suppose instead that there are more customers at Place 2 than at Place 1. In that situation, the profit and rate of return associated with option iii increases compared to option ii. Figures 2.5 and 2.6 show profit and rates of return, respectively, for case where $\alpha = 15$, $\beta = 1$, $C = 3$, $K = 50,000$, $N_1 = 200$, $N_2 = 200$, $r = 0.05$, $sx = 4$. Rate of return is 0.208 under options ii or iii; 0.080 under option iv. Horizontal axis scaled from 0 to 14; vertical from 0 to 0.35.

Fig. 2.4 Model 2D: rate of return as a function of shipping rate.
Note: $\alpha = 15$, $\beta = 1$, $C = 3$, $K = 50,000$, $N_1 = 200$, $N_2 = 200$, $r = 0.05$, $sx = 4$. Rate of return is 0.208 under options ii or iii; 0.080 under option iv. Horizontal axis scaled from 0 to 14; vertical from 0 to 0.35.
Fig. 2.5 Model 2D: profit as a function of shipping rate.

Note: $\alpha = 15$, $\beta = 1$; $C = 3$; $K = 50,000$; $N_1 = 200$, $N_2 = 250$, $r = 0.05$, $sx = 4$. Profit is 8,700 under option ii, 9,700 under option iii, and 11,200 under option iv. *Horizontal axis* is scaled from 0 to 14; *vertical* from 0 to 16,000.

than iii, the opportunity cost of capital has to be sufficiently low to make option iv attractive.\(^63\)

Finally, because I have assumed that the two places have a common currency and no restrictions on the shipment of commodities other than a unit shipping cost, I do not have to consider here the strategy of *tariff jumping*, where a firm builds a second factory to avoid tariffs or other restrictions on trade. This is a rich literature on its own.\(^64\)

Let me close this section with an observation about the use of shipping here. Our firm will ship either (1) nothing at all or (2) from the home to the remote market only. Since the remote market would then normally have a price higher than the home market by half-freight, the shipment is said to flow up the price gradient. There will never be a shipment in the opposite direction: i.e., a cross haul or shipment down the price gradient. This is not surprising. To have both shipments from A to B and

\(^{63}\)Backhaus (2002) makes a similar point about the importance of opportunity costs in location theory.

from B to A happening at the same time would presumably require plants at both places; in such cases, why would the firm ship at all?

2.10 Comparative Statics in Model 2D

Comparative statics are more difficult to assess in Model 2D than was the case earlier in Models 2A through 2C. The reason for this is that the outcome in Model 2D is sometimes Model 2A, sometimes Model 2B (or its equivalent assuming one factory only at Place 2), and sometimes Model 2C. As long as the change in the exogenous variable or parameter can be solved with the same model, the comparative statics are shown there. However, if the change in the exogenous variable or parameter
causes us to switch from one of Models 2A through 2C to another, the comparative statics are more complicated. I will not belabor that analysis here. I make only one comment. Fortunately, as evidenced in Fig. 2.3 through Fig. 2.6 in the case of the shipping cost, there appear to be at most three switches possible in a regional economy where $N_1$ and $N_2$ grow over time: a switch from no production to a factory at one place, a switch from a factory at one place to a factory at the other place, and a switch from one factory to two factories.

2.11 Risk Aversion and Multiple Plants

In Models 2A through 2D, I assume that all outcomes are known with certainty. It is beyond the scope of this chapter to model uncertainty here as exemplified in the implicit treatment of goodwill above. However, I can speculate how some particular kinds of uncertainty might affect our conclusions. Suppose a factory suddenly were to become unusable or more costly to operate, customer demand at either Place 1 or Place 2 were to grow unexpectedly, or the cost of shipping between the two places were to change or even become prohibitive. Option iv gives the firm flexibility to cope with such changes and therefore might be a more attractive to a firm averse to risks. Put differently, where options ii or iii are modestly more profitable than option iv, a risk-averse firm might be willing to forego that profit to guarantee that it has the ability to participate profitably.65 Of course, we should keep in mind that these are only a few among many risks facing a firm.

2.12 Model 2E: Contestability and Preemption of Competitors

Is there a case to be made here for behavior by a firm that we might label market preemption or entry deterrence?66 We have seen here that building just one factory (by spreading fixed cost over two markets) is more profitable than building two separate factories (each with that same fixed cost) unless the shipping rate is too high. However, this raises the question of how the firm behaves given the risk a competitor builds a factory at the second (smaller) market in the firm’s absence to serve just that market. For the firm with a factory only at the larger Place 1, its profit at risk is (2.3.6). In effect here, I am treating Place 2 as a contestable market.67

We could set this up as a sequential game played by the firm (the incumbent) and a competitor (the entrant). I do not do that here. My purpose is simply to show that the models developed in this chapter give an interesting insight into the conditions under which the incumbent might want to preempt: i.e., build a factory of its own at

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65See Penfold (2002).
67See Baumol, Panzar, and Willig (1982).
Place 2 to forestall the entrant even though that would be less profitable than option ii absent competition.

In what follows, assume the following specific scenario. An entrant with the same costs (i.e., same \( r, C, \) and \( K \)) and product plans a factory at the smaller Place 2 to sell soap there only. Prompting the entrant here is the gap (0.5sx) between the delivered price of the incumbent (absent the entrant) and the price the entrant intends to set. Despite the fact that the incumbent finds it profitable to ship to Place 2, the entrant does not plan to ship soap to Place 1. The entrant is myopic.\(^{68} \) Its conjectural variation is that it does not expect the incumbent to respond by changing its price at Place 2 or by building a second factory there. That entrant sets a price (2.8.1) and expects to earn an excess profit (2.8.2) similar to the one-market solutions (2.1.6) and (2.1.8), respectively. See Table 2.8. Here, price and profit are invariant with respect to sx because I have assumed the entrant does not ship product to Place 1.

There are two implications here for the incumbent. First, the entrant will find Place 2 profitable only if demand there is sufficient. The necessary condition can be inferred from (2.8.3): akin to the one-market solution (2.1.9). If Place 2 is smaller than this, the incumbent need not worry about an entrant. If Place 2 is larger than this, consider a second implication: the entrant’s profit-maximizing price (2.8.1) at Place 2 would be lower than that of the incumbent (2.3.4). Absent any difference between their products, the entrant would therefore capture all the market at Place 2.

However, is there a catch here? Since I have assumed that the entrant is like the incumbent in the sense of facing the same costs, whenever it is profitable for

<table>
<thead>
<tr>
<th>Table 2.8 Model 2E: market pre-emption</th>
</tr>
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<tbody>
<tr>
<td>Profit-maximizing price of competitor with factory at Place 2</td>
</tr>
<tr>
<td>( P_2 = 0.5(\alpha + C) )</td>
</tr>
<tr>
<td>Maximized profit of competitor with factory at Place 2</td>
</tr>
<tr>
<td>( 0.25N_2(\alpha - C)^2/\beta - rK )</td>
</tr>
<tr>
<td>Minimum number of customers required by competitor with factory at Place 2</td>
</tr>
<tr>
<td>( N_2 \geq 4\beta r K/(\alpha - C)^2 )</td>
</tr>
<tr>
<td>Rate of return for incremental option iv</td>
</tr>
<tr>
<td>( (V_{22} - V_{12})/K )</td>
</tr>
<tr>
<td>Reduced form for rate of return for incremental option iv</td>
</tr>
<tr>
<td>( (0.25N_2/(\beta K))(sx - 2(\alpha - C) sx) )</td>
</tr>
</tbody>
</table>

Notes: Rationale for localization (see Appendix A): Z1—Presence of fixed cost; Z8—Limitation of shipping cost. Given (parameter or exogenous): \( C—\) Marginal unit production cost; \( K—\) Capital required to build factory; \( N_i—\) Number of consumers at Place \( i \); \( r—\) Opportunity cost of capital; \( s—\) Cost of shipping one unit of soap one kilometer; \( x—\) Geographic distance from Place 1 to Place 2; \( \alpha—\) Intercept of individual linear inverse demand curve: maximum price; \( \beta—\) Negative of slope of individual linear inverse demand curve: marginal effect of quantity on price received. Outcomes (endogenous): \( P_i—\) Price of unit of soap at Place \( i \); \( Q_i—\) Quantity of soap supplied to Place \( i \); \( V_{ij}—\) Semi-net revenue from serving customers at Place \( j \) from factory at Place \( i \).

\(^{68} \) Any behavior of a firm such that it does not foresee any reaction by its competitors to its choices: e.g., with respect to price, range, or quality of commodities sold, or geographic location.
an entrant to locate at Place 2, wouldn’t it also be profitable for the incumbent to use option iv: i.e., also have a factory at Place 2? If so, market preemption would not be a concern for the incumbent. Interestingly, there is indeed a catch. Where \( N_2 < N_1 \), the rate of return for incremental option iv in (2.7.7) reduces to (2.8.4) and then to (2.8.5). For the incumbent, the profit of building a separate factory at Place 2 is based on a differential in semi-net revenues (\( V_{22} \) relative to \( V_{12} \)), whereas for the entrant it is based on \( V_{22} \) alone. When \( sx \) is prohibitively high, \( V_{12} \) is zero and the incumbent and entrant would experience the same gain in profit from having a factory at Place 2. However, when \( sx \) is smaller, the rate of return on incremental option iv is less than the rate of return to the entrant. Put differently, an entrant may find it profitable to build at the smaller market even when it is unprofitable for the incumbent to do so.

What is the potential loss in profit to the incumbent under option ii that arises should the entrant take over the market at Place 2? Assume here \( N_2 \) satisfies at least (2.8.3). If \( sx \) is sufficiently large, the incumbent finds its rate of return on incremental option iv\(^{69} \) is at or above \( r \); it therefore invests in a separate factory at Place 2 and incurs no loss. In Fig. 2.7, I show the opportunity cost of capital as the horizontal line \( HI \); i.e., the same regardless of shipping rate. When the rate of return on incremental option iv is larger than \( r \) (i.e., for \( sx \) larger than \( OS \) in Fig. 2.7), the firm builds a second factory at Place 2 and there is no risk. However, at a unit shipping cost smaller than \( OS \), there is an incentive for the entrant to build at Place 2. See the curve DQR showing the option ii rate of return with the entrant at Place 2. The curve UVS in Fig. 2.7 shows the loss to the incumbent because of the entrant. The loss here is greatest (amount \( OU \)) at \( sx \) near 0 and smallest (amount \( SV \)) when \( sx \) approaches the amount above which the incumbent would build a second factory. At the same time, remember that the entrant is less interested in investing in a factory when \( sx \) is close to zero because the price it would set would be almost the same as the incumbent’s; the entrant would be happier investing where it would a substantial price advantage: i.e., when unit shipping cost is closer to \( OJ \).

What exactly is the loss here? Suppose the unit shipping cost is somewhere in the interval between \( O \) and \( S \) in Fig. 2.7: say at point \( J \). Absent the entrant, the incumbent earns a return of \( JN \) based on option ii; the incremental return on option iv is \( JK \) which is below the opportunity cost of capital \( OH \). If the entrant now builds at Place 2, the return to the incumbent on option ii drops to \( JP \) and its loss is \( JY \); note amount \( JY \) equals amount \( PN \).

Suppose the incumbent wants to mitigate the risk, in advance of the arrival of the entrant (i.e., preempt the competitor), by building a second factory at Place 2. The incumbent’s returns would then be \( JP \) on option ii and an incremental \( JT \) on option iv. As shown, both are above \( OH \) (the opportunity cost of capital). Preemption is profitable here, although not as profitable as option ii. Nonetheless, the incumbent might prefer the lower profit of preemption because it reduces the risk of loss. In Chapter 9, I return to the topic of locational decision making under uncertainty.

What does this model tell us about prices at the two places? If the firm preempts a competitor by building a factory at each place, the firm will sell the good at the

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\(^{69}\)See (2.7.7)
2.13 Final Comments

In this chapter, the principal model has been 2D. I included Models 2A through 2C to help readers better understand aspects of Model 2D. I included Model 2E to show how one thinks about entry deterrence at a remote place. In Table 2.9, I summarize the assumptions that underlie Model 2A through 2E. Many assumptions are common to all these models: see panel (a) of Table 2.9. The models differ in that (i) a remote place (market) is assumed in Models 2B through 2E and with it the possibility of price discrimination, (ii) even then, shipping cost can still be ignored in Model 2C because the firm produces at both places, (iii) Models 2D and 2E give the firm the choice of how many factories to build and where to build them, and (iv)
Table 2.9 Assumptions in Models 2A–2E

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>2A</th>
<th>2B</th>
<th>2C</th>
<th>2D</th>
<th>2E</th>
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<tbody>
<tr>
<td>(a) Assumptions in common</td>
<td></td>
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<tr>
<td>A1 Closed regional market economy</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>A3 Punctiform landscape</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>B1 Exchange of soap for money</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>B4 Local demand</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>C2 Fixed local customers</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td>C4 Identical customers</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>C5 Identical individual linear demand curve</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>D1 Monopolist</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>D6 Fixed cost in the form of interest on fixed capital requirements</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>D7 Horizontal marginal cost curve</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>(b) Assumptions specific to particular models</td>
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<tr>
<td>H2 Location(s) of firm given</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>C3 Fixed remote customers</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>M2 Price discrimination</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>E5 Firm bears shipping cost to market</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>E4 Unit shipping cost symmetric</td>
<td>x</td>
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<tr>
<td>D4 Choice of factory locations</td>
<td>x</td>
<td></td>
<td>x</td>
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<tr>
<td>F1 Competitor sells same product</td>
<td>x</td>
<td></td>
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<tr>
<td>F4 Competitor sells at price that ignores competition</td>
<td>x</td>
<td></td>
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<tr>
<td>F7 Location of competitor is given (Place 2)</td>
<td>x</td>
<td></td>
<td></td>
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<tr>
<td>F9 Peer competitor in remote market</td>
<td>x</td>
<td></td>
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<td></td>
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<tr>
<td>F10 Customers shared</td>
<td>x</td>
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</table>

Model 2E allows for competition from a new entrant at the remote place and the uncertainty that creates. Given the assumptions of the model introduced here, where the number of customers is sufficiently large—which in turn may require that the two places be sufficiently close together—there will be at least one factory, and it will be located at the place with the larger number of customers (the home market). If the unit shipping cost is sufficiently low, there will be localization (i.e., only one factory) and soap will be priced differently at the two places (the half-freight rule). If unit shipping cost is sufficiently high, and the smaller place has enough customers, the firm will decentralize production (i.e., build a second factory there) and prices will be the same at the two places. Put differently, localization (of production) and price differentiation are joint outcomes in Model 2D.

In Chapter 1, I argue that prices are important in shaping the location of firms. In this chapter, those prices are $r$, the price of a unit of capital inherent in our measure of $K$, various input prices subsumed in $C$ and $s$, as well as consumer income (typically derived from a labor market) and the prices of other consumer commodities that are presumably incorporated in $\alpha$ and $\beta$. These other prices are all determined in markets outside the scope of this model where the firm competes against other firms and demanders. These input prices in turn help determine which of the four
options (each a combination of locations and prices) is most profitable to the firm and thereby the extent of localization. To this point, I think Walras would argue that the analysis has been only partial in the sense that we have not looked explicitly at the simultaneity among prices in these markets. In later chapters, there will be opportunities to do that. Nonetheless, even here, the decision of the firm to choose option ii or iii implies that the price of soap will differ between the two places. To the extent that the firm does not choose option iv, this price effect has the potential (not explored in this chapter) to create an incentive for customers to relocate to a place where the firm has built a factory.

What about the regional economy here? There are two problems. First, what is the region here? Second, what is the nature and extent of economic activity within it? The models in this chapter paint a picture of only one part of regional economy: one firm and its customers. We don’t know anything about overall regional product or regional income (factor payments); however that region might be defined. The models in this chapter say little about the distribution of income in society among factors (labor, capital, and land). We know how much profit the firm will earn. We know also that the firm incurs costs, but (aside from the opportunity cost of capital) these are not related explicitly to factor payments such as the hiring of labor or the rental of land. Therefore, the only recognizable income gains that arise accrue to the firm owner in the form of increased profit. We also know that the price set by the firm affects the well-being of customers; in this chapter, such changes have been measured by consumer surplus. Suppose Place 1 is large enough by itself to make production profitable for the firm, Place 2 is not, and the firm therefore builds a factory at Place 1. Assume also initially that the unit shipping cost is prohibitive in the sense that $C + sx > \alpha$. The firm is limited to its home market. In the absence of information about other firms and their shipments, we might think of the region here simply as the firm and its customers at Place 1. However, we do know that the firm benefits from this market (as indicated by its monopoly profit) as do consumers at Place 1 (as indicated by their consumer surplus). Now suppose the unit shipping cost were to drop to a level where it becomes profitable for the firm to serve the Place 2 as well. In this case, we might think that the region now includes Places 1 and 2. We still don’t know anything about overall regional product or regional income. However, we do know that there has been an addition to the firm’s monopoly profit, a new consumer surplus for customers at Place 2, and no reduction in consumer surplus for customers at Place 1.

Finally, this chapter has put much emphasis on the role of the opportunity cost of capital as a fixed cost. That the firm has to invest capital in one or two factories and incurs an opportunity cost thereby implies that unit cost falls the greater the scale of production. That is the one and only rationale for localization envisaged in this chapter. There is not, for example, any explicit consideration of the efficiencies that might arise from division of labor in accounting for localization here.
The Geography of Competition
Firms, Prices, and Localization
Miron, J.R.
2010, XXIV, 456 p., Hardcover