

## 9: Natural Monopoly

(From *The Simpsons* TV cartoon):

MR. BURNS [MENACING]: *"I want that oil well. I've got a monopoly to maintain! I own the electric company, and the water works —plus the hotel on Baltic Avenue!"*

PRINCIPAL SKINNER: *"That hotel's a dump and your monopoly's pathetic. This school's oil well is not for sale, particularly to a blackhearted scoundrel like yourself."*



February 21, 2019

<http://rasmusen.org/g406/reg-rasmusen.htm>, [erasmuse@Indiana.edu](mailto:erasmuse@Indiana.edu)

## 9.1: Introduction

Antitrust laws can't deal with all situations of monopoly. Consider the following scenario:

National Electric Company has been serving Springfield for many years. It buys power from various companies on the national power grid, and resells it to home and business customers in Springfield using the company's network of underground cables. National pays a lot to maintain its cable system, but it is a profitable company and it pays a 10% dividend each year, even though most companies only show a 5% return on capital. No other company even tries to sell electricity in Niceville.

The new mayor of Springfield calls for the state Attorney-General to crack down on National. "National is an obvious monopoly," he says. "They are making monopoly profits, and they should be broken up. If we had three different electrical companies competing, then service would be better and rates would be lower." National's CEO replies, "No— to break us up would be disastrous. It would result in destructive competition and heavy losses for all three companies, because we would compete prices down to where we couldn't cover our investments in plant and equipment. And it would be silly to have each home served by three underground cables, when it only buys from one electric company at a time. Leave well enough alone."

The mayor has a point. National is charging above marginal cost, so output is inefficiently low, as we've already discussed in the previous chapter. But the CEO has a point too. If there were three companies laying down and maintaining cable, costs would increase. So what should happen?

This question is important. Electricity is a big business. Mostly it is sold by utilities, companies which generate, transmit, and distribute electricity to consumers. There are 3,273 traditional electrical utilities in the USA— 210 investor-owned, 2,009 state and local, and 9 Federal electric utilities, and 883 rural electric cooperatives. There are also 1,738 nonutility power producers, the most important of which are investor-owned companies that sell only wholesale. These nonutilities do not have regulated prices or retail franchise territories. Electricity companies vary tremendously in size. 38% of the gigawatt capacity is from investor-owned utilities, 9% state-and-local, 7% federal, 4% cooperatives, and 42% nonutilities.<sup>1</sup> It isn't just in electricity that it seems more efficient to have just one big supplier instead of competition. People have favored concentration of production in water, supply, railroads, mass transit, schools, and steel mills. There are lots of situations where it seems as if it's more efficient to have one big company—or one big government agency—producing everything. In this chapter, we'll try to figure out when "big is better" means we should allow monopolies but "Monopolies restrict output" means we should regulate them. It will turn out that we have to look carefully at each situation, and in this chapter you'll learn what to look for to decide when monopoly is inevitable and when regulation is helpful.

---

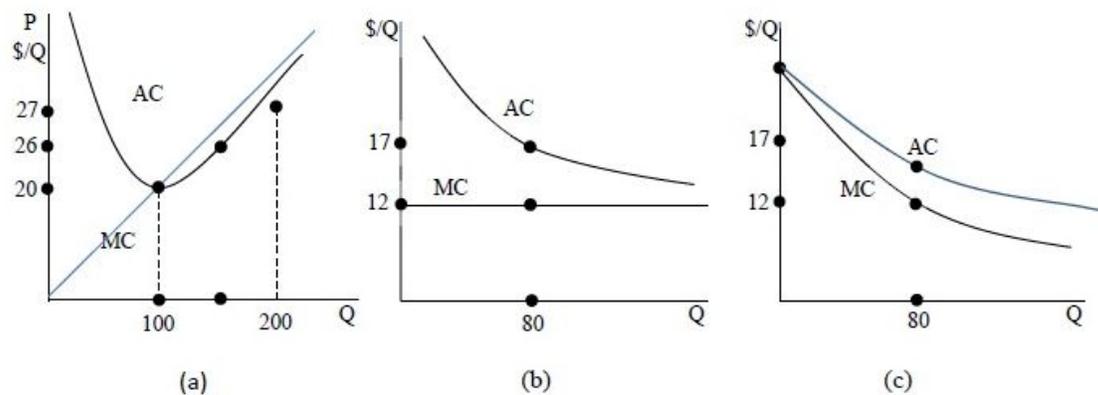
<sup>1</sup>U.S. Energy Information Administration (EIA), "Electric Power Industry Overview 2007," <http://www.eia.doe.gov/electricity/page/prim2/toc2.html>.

When should the government decide it is best for society to allow monopolies, but to regulate them?

Most of anti-trust law is devoted to preventing artificial monopolies—to prevent industries that would otherwise be competitive from acting as monopolies. If the government bans bad practices such as price agreements, then the market will settle down to the natural equilibrium that maximized social surplus, and companies will voluntarily choose to use efficient methods of production.

Such reasoning assumes that the cost curves for the industry are U-shaped, so average cost first rises and then falls with output. If average cost falls with output, then the bigger the firm, the lower its average cost. Take a look at figure 9.1, which shows three different kinds of cost curves.

FIGURE 9.1  
THREE KINDS OF COST CURVES



In Figure 9.1(a) the average-cost curve is U-shaped. If every company has this cost curve, then the cheapest way to produce 200 units of electricity is to have two different companies produce 100 units each, rather than one company producing 200. If they each produce 100, they could charge a price of \$20/unit and break even. If one firm operated as a monopoly, it would produce less, charge more, and have higher costs than necessary. If two firms operated as a cartel, they would keep costs lower, but they would still choose to produce less than 200 units so as to drive up the price and maximize their own profits. Antitrust law which encouraged entry and discouraged price cooperation would help move the the outcome closer to the ideal of two firms producing 100 units each. If the two firms could not cooperate, their competition would not drive the price down all the way to \$20/unit and output all the way to 200 units. Since there are only two of them, competition wouldn't force prices all the way down to zero profits, but competition would at least limit their ability to operate inefficiently and to raise prices.

In Figure 9.1(b) the average-cost curve is falling over its entire length, and the marginal cost curve is flat. This means the company has a large fixed cost but constant marginal cost; it has to pay for overhead, but its extra production cost to produce an extra unit is always the same, no matter how much it produces. Thus, the bigger a company's sales, the lower its average cost.

In Figure 9.1(c) the average-cost curve is falling over its entire length, as in Figure 9.1(b), but the marginal cost curve is also falling. Moreover, the average and marginal costs start out the same. This means that the firm has no fixed cost. The first unit's average cost is the marginal cost plus the entire fixed cost, so if the first unit's average cost equals its marginal cost, the fixed cost must be zero. As the firm produces more output, though, the cost of each extra unit falls, so the average cost is dragged down as we average in the new cheaper units.

We say there are **economies of scale** whenever average cost falls with output. Average cost can fall for two reasons: because a fixed cost is averaged over more and more units, or because the marginal cost is falling. It's also possible to have a fixed cost and falling marginal cost. A good exercise is to try to draw a new figure to illustrate that.

Now let's get back to the monopoly problem. We'll use the industry in Figure 9.1(c) for illustration. Suppose there are two firms in the industry and we think about having them compete price down to marginal cost and split the market, our usual ideal. What would happen?

The problem is that our usual equilibrium conditions of price equalling marginal cost and zero profits are contradictory. Suppose the price equals marginal cost, and the firms split the market, at outputs of 50 each. For one thing, the price will be below average cost, so each firm will make a loss. For another thing, one of the firms would deviate by cutting its price, so it could increase its market share, since with the increased output, its marginal cost would be lower and it would profit from the extra sales. Whichever firm is bigger will have a cost advantage. So we would expect a costly war of attrition as the two firms each struggled along making losses in the hopes that the other firm would drop out, leaving it free to raise prices drastically as a monopoly.

In addition, our earlier finding that competition maximizes social surplus wouldn't apply. If you were a social planner, would you want to have two small firms split the market? No. Instead, because there are economies of scale you would want one big firm to operate and produce the same output but at lower cost.

### Network Externalities

Economies of scale are a supply-side reason for economies of scale. There is also a demand-side reason: **network externalities**. Network externalities are present when buyers are willing to pay more for a product if they expect other people to buy it too. Telephone service is an example. It is useless to be the first person in the world

to own a telephone. There is nobody else to call! The more people with telephones, the more valuable it is to own a telephone yourself. This was true in the early days of telephone and it is true of cellphones today. If more of your friends have cellphones and are texting messages to each other, that increases your willingness to pay for a cellphone yourself.

Many information products are natural monopolies. Microsoft Windows dominates the operating system market because if everybody else uses Windows, you want to use it yourself. Even if it costs more or doesn't work as well, more software applications will be written for it because it's so popular. Thus, there are network externalities. In addition, software in general has high fixed costs of production—the cost of developing it—and low marginal cost—the cost of copying and marketing it. We frequently see wars of attrition as companies introduce competing new products knowing that whoever grabs the biggest market share first will get the entire market.

### 9.2: Solutions to Natural Monopoly

There are several policies to deal with natural monopoly.

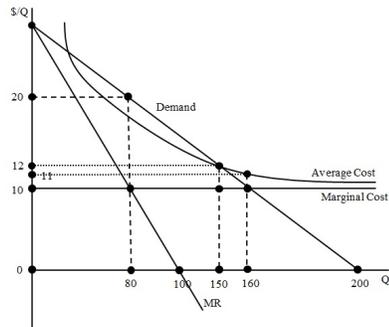
1. Just let it be an unregulated monopoly.
2. The government sells a license to be the unregulated monopoly in that industry.
3. Government ownership
4. Marginal-cost pricing plus a subsidy
5. Price caps
6. Average-cost pricing

We'll go through these one by one.

#### Unregulated Monopoly

Just because there is market failure does not mean that the government should regulate the industry. What will happen if the government does nothing? As just discussed, there may be a **war of attrition** as several companies battle it out to be the surviving monopoly. Once it is clear which company will survive, it will operate as a monopoly. In figure 9.2, the company has a fixed cost of \$300 and a constant marginal cost of \$10. If it is an unregulated monopoly, it will use the standard rule of maximizing profit by choosing quantity to equate marginal revenue to marginal cost, which happens at a quantity of 80 and a price of \$20. That is less than the quantity which maximizes social surplus, 160, which consumers would buy if the price equalled \$10, which is the marginal cost at  $Q=160$ .

FIGURE 9.2  
REGULATED AND UNREGULATED NATURAL MONOPOLY



The bad things about not regulating are the usual bad things about monopoly: too little trade because the monopoly wants to force up the price, rentseeking to acquire the monopoly (that war of attrition), and possible operating inefficiency because the company that has the monopoly might have higher costs than a potential rival. In addition, a lot of the social surplus would go to the seller instead of to buyers, which is bad if you value the welfare of consumers more than of sellers, or if you don't like the idea of monopolists being rewarded for bad behavior.

The good thing about not regulating is that it avoids the possibility of government failure. As we will see shortly in talking about the other policies towards natural monopoly, it is easy for the government to make the wrong choices, and also tempting when so much money is at stake. We have to balance the costs of market failure against the dangers of government failure.

This may explain why governments follow the "do nothing" policy with information industries that are natural monopolies. The downside of monopoly is not so great when the product is a software application instead of electricity, because software is an innovative industry where new products are constantly appearing. Microsoft may have a natural monopoly, with high profits, from MS-Word, but consumers do have access to other word-processing applications and Microsoft always faces the threat of some superior word-processing application being developed. Also, price regulation is a slow and cumbersome process, and the mere administration of it would be difficult with such a differentiated product as software. Finally, monopoly profits are actually a good thing in innovative industries, because we want to encourage companies to create new products by giving them the prize of monopoly profits.

Electricity distribution is different. There is innovation, but it's in the production technology, not the product. Electrons are electrons. Demand is inelastic—insensitive to price, with a steep demand curve. Hence, a monopoly has a lot of market power, a

lot of profits, and a lot of political power. Leaving the monopoly unregulated is a bad idea.

### Franchise Bidding

Monopolies have high profits, and restrict sales. If we're willing to accept the restriction of sales, we can deal with the high profits by just taking them away. The government could do this by taxing the electricity monopoly enough to take away its profits. That, however, raises the question of how the government knows how much to tax the monopoly. It could examine the monopoly's books, or tax the dividends it pays.

A clever solution, known as **franchise bidding** is to sell the right to be the monopoly by auction. The Niceville government could announce that whichever company paid the biggest lump sum at an auction would have the exclusive right to sell electricity in Niceville. This turns the rentseeking to good use. If all potential companies had the same costs, they would all bid amount  $80(\$20 - \$10) - \$300 = \$500$  in figure 9.2, and the government would choose one of them as a tiebreaker. The company would charge the monopoly price, but its net profit, after subtracting the auction payment, would be zero. And there would be no destructive war of attrition.

Even better, if one firm had lower costs than the others, it would be willing to bid higher. So this method would select the lowest-cost company.

A variant on this is to have each company's bid take the form of the price it would charge for electricity. The company that won would not have to pay anything to the government, but it would have to charge buyers the electricity price it submitted in the auction. Again, this would select the lowest-price seller. In figure 9.2, the price would be \$12, equal to average cost so that the profit was zero. No company would offer a lower price, since it would make negative profits, and any company that tried to offer a higher price would be underbid.

Of course, once one company is established, if the license comes up for renewal that company will have a big advantage in the auction. Thus, it makes more sense for new products such as cable TV was in the 1980's than for old products such as electricity.

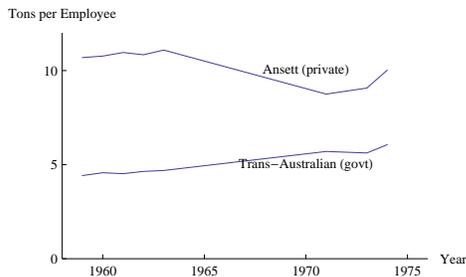
### Government Ownership

Socialism refers to a system of government in which the government produces goods and services. There are varying degrees of socialism. In practically all modern countries, the government provides roads. In most, it provides education, for free (grade schools) or for tuition (at state universities), often in competition with private-sector for-profit and non-profit companies. In some, the government owns airlines, steel mills, and stores, though with the fall of Communism in the 1990's and privatization in many countries that were partly socialist but not Communist this has become less common.<sup>2</sup>

---

<sup>2</sup>One might also say an economy is socialistic if the government makes the decisions of the firm that

**FIGURE 9.3**  
**GOVERNMENT VS. PRIVATE**  
**AIRLINES**



Government failure means that governments generally will not provide goods and services at as low costs as private companies, and they will be tempted to use laws and regulations to favor the government companies at the expense of private competitors. It has gone out of favor to have governments owning steel mills and car companies. The U.S. government's acquisition of shares in General Motors, Chrysler, Citigroup, and AIG in 2009 was a desperate measure during the financial crisis, and the government sold its shares as soon as it felt the economy was stable again.

In the case of industries that are not natural monopolies, private ownership is an easy policy decision. It avoids government failure either via inefficient government operation or inefficient government regulation. But in the case of a natural monopoly like electricity distribution, government ownership might be the lesser of evils. Perhaps costs will be higher than for a private company, but the government enterprise at least could set the price equal to marginal cost, and cover the resulting losses (since  $P < AC$  in that case) using revenue from income taxes. The price would be \$10 and the subsidy would equal area  $(\$11 - \$10)(160) = \$160$  in figure 9.2.

Or, if government operation leads to higher marginal costs, the marginal cost curve in figure 9.2 would rise, and there would be a rectangle of surplus loss consisting of the amount of increase in the marginal cost times the quantity sold. Since the higher marginal cost would also lead to a higher price, this would in the end lead to a lower quantity than under private ownership and  $P = MC$ , so we would also lose some consumer surplus from underproduction.

We also would have to worry about providing a service that should not be provided at all. It might be that consumers would pay a price equal to marginal cost for a product, but would drop the product entirely if the price rose to average cost. Suppose government phone service has an average cost of \$30/month and a marginal cost of \$5/month, while private cellphone service has marginal cost equal to average cost equal to \$10/month. If the government charged \$5/month, everybody would use its phone service, but for surplus maximization we want people to use cellphones instead. If the government charged average cost instead of marginal cost, it would discover this quickly and leave the phone business. Charging marginal cost, it might never realize how little consumers value the product.<sup>3</sup>

a board of directors or executive would otherwise make, even if ownership in the sense of receiving some or all of the profits is left to private individuals.

<sup>3</sup>Ronald Coase made this argument in the 1940's as a response to Harold Hotelling's 1930's proposal to

The very fact that the government can cover losses using tax revenue should lead us to expect problems with cost and quality, and perhaps inefficiently low prices, and regulations to protect against low-cost private-sector competitors. Consider garbage collection, an industry that is government-owned in many cities. The government officials running the garbage operation may well find it easier to lobby for extra subsidies than to find ways to save costs or to incur the anger of unionized workers by trying to reduce pay. Remember, too, that those workers are also voters. The officials also can expect little reward for saving so much on costs that they can return part of the subsidy that is supposed to cover their loss. And if some competitor to city garbage collection is provided by private companies, the government will be tempted to ban those competitors so as to help the government company. A true natural monopoly would not need protection against entry unless its operating costs were far higher than that of potential competitors, but such might be the case. Thus, city regulations often ban competition from mom-and-pop garbage haulers.

TABLE 9.1  
PRIVATIZATION IN THE UNITED KINGDOM—YEAR OF FIRST SALE OF SHARES

Organization	Industry	Year
British Petroleum	Oil	1979
National Enterprise Board Investment	Various	1980
British Aerospace	Aerospace	1981
Cable & Wireless	Telecom	1981
Amersham International	Scientific goods	1982
National Freight Corporation	Trucking	1982
Britoil	Oil	1982
British Rail Hotels	Hotels	1983
Associated British Ports	Ports	1983
British Leland (Rover)	Cars	1984
British Telecom (BT)	Telecom	1984
Enterprise Oil	Oil	1984
Sealink	Sea transport	1984
British Shipbuilders and Naval Dockyards	Ship building	1985
National Bus Company	Bus service	1986
British Gas	Gas	1986
Rolls Royce	Airplane engines	1987
British Airports Authority	Airports	1987
British Airways	Air travel	1987
Royal Ordnance Factories	Armaments	1987
British Steel	Steel	1988
Water industry	Water	1989
Electricity distribution industry	Electricity	1990
Electricity generation industry	Electricity	1991
Trust Ports	Ports	1992
Coal industry	Coal	1995
Railway industry	Rail transport	1995-97
Nuclear energy industry	Nuclear energy	1996

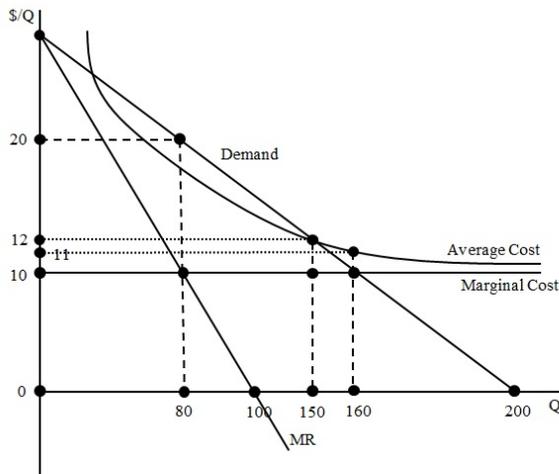
use marginal cost pricing. An excellent discussion is at Brett M. Frischmann and Christiaan Hogendorn (2015) "The Marginal Cost Controversy," *Journal of Economic Perspectives*, 29:193-206.

In addition, remember that taxation itself creates deadweight loss. Thus, when  $P=MC$  and a subsidy is used, we do not really avoid hurting economic value, because the subsidy requires increasing the income tax or some other tax where the triangle loss might be even greater than from having higher utility prices. Which loss is greater, from income tax or from higher electricity prices, would depend on the elasticity of demands of labor supply and of electricity demand.

Government ownership is actually in widespread use in the United States for public utilities. Notable examples are the federally owned Tennessee Valley Authority and garbage collection and water supply in many cities. Not all of these use marginal-cost pricing, however. It is common for government enterprises to be required to break even, which amounts to using the average-cost pricing system we will discuss later. Government ownership has been on the decline over the past fifty years. The United Kingdom is notable for the number of industries that have been **privatized**: sold off to become for-profit companies that may or may not be regulated, depending on whether they are natural monopolies. Table 9.1 shows what happened from 1979 to 1996.

**Marginal-cost pricing plus a subsidy**

FIGURE 9.2 (AGAIN)  
REGULATED AND UNREGULATED  
NATURAL MONOPOLY



In preference to government ownership, we could have private ownership, with a regulation requiring the private company to set the price at marginal cost. The private company would operate so as to maximize profits, which means it would try to minimize its costs for a given level of output. The price regulation would prevent it from restraining output to increase the price to the monopoly level, and the subsidy would take care of the fact that then the price would be less than average cost. In Figure 9.2, this would look just like government ownership: the price would be \$10/unit and the subsidy would equal \$160. As with government ownership, there would be deadweight loss from the taxation needed for the subsidy, and that loss could easily overwhelm the benefit from pricing at marginal cost. But we would at least hope that costs would not rise because of government failure.

Government failure is still a problem, though. The private company would want to minimize costs, but it would like to pretend that its costs are high so it can get a bigger subsidy to cover its supposed losses. Like the government-owned enterprise, its CEO might find that the most effective use of his time is not to make a good product at a low cost, but to lobby the government for additional help. Direct corruption would also be a concern, since the necessity of some subsidy provides a cover to a government official to funnel extra money to someone who bribes him.

### **Price caps**

Since the 1980's, an increasingly common way of regulating natural monopolies is by **price cap regulation**. Under a price cap scheme, the government sets an initial price ceiling for the utility, and then the utility can increase the price at the rate of inflation minus an **X-factor**. The X-factor is an adjustment for technological improvement in the industry that is expected to reduce costs over time. Thus, if the initial price was \$100, the X-factor was 2%, and the rate of increase of the consumer price index turned out to be 3.5% in the first year, the second-year price would be \$101.50, an increase of 1.5%. The scheme is like a contract between the utility and the government, one that lasts for a specified length of time with the same terms whether the utility makes a profit or a loss.

The United Kingdom was the first country to use price caps, introducing them when it privatized government-owned monopolies on electricity and natural gas in the 1980's. The reason to let prices rise with inflation is that we would expect inflation to raise costs for the utility. A good guess for the rate of increase of wages, for example, is the rate of increase of prices generally. A utility's costs, however, will not increase at the same rate as costs in the general economy. For one thing, utilities are more capital-intensive than the economy generally, and capital productivity might rise more than labor productivity. In addition, the product the utility produces stays much the same, any innovation could be expected to reduce production costs rather than improve the product (which might increase costs too—think of how automobiles have gotten more expensive over time). Also, with growth in the economy the scale of operation increases and that should reduce costs too in a natural monopoly. Thus, the X-factor is subtracted because we expect the utility to be able to take advantage of cost growth lower than in the economy at large. This can be combined with yardstick competition. This is done by adjusting the X-factor for the performance of other firms in the same industry.

The main selling point of price cap regulation is that it encourages the utility to minimize costs. Whether its costs rise or fall, its rate of price increase remains fixed. Also, past the initial year the government need not try to estimate the firm's costs. A drawback is that it is hard to commit to keeping the price cap scheme the same. In particular, if the firm manages to reduce its costs faster than expected, the government

will be very tempted to break the agreement and either reduce prices or impose an excess-profits tax, as happened in the United Kingdom in the 1990's.<sup>4</sup>

**Earnings sharing regulation** is similar to price cap regulation in that it sets up a contract between the utility and the government for a relatively long period of time, but it does not allow such extremes of profitability and unprofitability. Also, it is set up in terms of rates of return on investment for the utility. A typical plan sets a target rate of return on investment (say, 12%) and a “no-sharing” range of returns (say, 10% to 14%). If the rate of return is within the no-sharing range, that is exactly what the utility keeps. If the rate becomes lower (say, 9%) then the regulator allows a price increase so that the pain is shared between the utility and the customers. If the rate becomes higher (say, 15%) then the regulator requires a price reduction to share the unexpected profits between the utility and the customers. Thus, earning sharing regulation has the effect of raising the price cap if profits are too low and lowering the price cap if profits are too high.<sup>5</sup>

In practice, price cap regulation looks a lot like average-cost pricing regulation. The greatest similarity comes at the start of the process. How does the government set the initial price cap? It wants to set it to yield an average of zero economic profit, but that is exactly the goal of average-cost regulation. The difference is that under price cap regulation the prices are not supposed to be reset, but resetting prices is inevitable after enough years have past, whether it is because the utility is making embarrassingly large profits or because its losses are so high it cannot stay in business without price hikes.

### 9.3: Average-Cost Pricing

The traditional private monopolies whose price is regulated to roughly equal their average cost. This is known as **cost-of-service** or **rate-of-return** regulation, since it tries to set revenue equal to cost by giving the company a fair return on its investment.

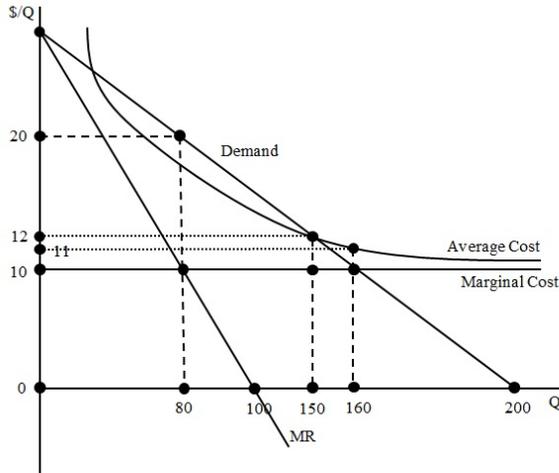
The disadvantage of this scheme is that it results in a price higher than the ideal one:  $P=AC$  instead of  $P=MC$ , amount  $P=\$12$  in figure 9.2 rather than  $P=\$10$ . Thus, there remains the triangle welfare loss  $.5(160-150)(\$12 - \$10)=\$100$ , because the company could produce more electricity and customers would be willing to pay the extra cost. But average-cost pricing has the advantage that we don't need a government subsidy any more. The government might still allow too generous a price, but at least no cash transfer is made from government to private business. The enterprise is self-financed.

---

<sup>4</sup>See <http://www.ifs.org.uk/fs/articles/fslucy.pdf>.

<sup>5</sup>David E. M. Sappington and Dennis L. Weisman (2010) “Price cap regulation: what have we learned from 25 years of experience in the telecommunications industry?” *Journal of Regulatory Economics* 38: 227-257.

FIGURE 9.2 (YET AGAIN)  
REGULATED AND UNREGULATED  
NATURAL MONOPOLY



The company also has an incentive to keep its costs low, because the actual way average-cost pricing is implemented is to set a price every few years that aims at equalling average cost, but which is fixed even if the companies costs go higher or lower. Thus, in figure 9.2 the company is allowed to charge  $P=\$12$ , but if the company finds some way to reduce costs so that  $AC = \$10.5$ , it can keep the profits. Or, if it can find some way to increase the demand for electricity so that sales at  $P = \$12$  come to equal  $Q = 170$  instead of the  $Q = 150$  shown in the figure, it can also make positive profits.

Next we'll see how the government figures out which price equals average cost.

**A Rate Case**

The general idea of average-cost pricing is to find a price which equals average cost. Here's how it's done.

First, the state legislature sets up a public utility commission. This is a committee of about five members who vote on what price to grant the electrical and other regulated utilities in the state. In some states, the members are elected. In others, they are appointed by the governor, but cannot be fired by him.

Once the utility commission is set up, the utility company applies for permission to charge a particular set of prices. This actually isn't just one single price for electricity; it is a whole schedule of prices. There can be one price for businesses, and one for homes. There can be one price for daytime, and one for night. There can one price for the small-quantity user and another for high volume.

The utility company presents its case for why these prices can be expected to yield zero profits. Importantly, by "zero profits" here we mean zero economic profits. The company must be allowed to cover its cost of capital, just as any private company must do. The crucial equation in rate- of-return regulation is

$$\sum_{i=1}^m price_i * E(Q_i^d(price_i)) = E(\sum_{j=1}^n price_j * input_j) + R * (\text{Rate Base}) \tag{1}$$

Let's look at the terms in this equation carefully. The commission needs to choose  $m$  different prices for the company's  $m$  different products,  $price_1, price_2, \dots, price_m$ . "Product" might mean a customer category—"home electricity", for example. The company's sales of product  $i$ ,  $Q_i^d$ , will be a function of the price of  $i$ . The left-hand-side of the equation,  $\sum_{i=1}^m price_i \cdot EQ_i^d(price_i)$ , equals the company's expected revenue, where the  $E$  represents the fact that we have to estimate what the output will be for a given price because demand curves shift over time.

The right-hand side of the equation is the company's expected costs. The first component of the costs is  $E(\sum_{j=1}^n price_j \cdot input_j)$ , the prices of the various inputs such as coal, labor, and capital depreciation. The amount of inputs used will depend on the output, of course, which itself has to be predicted. The prices of some inputs are volatile. Often, utility commissions will allow the utility to use a formula under which electricity prices rise and fall with fuel prices. Also, the input may be electricity itself, because a utility might choose to buy electricity from another company rather than generate it using its own power plants.

The **rate base** is the amount of capital needed, and  $R$  in the formula is the fair return on capital.

The commission does not have to accept the electricity prices the company suggests. The commission will decide for itself whether the company's estimates of revenue and costs are reasonable. The commission will also decide whether every capital expenditure really is justified, and should be put in the rate base. There have been some big denials. The two biggest were California's 1987 denial of \$2 billion for the rate base of Pacific Gas & Electric Company ("PG&E") for the Diablo Canyon One and Two nuclear plants and New York's 1987 denial of \$2.1 billion for the Nine Mile Two nuclear plant, which was 41% owned by Niagara Mohawk Power, 14% by Rochester Gas & Electric, 18% by New York State Electric and Gas, 9% by Central Hudson Gas & Electric, and 18% by the Long Island Power Authority.<sup>6</sup>

---

<sup>6</sup>Lyon, Thomas P. & Mayo, John W., "Regulatory Opportunism and Investment Behavior: Evidence from the U.S. Electric Utility Industry," *RAND Journal of Economics*, 36: 628-644 (Autumn 2005). Eliot Spitzer, Eliot, "Comments of Eliot Spitzer Attorney General of the State of New York Regarding Settlement Proposals," (September 25, 2001). [www.ag.ny.gov/media\\_center/2001/sep/NineMile.pdf](http://www.ag.ny.gov/media_center/2001/sep/NineMile.pdf).

**BOX 9.1****NIPSCO'S PRICES**

For households:

Customer Minimum Charge -\$5.95 including the first 36 kilowatt hours per month

16.522 cents per kilowatt hour for the next 14 per month

12.041 cents per kilowatt hour for the next 150 per month

9.637 cents per kilowatt hour for all over 200 per month

For any customer who regularly uses and depends on permanently installed electric spaceheating facilities:

7.149 cents per kilowatt hour beyond 500 from October to April.

For non-industrial businesses:

\$206.15 for the first 10 kilowatts or less of Maximum Demand per month

\$7.59 per kilowatt per month for all over 10 kilowatts of Maximum Demand per month

6.206 cents per kilowatt hour for all kilowatt hours used per month

The above rates are subject to a Purchased Power Cost Adjustment Tracking Factor and shall be adjusted for cost of fuel in accordance with the formula set forth in Rule 39 of the accompanying Rules and Regulations.

NIPSCO, "Rate 811: Rate for Electric Service Residential," (July 16, 1987).

NIPSCO, "Rate 823: Rate for Electric Service General Service," (June 8, 1994).

**9.4: The 2010 NIPSCO Rate Case**

The Northern Indiana Public Service Company (NIPSCO) is an investor-owned public utility that sells electricity and natural gas in northern Indiana, in the city of Gary and the neighboring region. It has 460,000 customers. Though only 1% of its customers are industrial, they buy 53% of the electricity. You cannot buy stock in just NIPSCO, because it is owned by a holding company, NiSource, which also owns utilities in other states.

## BOX 9.2

THE INDIANA UTILITY REGULATORY COMMISSION      Commissioners are appointed by the Governor to four-year terms or to fill out unfinished terms, Indiana also has an Office of Utility Consumer Counsellor which generally opposes rate increases.



Chairman Huston      Commissioner Freeman      Commissioner Krevda      Commissioner Ober      Commissioner Ziegner

James Huston has been Chairman since 2014, and was reappointed in 2018. He Previously he was Executive Director of the Office of Faith Based and Community Initiatives and deputy chief of staff for three different U.S. congressmen.

Sarah Freeman was appointed in 2016. She was a lawyer with the Indiana Attorney General and the Indiana Legislative Services Agency.

Stefanie Krevda was appointed in 2018. She was formerly the Executive Director of External Affairs for the Commission and Chief of Staff at Indiana's State Personnel Department,

David Ober was appointed in 2018, after having been an Indiana State Representative.

David E. Ziegner was appointed in 1990. He was senior staff attorney for the Legislative Services Agency, and then General Counsel for the Commission.

NIPSCO is regulated by the Indiana Utility Regulatory Commission (IURC, “the Commission”). Its electricity rates had last been set in 1987 and had not changed for many years. In June 2008 it proposed an increase, which was granted by the Commission in August 2010. In between, NIPSCO filed memos and presented witnesses arguing for a price increase, and the Indiana Office of Utility Consumer Counsellor (OUCC) and customers argued for a smaller increase. Those opposing the rate increase included the LaPorte County Board of Commissioners, the Board of Commissioners and Council of Newton County, the city governments of Crown Point East Chicago, Hammond, and Munster; the Citizens Action Coalition of Indiana; industrial customers Accurate Castings/INCMA, ArcelorMittal USA, Beta Steel, Cargill, Marathon Petroleum, USG Corporation, and U.S. Steel; and the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union.<sup>7</sup> Here's a timeline.

<sup>7</sup>The Indiana Office of Utility Consumer Counsellor (OUCC), “Northern Indiana Public Service Co. Electric Rate Case, IURC Cause No. 43526, Public Field Hearing —Basic Facts,” 4pp. (July 15, 2009).

2008

June: NIPSCO filed its petition with the IURC.

August: The IURC issued a schedule.

NIPSCO filed testimony and exhibits in support of its request.

2009

January: A two-week technical evidentiary hearing was held in Indianapolis.

March: An IURC public hearing was held in Gary.

May: The OUCC and other parties filed testimony.

June: NIPSCO filed rebuttal testimony.

July: An IURC public hearing was held in Michigan City. July: An IURC technical evidentiary hearing is scheduled to begin in Indianapolis and last two weeks.

October: NIPSCO filed its proposed order, what it would like the IURC to approve.

December: The OUCC and others parties filed their proposed orders.

2010

January: NIPSCO filed its reply to the OUCC and other parties.

August: The IURC issued its final order, authorizing a rate increase and telling NIPSCO to come up with specifics.

September: The IURC authorized a specific schedule of prices.

The first item of contention was the rate base. An example of what was under consideration was whether to include prepaid pension assets in the rate base. The OUCC argued that it should not be included, and in the end it was not. Table 9.2 shows the Commission's final decision as to how big the rate base should be.

TABLE 9.2  
THE NIPSCO RATE BASE

Asset (Liability)	Amount
Utility Plant	5,205,578,748
Common Plant Allocated	214,502,540
Less Schahfer 17 Disallowed Plant	(31,733,655)
Total Utility Plant	5,388,347,633
Accumulated Depreciation and Amortization	(2,800,380,478)
Sugar Creek Accumulated Depreciation and Amortization	(5,618,432)
Common Plant Accumulated Depreciation Allocated	(98,409,168)
Less Disallowed Plant Accumulated Depreciation	27,399,652
Total Accumulated Depreciation and Amortization	(2,877,008,426)
Net Utility Plant	2,511,339,207
Schahfer 17 Deferred Depreciation	542,928
Schahfer 18 Deferred Depreciation	5,206,694
Schahfer 18 Deferred Carrying Charges	16,132,193
Prepaid Pension Asset	0
Materials & Supplies	46,907,735
Sugar Creek Materials & Supplies	1,495,291
Production Fuel	57,566,559
Total Rate Base	\$2,639,190,607

A second issue was the cost of capital for NIPSCO. This had two parts: the capital structure to be used, and the cost of equity capital.

NIPSCO had 61% common equity and 39% long-term debt. This is unusual for a public utility, and the OUCC said it included too much equity capital, which is more expensive than debt capital.<sup>8</sup> The OUCC noted that the average share of equity cap-

<sup>8</sup>Capital structure is complicated, though. The Modigliani-Miller Theorem points out that adding debt to a company increases the riskiness of its equity (and its existing debt), which can cancel out the

ital in a comparison group of utilities they picked was only 47%. Moreover, NIPSCO is a wholly owned subsidiary of NiSource, which only has 52% equity. The OUCC said that NIPSCO's revenue requirement should be reduced by \$30 million because it was justified by too high a share of equity. The Commission sided with NIPSCO on this issue.

The cost of debt capital for NIPSCO was 6.6%, which is straightforward to compute using the actual interest rates on the debt. The cost of equity capital is much trickier to estimate. NIPSCO said its cost of equity capital was 12.0%. The OUCC said it was 10.0%. The Industrial Group, an alliance of industrial customers, said it was 9.2%. Estimates were presented using a variety of finance methods including the CAPM model.

To calculate the cost of capital using the CAPM model requires as ingredients **the risk-free interest rate**, the company's **beta** (how much its stock rises on average when the entire stock market goes up—1 if when the stock market rises 10% as a whole, the best guess for the increase in value of this stock is also 10%), and the extra interest the market requires for riskier companies, the **risk premium**.<sup>9</sup> Thus, the required return on a company's stock is

$$r = \text{riskfree rate} + \beta(\text{risk premium})$$

NIPSCO used a 4.5% risk-free rate based on recent historical yields on long-term treasury bonds, Blue Chip forecasts and recent trends, a beta of 0.85, which is the average of the betas for the companies in the Electric Group as estimated by Value Line (a financial information company) and a risk premium of 8.44%, which averages the difference between historical market returns and treasury bond returns (6.5%) and the difference between forecasted market returns and treasury bond returns (10.37%).

The OUCC used a risk-free rate of 4.00%, the upper end of the range of yields in 10- and 20-year treasury bonds, a beta of 0.68, the average in his comparison group of utilities, and a risk premium of 4.61%, less than historical returns because the risk premium has declined with the big increase in stock prices 2001-2008. This estimate was the average of 7 historical studies for periods beginning as early as 1872; 25 equity-premium-puzzle studies published between 1999 and 2009 (which tried to explain why equity seemed to have so much higher a return than debt before 2001); four surveys of forecasters, chief financial officers, and academics; and two ground-up

cheapness of debt finance.

<sup>9</sup>The CAPM is one of the simplest models of stock pricing. Other models add more variables, such as the size of the company and its ratio of market value to book value. See Kent Womack, Ying Zhang, Adam Borchert, Lisa Ensz, Joep Knijn, Greg Pope, and Aaron Smith (2003) "Understanding Risk and Return, the CAPM, and the Fama-French Three-Factor Model," Tuck School at Dartmouth No. 03-111.

[http://www.portfoliosolutions.com/pdfs/FF\\_3\\_Factor\\_Tucks.pdf](http://www.portfoliosolutions.com/pdfs/FF_3_Factor_Tucks.pdf).

estimates based on current conditions, including one that the OUCC's expert witness did himself. The purpose was no doubt to impress the regulatory commission with the number of studies used, but often what is best is simply to decide which of many studies is best and use just that one.

The Industrial Group used a 4.30% risk-free rate based on a Blue Chip projected treasury bond yield; a beta of 0.73 based on the average Value Line estimate for a group of similar companies, and a risk premium of 6.5–7.0% based on its estimate of historical returns and the expected return on the S&P 500.

The Commission chose 9.9% as the cost of equity. Table 9.3 shows how it calculated the weighted average cost of capital.

TABLE 9.3  
NIPSCO'S COST OF CAPITAL

Capital Source	Amount	Percent of Capital	Cost	Weighted Average Cost
Common Equity	\$ 1,395,245,772	49.95%	9.90%	4.94%
Long-Term Debt	\$ 906,631,137	32.46%	6.52%	2.12%
Customer Deposits	\$ 63,684,199	2.28%	6.00%	0.14%
Deferred Income Taxes	\$ 294,780,249	10.55%	0.00%	0.00%
Post-Retirement Liability	\$ 102,637,766	3.67%	0.00%	0.00%
Post-1970 Investment				
Tax Credit	\$ 30,350,460	1.09%	8.57%	0.09%
Totals	\$ 2,793,329,583	100.00%	—	7.29%

As you can see, rate cases become quite involved. My summary so far only takes us to page 33 of the Commission's 131-page Final Order, and the Final Order itself is only a summary of the much lengthier testimony the various parties presented, but it gives the flavor of a typical rate case. We will refrain from looking at the discussion of operating costs, however, and go straight to the result. NIPSCO asked for prices that would give it gross revenue of \$974,062,979. What the Final Order said was:

Petitioner Northern Indiana Public Service Company shall be and hereby is authorized to revise its basic rates and charges for electric utility service to provide annual gross margin revenue of \$899,401,890 plus non-trackable fuel expense of \$11,015,038 which on the basis of annual electric operating expenses of \$706,976,357 (net of revenues and expenses relating to trackable and non-trackable fuel and purchased power and related Utility Receipts Tax) are estimated to provide net operating income of \$192,425,533.<sup>10</sup>

<sup>10</sup>*Petition of Northern Indiana Public Service Company ("NIPSCO") For (1) Authority to Modify Its Rates . . . Indiana Utility Regulatory Commission Cause No. 43526, Final Order, pp. 129–130 (August 25, 2010).* [http://www.in.gov/iurc/files/Order\\_in.Cause.No..43526.pdf](http://www.in.gov/iurc/files/Order_in.Cause.No..43526.pdf)

Thus, the Final Order gave NIPSCO rates expected to generate \$910 million in revenue, as opposed to the \$974 million that NIPSCO asked for. This is a typical result; the utility asks for their rates on various kinds of electricity to increase by a certain amount, customers object, and the regulatory commission grants some but not all of the requested rate increases.

### 9.5: Ramsey Pricing

Suppose the company in the story at the start of the chapter comes back to the mayor and says,

“Mayor, we’ve settled into the new regulatory regime, and we’re not going to try to get rid of it. We do, however, wish that the regulation weren’t so rigid. Right now, the regulatory commission sets a price for each product that gives us a fair return on that product. So, of course we have a fair return overall. But wouldn’t it be okay if we made a profit on some products, so long as it was balanced by a loss on others?”

The mayor is suspicious, because he knows that companies try to come up with fancy schemes to fool the government. But the CEO actually has a point. Social surplus can be increased by raising some prices, if other prices are lowered at the same time. The idea is to raise prices on goods whose quantity demanded is insensitive to price, while reducing prices on goods whose quantity demanded is sensitive. That would give us an increase in the quantity demanded of goods, while not allowing profits overall to stay at zero. The idea is called Ramsey pricing.

To see this we will use a numerical example.<sup>11</sup> Let the company sell business electricity ( $Q_b$ ) and home electricity ( $Q_h$ ), with a total cost of

$$TC = 1800 + 20Q_b + 20Q_h. \quad (2)$$

Let the demand curves be

$$Q_b = 100 - P_b \quad (3)$$

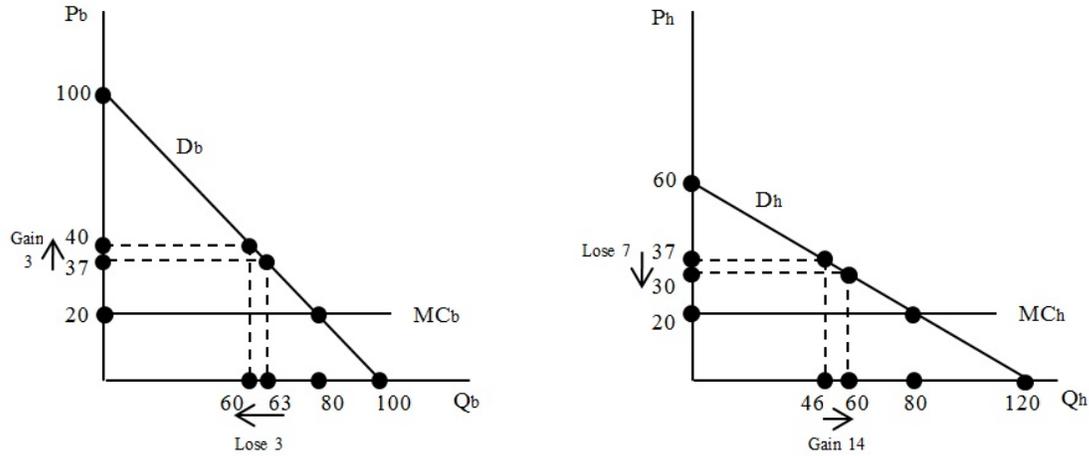
and

$$Q_h = 120 - 2P_h. \quad (4)$$

<sup>11</sup>This is based on an example in Chapter 11 of W. Kip Viscusi, Joseph E. Harrington, and John M. Vernon, *Economics of Regulation and Antitrust*, 4th edition, MIT Press (2005).

As shown in figure 9.4, home electricity has a flatter, more elastic, demand curve.

FIGURE 9.4  
RAMSEY PRICING



The marginal cost is \$20 for sales to either kind of customer. If the firm charges  $P = \$20$  it will sell 80 units of each good (a coincidence to make the computations easier here) and suffer a loss of \$1,800 since it won't cover its fixed costs. There would be zero triangle loss, because at that price and quantity the marginal cost to the firm equals the marginal benefit to consumers. We are aiming to use average-cost pricing so the firm will break even, and that means the prices must rise and we must accept a certain amount of deadweight loss.

The simplest pricing scheme would be for the firm to raise both prices to  $P_b = P_h = \$37$ , selling 63 units to B and 46 units to H. It would be receiving net revenue of \$1,071 ( $= 63(37 - 20)$ ) from B and \$736 ( $= 46(37 - 20)$ ) from H, which when summed covers the fixed cost of \$1,800 with a little bit left over. The deadweight loss would be \$144.50 ( $= .5(80 - 63)(37 - 20)$ ) from B and \$289 ( $= .5(80 - 46)(37 - 20)$ ) from H, a total loss of \$433.50.

As you can see, the same price increase from \$20 to \$37 gives us less extra revenue and more triangle loss from good H than from good B. The problem is that the quantity demanded falls so much more from H, because its demand is more elastic, more price sensitive. The elasticity of demand is

$$\text{Elasticity of demand} = \frac{\% \text{ Change in quantity demanded}}{\% \text{ Change in price}} = \frac{dQ}{dP} \frac{P}{Q}. \quad (5)$$

It is useful to write the elasticity of demand as  $\frac{dQ}{dP} \frac{P}{Q}$  here because we can use the demand equations to estimate the elasticities when the price is \$37.

$$\text{Elasticity of demand}_b = (-1) \frac{37}{63} \approx -.59. \quad (6)$$

$$\text{Elasticity of demand}_h = (-2) \frac{37}{46} \approx -1.61. \quad (7)$$

The solution is to increase the price of H to less above marginal cost and to increase the price of B to further above marginal cost to recoup the lost profit.

Instead of both groups being charged 37, let the firm use prices of  $P_b = \$40$  and  $P_h = \$30$ . These will still be able to cover the fixed cost without so much welfare loss. The company would get net revenue of \$1,200 ( $= 60(\$40 - \$20)$ ) from B and \$600 ( $= 60(\$30 - \$20)$ ) from H, which when summed would cover the fixed cost of \$1,800. The triangle losses of social surplus would be \$200 ( $= .5(80 - 60)(\$40 - \$20)$ ) from B and \$100 ( $= .5(80 - 60)(\$30 - \$20)$ ) from H, a total loss of just \$300. The elasticities are now closer together:

$$\text{Elasticity of demand}_b = (-1) \frac{40}{60} = -\frac{2}{3} \quad (8)$$

and

$$\text{Elasticity of demand}_h = (-2) \frac{30}{60} = -1. \quad (9)$$

The idea of marking goods up less if they have more elastic demand to attain a given net revenue target is known as **Ramsey pricing**. The equation that determines the optimum is known as the **Ramsey rule**. The Ramsey rule, which I will not prove here, requires prices of both goods  $i = b, h$  to be set so:<sup>12</sup>

$$\frac{\text{Price}_i - \text{MC}_i}{\text{Price}_i} = \frac{\lambda}{-\text{Elasticity}_i'} \quad (10)$$

where  $\lambda$  is a parameter between 0 and 1 that is made just big enough to generate the required revenue. If the company doesn't need to make any profit to survive, then  $\lambda = 0$  and price equals marginal cost for each good. Here, the Ramsey rule yields

$$(\text{Business}) \quad \frac{40 - 20}{40} = \frac{\lambda}{\frac{2}{3}}, \quad (11)$$

and

$$(\text{Home}) \quad \frac{30 - 20}{30} = \frac{\lambda}{1}, \quad (12)$$

<sup>12</sup>Frank P. Ramsey, "A Contribution to the Theory of Taxation," *The Economic Journal* (1927).

Thus,  $\lambda = \frac{1}{3}$ , which makes both equations true ( $\lambda$  is the Greek letter lambda). At the optimum, the elasticity is still higher for home electricity, but it is marked up less over cost than business electricity is.

A curious feature of Ramsey pricing which I will not prove here is that another way to find the optimum is to reduce quantity by the same percentage for each product below the quantity where  $P = MC$ . Here, the quantity where  $P=MC$  was 80 units for both products, and both were reduced by 25% to 60 units.

In this electricity example there are just two goods, but the Ramsey rule applies even if there are three or more goods—just make sure each has its price increased above marginal cost in inverse proportion to its elasticity of demand. If the company wants to make as much profit as possible, set  $\lambda$  equal to 1, which makes the firm's profit as large as possible and we get—surprise!—the **Lerner Rule**:

$$\frac{P - MC}{P} = \frac{1}{-Elasticity}$$

Thus, one implication of the Ramsey Rule is that a multi-product monopolist should mark up the price of the less elastic good more, at least if the demand for the two goods is independent. (If demand for one of the goods depends on the prices of both goods, things become more complicated).

#### REVIEW QUESTIONS

1. What is natural monopoly and what problems does it create?
2. What are the solutions to natural monopoly?
3. How does rate-of-return regulation work?
4. How would you figure out a regulated utility's cost of equity capital?
5. How can firms use Ramsey pricing to reach a profit target with less allocative inefficiency?

## READINGS

1. "Indiana Toll Road Bankruptcy Chills Climate for Public-Private Partnerships," William J. Mallett, *CRS Insights*.
2. "Texas Looks into Price Spike at Hunt-Owned Sharyland Utilities," *Dallas Morning News*.
3. "Trashy Politics: Why Dallas Is Dealing in Garbage; Local Governments Have a Creative New Revenue-Raising Method: Take Over from a Profitable Private Enterprise," *The Wall Street Journal*.
4. "Who's Afraid of Comcast?," Jack Shafer, *Reuters*.
5. "Price Caps, Rate-of-Return Regulation, and the Cost of Capital," Ian Alexander and Timothy Irwin, The World Bank.