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Energy Efficiency: Efficiency or Monopsony?

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RESOURCES FOR THE FUTURE

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Abstract

The cliché in the electricity sector, the "cheapest power plant is the one we don't build," seems to neglect the benefits of the energy that plant would generate. Those overall benefits could be countered by benefits to consumers if "not building that plant" was the result of monopsony. A regulator acting as a monopsonist may need to avoid rationing demand at monopsony prices. Subsidizing energy efficiency to reduce electricity demand at the margin can solve that problem, if energy efficiency and electricity use are substitutes. We may not observe these effects if the regulator can set price as well as quantity, lacks buyer-side market power, or is legally precluded from denying generators a reasonable return on capital. Nevertheless, the possibility of monopsony remains significant in light of the debate as to whether antitrust enforcement should maximize consumer welfare or total welfare.

Key Words: energy efficiency, monopsony, consumer welfare, total welfare, electricity

JEL Classification Numbers: L51, L94, L12

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Introduction

An observation common in energy policy circles, to the point of being a cliché, is that "the cheapest power plant is the one you don't build."[1] From the perspective of economic efficiency, if not necessarily energy efficiency, the statement is at best incomplete. One needs to consider not only the cost saved by not building a plant, but also the benefits forgone in not building it. Observing that "the cheapest elementary school is the one we don't build" or "the cheapest polio shot is the one we don't give" would be just as easy to do.

A possible efficiency justification for not building plants is that the forgone benefits are less than the cost of the plant because the price of electricity is too low. This is especially likely to hold in peak demand periods, in the absence of marginal cost real-time pricing. The price of electricity may also be too low if there are negative environmental externalities not already reflected in the price of electricity through other policies, e.g., carbon taxes or emissions permit cap-and-trade programs. A second, more problematic justification is that consumers are using too much electricity because they are unable to determine for themselves that they would individually profit from investing in energy efficiency (Brennan 2009).

A third possibility has not received the attention it may deserve. In a deregulated market, the price of energy paid to all suppliers will equal the marginal cost of the last unit produced. With an upward-sloping supply curve, this means that consumers as a group could benefit through monopsonistic reduction of energy purchases, in effect not building that last plant in order to hold the price down. We examine the extent to which energy efficiency or demand-side

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[1] As phrased in a quote in from a Rocky Mountain Institute (2009) newsletter, "As Gary Zarke of Seattle City Light says: 'There's no cheaper, cleaner power than power you don't have to produce.'"

management policies may be worth undertaking from the perspective of the regulator acting as a monopsonist.[2]

Such activity would not be efficient, in that the forgone benefits to consumers from additional electricity use would exceed the cost of the electricity production. The extent to which regulators should nonetheless act monopsonistically connects directly to an ongoing debate regarding standards for antitrust violations. That debate centers on whether conduct such as price discrimination or mergers should be evaluated on a total welfare standard, taking both profits and consumer surplus into account, or on a consumer welfare standard, recognizing only the latter.

On the one side of the debate is the view that for reasons of congressional intent, distributive justice, or to correct for antienforcement bias in the policy process, the standard for assessing violations should be exclusively consumer welfare; cost savings captured in seller profit should not outweigh consumer harms (Fisher and Lande 1983; Pittman 2007). On the other side is the view that the total welfare efficiency standard used in comparing costs with benefits in every other policy arena ought to be applied in antitrust. Proponents support this view both on traditional efficiency grounds and on the view that over the long run, total surplus ends up being passed on to consumers (Heyer 2006; Carlton 2007).

The continuing debate regarding consumer vs. total welfare in antitrust prevents us from assuming that regulators, even if motivated by policy norms rather than special interests, would look to economic efficiency. This leads us to consider whether a regulator would want to maximize consumer welfare by monopsony and intervene in energy efficiency markets to do so. The next section of the paper introduces the basic monopsony model for those unfamiliar with it. It also shows that if demand is rationed over all purchases for which the willingness to pay exceeds the price, monopsonistic price reductions could reduce consumer welfare alone, as buyers with low willingness to pay effectively take output from those with high willingness to pay.

The following section addresses efficiency investments. It begins by showing that the effect of energy efficiency on electricity demand needs to be assumed; for sufficiently high

[2] This view of the regulator as favoring consumers runs counter to the classic view of the regulator as captured by the regulated firm (Stigler, 1971) or as reacting to differential political influence from stakeholders (Peltzman, 1976). The potential for monopsony is more in line with the opportunistic perspective in Gilbert and Newbery (1994).

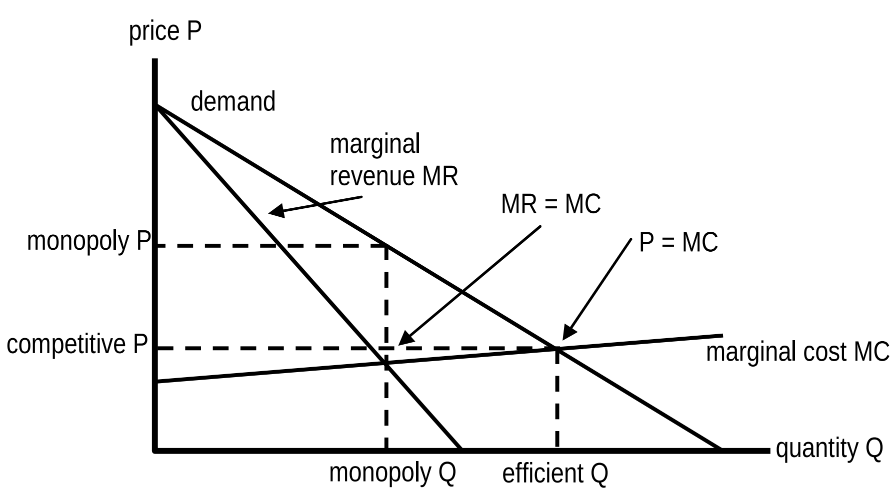
prices, increased energy efficiency would typically induce more, not less, energy use. Assuming that at the margin energy efficiency and electricity are substitutes, we find the simple "price equals marginal cost" optimum for electricity use and energy efficiency investment. We then provide our main result: If consumer welfare alone is the policy norm, a regulator would want to subsidize energy efficiency to reduce demand just to reduce price. We then discuss caveats, including (a) whether a regulator that could set price and quantity would monopsonize, (b) lack of market power on the buyer side, and (c) implications of the divergence between price and short-run marginal cost. A brief conclusion follows.

Monopsony Basics

Overview of the Theory

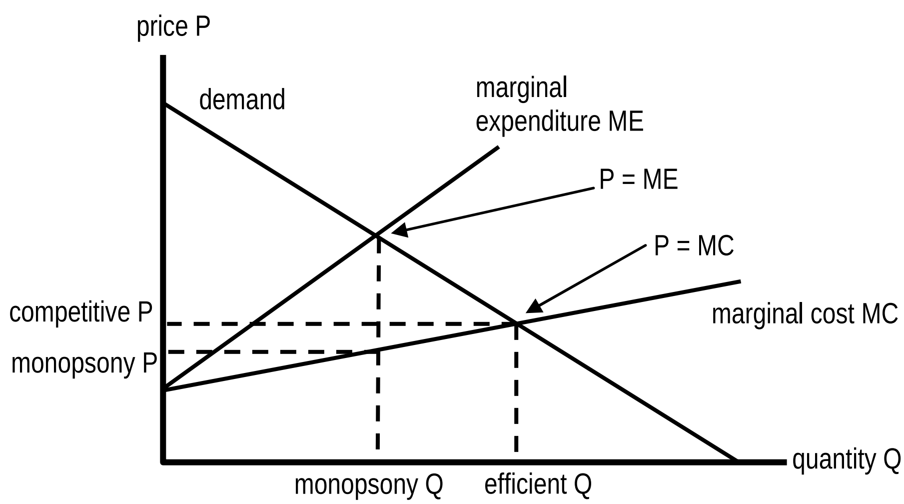
The basic theory of monopsony is the familiar monopoly model turned upside down. In monopoly, a single seller finds it worthwhile to hold product off the market to raise price. Unlike a price-taking firm, which acts as if it can sell as much as it wants at the prevailing price, a single firm in a market can increase sales only by depressing the price. This requirement to depress price provides an incentive to withhold output that is not present for a firm acting competitively. For a monopolist, the firm's marginal revenue is thus less than the price. Maximizing profit, by choosing the level of output at which marginal revenue equals marginal cost, will thus lead to a price above marginal cost. A welfare loss follows, as the marginal benefit of additional production—the price—exceeds the marginal cost of additional production, indicating too little output. Figure 1 reproduces the familiar diagram.

Figure 1: Monopoly



Monopsony flips this story over. Instead of a single seller, we have a single buyer. Under a competition, buyers as price-takers act as if their volume of purchases has no effect on the price they pay. However, a single buyer will take into account the possibility that increasing the quantity it purchases will raise the market price and, thus, the price it pays for all the units it purchases. Just as marginal revenue is less than price for a monopolist, the marginal expenditure—the incremental effect of purchases on spending—will exceed the marginal cost of producing the good. In maximizing its welfare, the monopsonist will equate its marginal willingness to pay, represented by its demand curve, with the marginal expenditure, which in turn exceeds the price it pays, which equals the marginal cost of production. Because marginal willingness to pay exceeds marginal cost, again there is too little output. Figure 2 diagrams the situation.

Figure 2. Monopsony



The simple mathematics of monopsony will prove useful in analyzing the potential relevance of nominal energy efficiency programs that cut demand. The objective of the single buyer is to choose the level of purchases *q* to maximize its gross surplus from those purchases, less its expenditure on them. Assuming a competitive supply curve,[3]

the price the buyer pays has to equal the marginal cost of the sellers. Therefore, the buyer's expenditure is just $c'(q)q$, where c is the cost of producing *q* by the sellers and *c'* is the marginal cost. The buyer's gross surplus is given as the sum of its marginal willingness to pay for each unit up to *q*, represented as the area under its demand curve, where the demand curve is given by *w(q)*. Thus, the buyer chooses *q* to maximize

$$\int_0^q w(z)dz - c'(q)q$$

which occurs at the level of purchases *q* for which

$$w(q) - c'(q) = c''(q)q. \qquad (1)$$

From an overall efficiency perspective, we have too few purchases if the marginal willingness to pay exceeds marginal cost, which occurs when the right-hand side is positive. That will be the case if $c'' > 0$, i.e., the marginal cost curve slopes upward. Another way to view this condition is by dividing both sides of (1) by $c'(q)$:

$$\frac{w(q) - c'(q)}{c'(q)} = \frac{c''(q)q}{c'(q)} = \frac{1}{e_s}, \qquad (2)$$

where e_s is the elasticity of supply. The condition for monopsony to reduce output below the efficient level, $c'' > 0$, is thus equivalent to $e_s < \infty$; the elasticity of supply is finite.

The Rationing Problem

The monopsonist's optimization problem assumes that the q units purchased are used to meet demand with the highest marginal willingness to pay or reservation price. For a single buyer, that assumption is reasonable. It need not hold when the monopsony is executed on

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3 For clarity of illustrating the potential monopsony incentive for subsidizing efficiency investments, we assume that the supply curve of electricity is competitive. Some studies have found the opposite, e.g., Borenstein, Bushnell, and Wolak (2002). Although utilities may well have unilateral incentives to withhold electricity to raise price, these studies are flawed by relying on comparisons between price and average variable costs, when prices at or close to peak period in perfectly competitive markets would include premiums for capital cost recovery (Brennan 2006). Looking at quantities withheld rather than price is more informative; an example of a recent study taking that approach is Kwoka and Sabodash (2009).

behalf of a set of consumers who make purchases independently. It could be arranged to hold if those who are able to purchase the good at the low monopsony price are then able to resell the good. This might be plausible in the textbook example where a municipality attempts to monopsonize a local apartment market through rent control, but then allows those who get apartments at low rent to sublet them to those tenants willing to pay the highest rents.

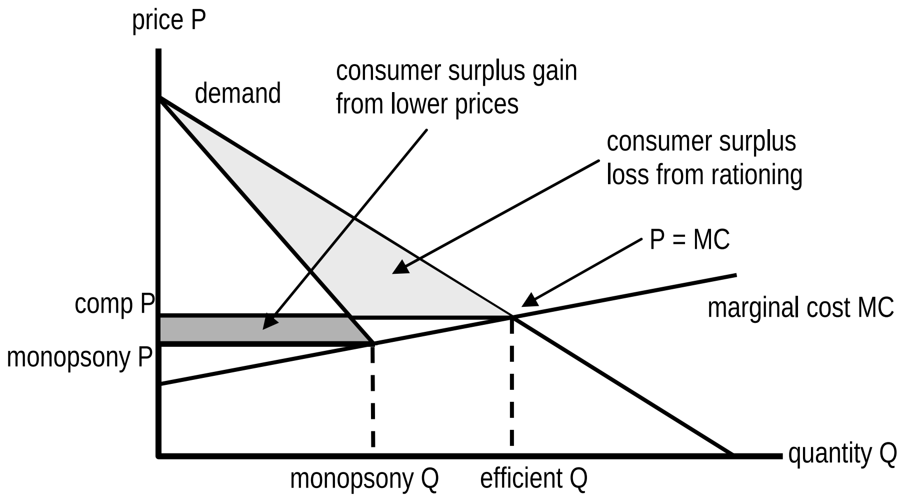
In the case of electricity, resale of purchased but unused kilowatt-hours seems impractical. If each consumer demands as much as she wants at the monopsony price, demand (greater than that at the competitive price) will exceed supply (less than that at the competitive price). Any individual consumer presumably is using the kilowatt-hours in the ways she views most valuable, but there is little to suggest that those will be all of the hours purchased. For monopsony to be effective, some sort of rationing scheme needs to be implemented.

Illuminating the importance of this concern, it turns out that if rationing is purely random, an agent acting on behalf of a set of consumers—such as a regulator—may not find monopsony worth exercising, even if motivated solely by the welfare of buyers and not that of the economy as a whole. To see this, we model the benefits purchasers make under monopsony as if the demand curve is shifted in proportionally such that the purchases made at the lower price just equal the amount supplied at the lower price.[4]

Figure 3 illustrates the effect. The dark shaded area represents the gains from monopsony, roughly equal to the price reduction obtained by those who are able to purchase the good at the lower price. The light gray area represents the loss of welfare from the rationing, representing buyers with high valuations who are unable to purchase the good. It turns out that at the margin, beginning at the competitive price, the light area can exceed the dark area, indicating that the benefits of low prices are outweighed by the costs of the rationing those low prices induce.

[4] A more general, less draconian set of rationing possibilities is considered in the Appendix.

Figure 3. Consumer Gains, Losses under Monopsony with Rationed Demand



To understand when rationing makes monopsony unprofitable, it is useful to model consumer surplus as a function of the price the monopsonizing agent, e.g., the regulator, would set. Letting *d(p)* be the demand from consumers at price *p*, the consumer surplus from purchasing electricity at *p* is given by

$$\int_p^\infty d(z)dz\,.$$

Consumers cannot purchase as much as they would like at price p, however. To represent rationing, we assume that the fraction of consumers who can obtain the good is the simple ratio *s(p)*/*d(p)*, where *d(p)* is as above and *s(p)* is the supply at *p* (equal to the quantity where marginal cost *c'(s(p)) = p)*. We assume further, perhaps as a worst-case scenario, that this rationing ratio applies equally along the demand curve.[5] Those with high reservation prices are not disproportionately more likely to obtain the product than those with low reservation prices.[6] If so, the rationed consumer surplus as a function of price, *CS(p)*, is simply

[5] In the conventional monopsony story, those with the highest reservation prices get as much as they want at the monopsony price, and those with the lowest reservation prices get nothing, maximizing the consumer surplus obtainable at that price.

[6] That this is an extreme case is indicated by recognizing that each individual consumer would presumably allocate her reduced purchases of the product to those uses she finds most valuable.

$$CS(p) = \frac{s(p)}{d(p)} \int_p^{\infty} d(z)dz \,. \tag{3}$$

The derivative of $CS(p)$ is

$$CS'(p) = \frac{s(p)}{d(p)}\left[-d(p)\right] + \int_p^{\infty} d(z)dz \left[\frac{d(p)s'(p) - s(p)d'(p)}{\left[d(p)\right]^2}\right]. \tag{4}$$

The first term in (4) is negative, reflecting the gains from reducing price, but the second term is positive, reflecting the lost surplus resulting from rationing along the demand curve. Monopsony with rationing would reduce welfare, at least at the margin, if $CS' > 0$ at the competitive price, where $s(p) = d(p)$. Letting p be the competitive price and collecting terms in (4), recognizing that $s(p) = d(p)$, gives the result that monopsony reduces welfare at the margin if

$$-d(p) + CS(p)\left[\frac{s'(p)}{s(p)} - \frac{d'(p)}{d(p)}\right] > 0.$$

Rearranging terms further allows us to rewrite this condition as

$$e_s + |e_d| > \frac{pd(p)}{CS(p)}, \tag{5}$$

where e_s and e_d are, respectively, the elasticities of supply and demand.[7] We thus have

Proposition 1: *If consumers are uniformly rationed, rather than quantities going to uses with the highest reservation prices, then monopsonistic price reductions can reduce welfare if the elasticities of supply and demand are sufficiently large.*

The condition in (5) tells us that if, at the competitive price, the sum of the elasticities of supply and (in absolute value) demand exceeds the ratio of expenditures to consumer surplus at the competitive price, monopsony could reduce welfare. Intuitively, a high sum of the elasticities means that the rationing induced by the increase in price, measured by the ratio of supply to demand, will be relatively greater and could outweigh the direct benefit to buyers from reducing the price. Recall that absent rationing, monopsony improves consumer welfare as long as $e_s < \infty$. Consequently, a regulator acting as an electricity monopsonist will want to look at

[7] $e_s = ps'/s$; $e_d = pd'/d$.

ways to inhibit the excess demand that leads to the rationing loss. This is where "energy efficiency" enters the picture.

Consumer Welfare Alone Implies Inefficient Efficiency Subsidies

The Base Case: Optimal Energy and Efficiency Prices under a Total Welfare Standard

Energy efficiency investments, such as high-efficiency air conditioners or compact fluorescent light bulbs, change the level of energy services that one obtains from a given amount of electricity. This, in turn, will move the demand curve for electricity. Before modeling this, it is useful to understand that the effect on the demand curve is not simply a reduction in demand. Because energy efficiency increases the amount of energy services one gets, the value consumers get from initial levels of consumption will increase, not decrease. Thus, the effect of energy efficiency investments is not to shift the demand curve down, as in the left graph in Figure 4, but to pivot it, as illustrated by the graph on the right, where $d(p, x)$ is the demand for electricity at price p and with energy efficiency investments of x, and $d(p, x + \Delta x)$ is the demand for electricity when Δx additional investment in energy efficiency is made.[8]

[8] Because surplus from electricity use is the sum of the area under the demand curve and the surplus one gets from not using electricity at all, this pivoting result may not hold if the benefit a consumer gets from using *no* electricity following an increased investment in efficiency increases by more than the reduced value she gets from using energy.

Figure 4. Effect of Energy Efficiency on Electricity Demand[9]

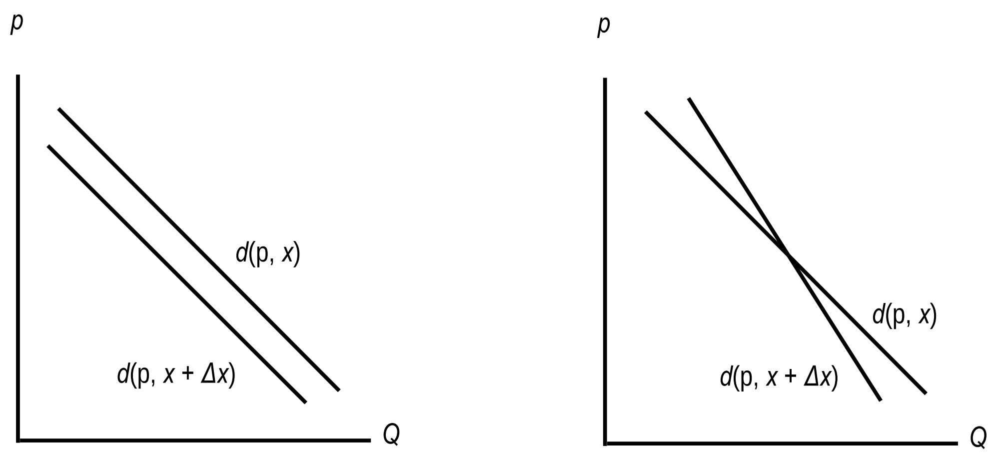


Figure 4 is important because it illustrates that the effect of energy efficiency on electricity consumption depends on energy prices. For efficiency services to increase the value consumers get from using electricity, there must be prices at which efficiency investments will increase, not decrease, the demand for electricity. The increase in the value of the services from electricity increases its value at the margin up to a point and thus increases demand. Hence, what is known as the "rebound effect" (Gottron 2001)—that increased efficiency can spur demand for energy, not reduce it—not just may hold, but will hold at some prices.

To see this, adapt the above notation to let *w(q, x)* be the marginal willingness to pay for the qth unit of electricity, with *x* units of energy efficiency in place. For example, one might imagine the value of the 100th kilowatt-hour of electricity with 10 compact fluorescent bulbs installed. The total value *V(q, x)* of that level of energy to a consumer is thus

$$V(q, x) = V(0, x) + \int_0^q w(z, x)dz \, . \qquad (6)$$

where $V(0, x)$ is the value consumers get with *x* units of energy efficiency installed when no energy is used. This differs from the usual consumer surplus formulation by allowing for positive benefit with zero use of the product, but with investment in equipment or service that changes the value one gets from use of the product. This could happen if the energy efficiency

[9] Figure 4 is adapted from Brennan (2009).

investment enabled consumers to avoid using energy in some cases, e.g., draft-proofing doors and windows to keep a house warm without having to run a furnace.[10]

By definition, energy efficiency increases the value the consumer gets from a given quantity of energy use, implying that $Vx(q, x) > 0$. From (6),

$$V_x(q, x) = V_x(0, x) + \int_0^q w_x(z, x)dz > 0. \tag{7}$$

The term w_x is the change in willingness to pay for electricity resulting from increased energy efficiency. It thus indicates how the demand curve for electricity shifts, as in Figure 4. For the demand curve to fall everywhere, $w_x(q, x) < 0$ for all q. That would imply the above expression is negative, contradicting the definition of energy efficiency, unless $V_x(0, x)$ were sufficiently large; i.e., the benefit from the energy conservation investment with *no* energy use renders additional use of energy less beneficial than otherwise. Hence, there must be some $q°$ for which $w_x(q°, x) > 0$. Moreover, if $w_{xq} < 0$, i.e., the effect of energy efficiency on the marginal value of electricity falls with the amount of electricity consumed—and it needs to become negative to induce conservation—then there exists some q^* for which $w_x = 0$, $w_x > 0$ for $q < q^*$, and $w_x < 0$ for $q > q^*$.

Together, those findings with (7) imply that Figure 4 describes the effect of increasing energy efficiency on electricity demand:

Proposition 2: *Unless energy efficiency investments convey benefits to consumers when they use no energy at all, an increase in energy efficiency investments will cause the demand curve for electricity to pivot at some level q*, assuming the effect of increased energy efficiency on the marginal willingness to pay for electricity falls with the quantity of electricity consumed.*

For sufficiently low levels of energy use or sufficiently high energy prices, the rebound effect would be observed; it may be empirically unlikely but it is theoretically predictable. As a consequence, the assumption that efficiency investments reduce demand is empirical, not theoretical. It is equivalent to assuming that energy is sufficiently inexpensive that the reduction in the marginal value of energy services obtained from a given level of electricity consumption

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[10] I owe this example to Michael Waterson.

outweighs the gain from the increased per-unit quantity of energy services that efficiency investments produce. We make that assumption here, and thus for convenience and without loss of generality, we drop the *V(0, x)* term for the value of no energy use from subsequent discussion.

The Base Case: Optimal Energy and Efficiency Prices under a Total Welfare Standard

We can formally model the base case for energy efficiency investments, using a conventional overall welfare standard of maximizing consumer surplus plus profits. As above, let *q* be the quantity of electricity produced and x the amount of energy efficiency used. The willingness to pay for the marginal unit of electricity (i.e., the demand curve for electricity), given the energy efficiency investment in place, is *w(q, x)*. The cost of producing electricity is given by *c(q)*, and the cost of energy efficiency is *h(x)*. Total net economic welfare is given by

$$\int_0^q w(z,x)dz - c(q) - h(x).$$

Choosing *q* and *x* to maximize total welfare gives the conditions

$$w(q, x) = c'(q);$$

$$\int_0^q w_x(z,x)dz - h'(x).$$

The left-hand side in the latter condition above is the change in surplus from increasing energy efficiency investment, given the quantity of electricity used—the marginal willingness to pay for energy efficiency.[11] Assuming there are no other constraints, in particular, that prices for electricity and energy efficiency are sufficiently high for all suppliers to cover cost, both of these conditions are essentially that price—marginal benefit—of electricity and energy efficiency just equals marginal cost of production.

[11] If energy efficiency shifted the entire demand curve for electricity downward, $w_x < 0$ for all *q*, and the integral on the left-hand side would be negative, implying that the demand for energy efficiency would be zero. This also assumes rational choice of energy efficiency on the part of consumers, an assumption many energy policy advocates doubt (Brennan 2009).

Inefficient Subsidies for Monopsony

To analyze whether the regulator might have monopsonistic incentives to intervene in the energy efficiency market, we modify the above optimization exercise to maximize consumer welfare from electricity sales, not total welfare, continuing to assume for simplicity of exposition that electricity is supplied competitively.[12] To focus on incentives to intervene in the energy efficiency market because of the specific effects on the welfare from electricity, we assume that the total cost of energy efficiency is subtracted from consumer welfare.[13]

With those assumptions, we assume the regulator is choosing the quantity of electricity and amount of energy efficiency investment purchased to maximize consumer welfare alone.

$$\int_0^q w(z,x)dz - w(q,x)q - h(x) + \lambda[w(q,x) - c'(q)] \qquad (8)$$

The first two terms are the consumer surplus, the area under the demand curve less the revenue. There is now no rationing; the quantity demanded at the price $w(q, x)$ is q. The middle term is the cost of energy efficiency, which, as noted above, we assume consumers bear.[14] The last term is a constraint requiring that the price at which consumers would demand q units covers the marginal cost of producing the q^{th} unit.

The first-order condition for maximizing consumer welfare from the choice of electricity is

$$\lambda[w_q(q, x) - c''(q)] = w_q(q, x)q,$$

which gives

$$\lambda = q\frac{w_q(q,x)}{w_q(q,x) - c''(q)}.$$

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12 See note 3 *supra*.

13 This could be justified by assuming that energy efficiency is sold under constant costs ($h'' = 0$), implying that there is no benefit to attempting to monopsonize against the energy efficiency sector as well. To the extent the costs of a subsidy could be shifted away from the regulator's client buyers, the case for monopsony would be stronger. However, I've observed that energy efficiency subsidies are to be covered by utilities, which then would pass those program costs on to the buyers.

14 Energy efficiency subsidies could be paid for by surcharges on electricity prices (Brennan 2009). Incorporating this, however, would only subtract a second-order "triangle" effect from the consumer welfare calculation.

Because w_q is negative (downward-sloping demand) and c'' is nonnegative (flat or upward-sloping marginal cost), we have

$$\lambda \leq q, \tag{9}$$

with equality holding only if $c'' = 0$, i.e., with perfectly elastic supply of electricity.

From (8), the first-order condition for energy efficiency investments is

$$\int_0^q w_x(z,x)dz - h'(x) = w_x(q,x)[q - \lambda]\,. \tag{10}$$

The integral term on the left-hand side of (10) is the marginal value to consumers of energy efficiency, i.e., its price. The second term, h', is the marginal cost of energy efficiency, so the left-hand side is price less marginal cost. The first term is negative from our assumption that at the margin, energy efficiency reduces use by reducing the willingness to pay for the last unit of electricity. The last term is nonnegative from (9), the first-order condition for maximizing consumer welfare from electricity use, and is strictly positive whenever monopsony would be ideally profitable, i.e., unless supply of electricity is perfectly elastic.

Equation (10) thus implies that at the optimum, the price of energy efficiency would be less than its cost. Even if consumers bear the full cost of the subsidy—reflected in subtracting $h(x)$ from consumer welfare—the monopsonistic effects of the reduction in price would explain why a regulator would want to subsidize energy efficiency on behalf of consumers. We summarize this as

Proposition 3: *If supply is less than perfectly elastic, rendering monopsony profitable, a regulator motivated solely by consumer welfare would subsidize energy efficiency, to reduce demand for electricity and thus reduce its price, even if consumers bear the full cost of the subsidy.*

Caveats

The insights from the above result need to be qualified by some potential aspects of the regulatory setting or the nature of the electricity supply curve.

Would a Consumer-Oriented Regulator Monopsonize?

The argument that a regulator pursuing only consumer welfare would reduce purchases to drive price down, even if rationing were not a problem, rests on the assumption that price has to equal the cost of producing the marginal unit supplied. This need not hold. One exception would be price discrimination, purchasing each unit at its marginal price. This, however, may not be feasible because of information limitations associated with knowing the marginal cost of producing each unit.

A second issue would be to expand the regulator's ability, perhaps only slightly, to allow it to set price and quantity independently, constrained only by the ability of the sellers to cover cost. If all sellers are identical—an eventuality unlikely to be realized in electricity markets—or if the regulator can set individual supply targets for each generator (to minimize overall production costs),[15] this decision could be represented by choosing quantity q and price p to maximize gross consumer surplus less expenditure, subject to the constraint that expenditure equals the total cost of producing the given quantity of electricity.

$$\int_0^q w(z)dz - pq - \lambda[pq - c(q)].$$

This expression is equivalent to choosing q to maximize total welfare, gross consumer surplus less costs $c(q)$, and then setting price equal to average cost $(c(q)/q)$ at that q, transferring all of the producer surplus to the buyers. If regulators can mandate supply rather than have suppliers independently choose how to maximize profits at the regulated price, the regulator simply sets quantity where total surplus is maximized and then uses price to transfer that entire surplus to consumers.[16] The temptation to monopsony arises for a consumer welfare–oriented regulator only if it is limited in its capacity to set minimum levels of supply as well as maximum levels of price.

Could a Consumer-Oriented Regulator Monopsonize?

The analysis of monopsony here presupposes that the buyers within the regulator's jurisdiction collectively possess market power that the regulator could exploit to their advantage. This need not be the case. Markets in which generators sell electricity typically span multiple states. For example, PJM, the main regional wholesale market operator in the mid-Atlantic region, serves virtually all of Pennsylvania, New Jersey, West Virginia, Maryland, Delaware, and Virginia, along with substantial portions of Ohio and parts of four other states. A regulator

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[15] One could also achieve cost minimization by issuing q marketable production permits.

[16] This result is a corollary to Becker's (1983) argument that political processes would achieve efficient outcomes to maximize the amount that could be distributed to stakeholders; in this case, there is only one stakeholder with political influence.

in one of these states would probably not control a sufficiently large market share to be able to drive down the price of electricity sold over such a large region.[17]

On the other hand, some regional wholesale market operators operate over essentially a single state. Three examples include the independent system operators serving California (CAISO), New York (NYISO), and Texas (ERCOT). Although the last of these has deregulated its retail market,[18] any one of these could find it useful on behalf of its buyers to subsidize energy efficiency solely to drive the price of electricity below the price that a competitive market would set.

At times of high demand, however, transmission constraints may limit the geographic scope of electricity markets, creating "load pockets." These small geographic areas may be intrastate, even when during unconstrained periods the relevant markets match the large interstate transmission organizations, such as PJM. These small markets would then fall within the jurisdiction of a state regulator and create the potential for monopsony during peak periods. It is also important to recognize that absent real-time pricing, electricity demand at such peak periods is likely to be excessive because the time-averaged prices will be below cost, sometimes by orders of magnitude, for reasons discussed in the next section. In such cases, energy efficiency subsidies would be an economically efficient second-best response to the underpricing of electricity when energy efficiency and electricity use are substitutes, i.e., when subsidizing energy efficiency reduces electricity use.

Is Electricity Generation Susceptible to Monopsony?

One of the accepted observations in electricity is that the supply curve goes from nearly horizontal over long stretches to almost vertical, in a "hockey stick" shape (Sweeney 2002 at 112). To some degree, this reflects an expectation that electricity is produced with durable generators. Those that are installed with the expectation of serving only at times of high demand are likely to have lower capital costs and higher operating costs (Crew and Kleindorfer 1987). Sweeney (2002) observes that electricity supplies in California exhibit this property, resulting in an increasing marginal cost function. Off peak, when demand is low, the market is in the flat part of the hockey stick, where supply is highly elastic, implying monopsony would not be a

[17] http://www.pjm.com/about-pjm/how-we-operate/territory-served.aspx, accessed February 24, 2009.

[18] The last of these, Texas, has largely deregulated its operations. http://www.powertochoose.org/_content/_resources/faqs.asp, accessed February 24, 2009.

significant matter. At peak demand periods, marginal costs appear to be increasing, i.e., $c'' > 0$, rendering monopsony potentially profitable.

But appearances may deceive. One needs to be careful in making this inference because high prices need not imply high marginal costs, as normally understood. Since electricity cannot be stored, the capacity to produce electricity that might be used at any given time has to be in place all of the time. Some capacity will thus be used only a small fraction of the time. To take what I believe to be a representative example, in Ontario, peak electricity demand is about 27 gigawatts, but capacity in excess of 25 gigawatts is used for only 32 of the 8,760 hours over the course of a year (IESO 2007). If the same generation technology were used to provide electricity during these 32 hours as over the rest of the time, the average cost per kilowatt-hour of the capacity used to provide that kilowatt-hour would be more than 270 (8,760/32) times the cost of capacity used that provides electricity all the time.

This is why Crew and Kleindorfer (1987) found that one would expect that generators used infrequently would be designed to use less expensive capital per kilowatt of power capacity and more fuel per kilowatt-hour of energy produced. But assume for the moment that this were not true because there were no technological options in generation, leading to fixed proportions of capital to energy produced. If so, one would expect the price of electricity to be greater when more is used, but not because the marginal cost of generating electricity increases with output. Rather, it would be only because more electricity is used a shorter fraction of time, increasing the average cost of the capacity and requiring higher prices to cover that capital cost.[19]

As a consequence, one could observe a positive relationship between electricity supplied and price, but with constant short-run marginal cost over the entire range. As noted, there is likely to be some positive relationship between supply and marginal cost because more fuel-intensive and less capital-intensive technologies would be employed the smaller fraction of time over which that higher demand is observed. However, short-run marginal cost is still likely to be increasing less dramatically than price. If marginal cost is not increasing very quickly, monopsony may be less dramatic or powerful. Recall that for monopsony to hold, $c'' > 0$, and the above discussion shows that $c'' = 0$ could be consistent with a strong correlation between

[19] As noted above, insufficient recognition of this aspect of electricity pricing has led to erroneous measures of market power based on measuring price against only average variable cost, used as a proxy for marginal cost (Brennan, 2006).

price and supply. In the extreme, a regulator would be tempted to drive demand just below the capacity in place to serve it, driving price down to the short-run marginal cost.

If so, however, the greater problem may not be monopsony as such, but opportunism (Gilbert and Newbery 1994). The gains in consumer surplus would be not from driving down a supply curve as normally understood, but from refusing to pay for capital once installed. The potential for such opportunism is widely understood, serving as the foundation for the important legal decisions that state and reinforce obligations to ensure that regulated firms have a fair opportunity to cover capital cost. As the U.S. Supreme Court said in Federal Power Commission v. Hope Natural Gas (citations omitted),[20]

> The ratemaking process under the Act, i.e., the fixing of "just and reasonable" rates, involves a balancing of the investor and the consumer interests. Thus we stated in the *Natural Gas Pipeline Co*. case that "regulation does not insure that the business shall produce net revenues." But such considerations aside, the investor interest has a legitimate concern with the financial integrity of the company whose rates are being regulated. From the investor or company point of view it is important that there be enough revenue not only for operating expenses but also for the capital costs of the business. These include service on the debt and dividends on the stock. By that standard the return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks. That return, moreover, should be sufficient to assure confidence in the financial integrity of the enterprise, so as to maintain its credit and to attract capital.

In effect, the legal obligation to allow regulated entities to earn a return on capital, in preventing a regulator from driving prices down by reducing purchases given capacity in place, could deter monopsonistic reductions in purchases altogether.

Conclusion

Good reasons abound for concern that electricity demand is excessive. Electricity may be underpriced during peak demand periods, because inability to charge time-based rates means that price during peak periods may be vastly below the cost of producing electricity. Negative externalities from air pollution or greenhouse gases that are not (yet) reflected in prices through appropriate taxes or emissions limitation policies could justify subsidizing investments to reduce

[20] 320 U.S. 591, 603 (1944).

electricity demand. Some might argue that consumers fail to correctly invest in energy efficiency that would earn adequate returns through reduced expenditures on electricity over time.

Our focus here has been on the possibility that energy efficiency may be a device to implement monopsony against electricity suppliers. After describing monopsony, we showed that the inability to divert reduced purchases to those with the highest reservation prices could make monopsony unprofitable if supply and demand are sufficiently elastic. The main result is that energy efficiency investments solve this problem and would be subsidized by a regulator with the ability to monopsonize, even if consumers bear the full and not just the subsidized cost of those investments.

The ability or inclination of a regulator to monopsonize may be thwarted if it can set price and quantity together, lacks market power on the buying side, and is under legal obligations to ensure that those it regulates can recover capital costs. Of continuing interest, however, is that monopsony could be viewed as an appropriate policy goal in the first place, in a way monopoly virtually never would be.[21] In general, public policy analysis, even if not driven specifically by economic considerations, nevertheless typically grants at least some weight to gains across the board, not just to consumers (Bardach 2005). Antitrust law in the United States and most of the world—Canada being an exception (Ross and Winter 2005)—nevertheless treats consumers as paramount. Those who believe this should, as a matter of logic, endorse the proposition that a regulator ought to monopsonize if able to do so. Thus, when we hear advocacy of energy efficiency on the grounds that we would be better off without that last generator, one should not assume that the proponents have either energy efficiency or economic efficiency in mind.

[21] A possible exception might be labor unions, but even there one could view the object as maximizing "consumer welfare," with the presumption that workers are the same people as consumers.

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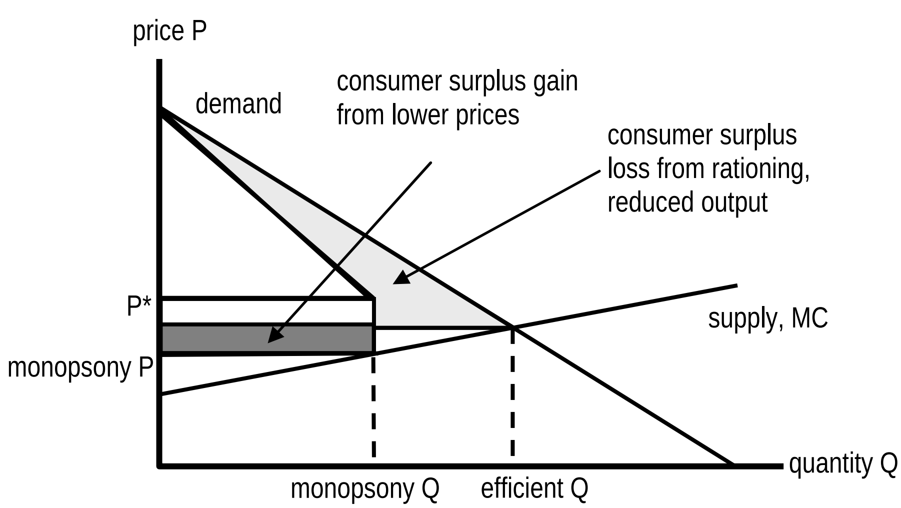
Appendix

Although the purpose of introducing the rationing model was to illustrate the possibility that rationing could eliminate gains to consumers from monopsony, there may be some interest in looking at more general settings than the extreme case in which all consumers with a reservation price above the monopsony price have an equal chance at getting the product.[22] To look at a range of settings, we posit a price *p** in between the monopsony price *p* and the willingness to pay for the marginal unit produced at the monopsony price. Only consumers with reservation prices above *p** can purchase the good, and they are rationed equally by the fraction $s(p)/d(p^*)$, where $s(p)$ is the supply at the monopsony price *p*. Figure A1 illustrates the welfare effects.

Figure A1. Welfare effects of partial rationing



At one extreme, p* = p, leading to Figure 3 in the text. At the other extreme, p* is the willingness to pay for the marginal unit at the monopsony price, giving the maximum consumer benefit as described in Figure 2. To model the intermediate cases, define p* specifically to be a weighted average of the monopsony price and the willingness to pay for the marginal unit supplied at the monopsony price:

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[22] I thank Svetlana Ikonnikova for this suggestion.

$$p^*(p) = t[d^{-1}(s(p))] + [1 - t]p.$$

It will be important to have on hand that

$$p^{*\prime} = t\frac{s'}{d'} + 1 - t.$$

At the competitive price, where $s(p) = d(p)$ and $p^* = p$,

$$p^{*\prime} = t\frac{e_s + |e_d|}{e_d} + 1. \qquad \text{(A1)}$$

where e_s and e_d are the elasticities of supply and demand, with $e_d < 0$.

Consumer surplus as a function of price, CS(p), is

$$CS(p) = \frac{s(p)}{d(p^*)}\int_{p^*}^{\infty} d(z)dz + [p^* - p]s(p).$$

The derivative of $CS(p)$ is

$$\frac{s(p)}{d(p^*)}\left[-d(p^*)\right]p^{*\prime} + \int_{p^*}^{\infty} d(z)dz\left[\frac{d(p^*)s'(p) - s(p)d'(p^*)p^{*\prime}}{\left[d(p^*)\right]^2}\right] + [p^* - p]s'(p) + s[p^{*\prime} - 1]$$

As with the specific example in the text, the question is whether CS'(p) > 0 at the competitive price, which would indicate that monopsony is unprofitable because of the rationing effect. Because p* = p and s(p) = d(p) = d(p*) at the competitive price, we can simplify the above expression considerably:

$$CS'(p) = -s(p) + CS(p)\left[\frac{s'(p)}{s(p)} - \frac{d'(p)p^{*\prime}}{d(p)}\right] > 0.$$

This expression implies that the general condition for monopsony to reduce consumer welfare because of rationing is the minimal adaptation of (5) in the text.

$$e_s + |e_d|p^{*\prime} > \frac{pd(p)}{CS(p)}. \qquad \text{(A2)}$$

If $t = 0$, $p^{*\prime} = 1$, and we get the condition in the text for when all demand is rationed equally. Under ideal monopsony, $t = 1$, and from (A1),

$$p^{*\prime} = \frac{e_s + |e_d|}{e_d} + 1 = \frac{e_s - e_d + e_d}{e_d} = \frac{e_s}{e_d},$$

implying that A2, the condition for monopsony to reduce welfare, becomes

$$\frac{pd(p)}{CS(p)} < 0.$$

Since both of these are positive, this will not happen; hence monopsony increases consumer welfare if there is no rationing of high-demand consumers.