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THE DEREGULATION OF THE ELECTRICITY INDUSTRY
A Primer

by Peter M. VanDoren

Executive Summary

Several states have enacted and others are contemplating changes in the traditional industrial organization of electricity markets. Those changes involve the creation of stock-exchange-like markets for the sale of electricity and the treatment of transmission and distribution lines as "common carriers" that deliver power from any generator to consumers at regulated rates and under regulated conditions.

Consumers in the Northeast and California have promoted such changes because they do not want to pay vertically integrated traditional utilities for their expensive electricity. The electricity is high cost because some nuclear plants are terribly expensive, as are some long-term contracts signed with independent and renewable power producers. In a competitive market for generation, some high-cost facilities would not be able to earn revenues to pay their initial capital costs. Shareholders rather than consumers should pay for that loss of wealth because shareholders of utilities have already been compensated for the risk created by changes in regulation.

The focus on generation has precluded thoughtful consideration of the useful role played by vertical integration. Vertical integration, in which generation and transmission services are jointly owned, is an effective solution to the externalities that independent generators impose on a transmission system. Before we take apart vertically integrated utilities, we should consider simple deregulation, the elimination of state-granted franchise monopolies. We should let vertically integrated utilities compete without state-provided protection from competition.

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Introduction

Until recently, the electricity industry largely consisted of firms that were state-regulated, vertically integrated monopolies. Within each franchise area, one firm generated, transmitted, and distributed electricity and was subject to traditional rate-of-return regulation by a state regulatory commission.

Several states have enacted and others are contemplating changes in the traditional industrial organization of electricity markets.[1] Those changes involve the creation of stock-exchange-like markets for the sale of electricity and the treatment of transmission and distribution lines as common carriers whose function is to ship the power determined to be cheapest by the activity of the stock-exchange-like auction market. The purpose of transmission, according to those who advocate these reforms, is to allow generators to compete to sell electricity to consumers.[2]

Although the fact that electric generation is not subject to market failure and, thus, should be subject to market forces was recognized over 25 year ago,[3] the big push for the creation of a "deregulated generation market" has occurred recently because large industrial customers in the Northeast and California do not want to pay vertically integrated traditional utilities for their expensive electricity. The electricity is high cost because some nuclear plants were terribly expensive to build and because long-term contracts signed with independent and renewable power producers as hedges against future high fossil-fuel prices proved to be very unwise. The first section of this study describes the factors that placed high-cost obligations on the traditional utilities that were then vulnerable to competition from lower cost alternatives.

Changes in the policies that regulate markets always increase the wealth of some at the expense of others. Electricity is not an exception. In the switch to a competitive generation market, some high-cost facilities will not be able to earn revenues to pay their initial capital costs. Thus, the market value of such facilities will be much lower than their current book value. The second section of the paper asks whether shareholders or consumers should pay for that loss of wealth, often described as "stranded costs." It critiques the predominant view that consumers should pay and argues that shareholders of utilities have already been compensated for the risk of a loss of wealth created by changes in regulation and, thus, should suffer any losses that occur.

In the push to restructure electricity regulation, the focus has been on generation. Most analysts accept the view that generation can become competitive but transmission and distribution still require regulation. Mandatory open access, in which all generators have access to the transmission and distribution system at rates determined by regulation, is now the dominant paradigm.[4]

Transmission and distribution deserve as much attention as generation. To counter the engineering perspective that now governs discussion of transmission and distribution, the third section of this study asks why transmission and distribution exist at all and how they should be priced. The design of efficient electricity transmission prices is difficult because power added anywhere in an interconnected electricity transmission system affects lines and generators everywhere in the system.

Three generic solutions exist for the externalities that generators impose on a transmission system: vertical integration, taxes and subsidies imposed by an omniscient operator, and decentralized bargaining and property rights. The rush to mandatory open access, a version of the second solution, has precluded consideration of the first and third. Ironically, vertically integrated utilities already exist. Before we take them apart with brute force, we should consider simple deregulation, the elimination of state-granted franchise monopolies.

Regulation has not protected consumers in the ways that populist rhetoric suggests. Regulation has given us excessively costly nuclear-power and cogeneration contracts. We should let vertically integrated utilities compete without state-provided protection from competition and allow the market to discover the most efficient forms of industrial organization. Such a scenario could not be any worse than the status quo.

The Transformation of Electricity from Regulation to Competition

Circa 1965, the electricity industry largely consisted of firms that were state-regulated vertically integrated monopolies.[5] Within each franchise area, one firm generated, transmitted, and distributed electricity and was subject to traditional rate-of-return regulation by a state regulatory commission.

Under state regulation, certain economic "truths" governed the design and operation of electric generation facilities. First, the cost of generating power decreased with plant size.[6] Second, the cost of producing steam from coal was cheaper than producing it from oil and natural gas.[7] As a result of those two "truths," large coal-fired plants generated so-called baseload power that was used all the time. Smaller (and older) coal, oil, and natural-gas units were used to generate "peak" power during the day and the summer when use exceeded baseload levels.

Four important factors changed that picture over the next 30 years:

- the development of the national electric grid following the 1965 New York City blackout,
- the construction of nuclear power plants,
- high fossil-fuel prices during the "energy crisis" of the 1970s, and
- the development of gas-turbine technology.

The net effect of those factors was to place high-cost obligations on the traditional utilities that were then vulnerable to competition from low-cost alternatives. In unregulated markets, those events would have resulted in the bankruptcy of the high-cost alternatives. In the regulated electricity market, however, those events have produced prices for electricity so high that commercial and industrial customers have relocated, generated their own power, and agitated for relief from the rates of existing utilities.

The Interstate Grid

The New York City blackout in 1965 illustrated the isolation of electric utilities.[8] When it lost one of its own generating plants, Consolidated Edison could not buy enough power from the primitive Northeast grid in existence at the time to prevent the collapse of its network. The development of the interconnected nationwide electricity grid made it technologically possible to develop interstate markets for electricity.[9]

In competitive markets, the price differences for identical commodities in two areas cannot exceed the costs of transporting the commodities between the two places. For example, the difference in the prices of candy bars in Boston and Springfield, Massachusetts, cannot be greater than the cost of transporting them from Boston to

Springfield. If the price difference were greater, an entrepreneur would make money by transporting the candy between the two locations.

Analogously, price differences for electricity in different areas of the country cannot exceed the cost of electric transmission between the areas. Until the development of long-distance transmission, however, the price of electricity could differ greatly between regions because the cost of transportation was infinite. The development of the national grid created the possibility of reducing the price differences for electricity across space, although federal regulations would inhibit the development of the interstate market until 1992.

Nuclear Power

During the 1964-67 period, some electric utilities made the very important decision to construct nuclear power plants rather than coal baseload units. The utilities made that decision on the basis of optimistic projections about costs provided by the two manufacturers of nuclear plants, Westinghouse and General Electric, as well as the Atomic Energy Commission.[10] Because those cost projections proved to be optimistic, most electric utilities that built nuclear plants are now burdened with capital costs that cannot be recovered at current wholesale prices for electric power.[11]

The Public Utilities Regulatory Policies Act of 1978

As long as state regulators forced customers to pay for the costly nuclear plants, the hypothetical existence of cheaper alternative power was of little consequence for utilities. But one of the policy responses to the energy crises of the 1970s, the Public Utilities Regulatory Policies Act of 1978, opened the door for such low-cost competition.[12] The initial result of PURPA, however, was not low-cost competition but high-cost obligations for the utilities.

World oil prices went from $1.90 per barrel in 1972 to $10.46 in 1975 to $34.99 in 1982.[13] The political reaction to the price increases was an extensive array of price controls on domestic oil, regulations designed to reduce oil consumption, and subsidies of alternatives to oil. The academic reaction was a large number of engineering and econometric models that predicted fossil-fuel prices would continue to escalate.[14]

Those political and academic trends were reflected in PURPA. An important provision of the law required electric utilities to purchase power generated by independent producers at a price equal to what are known as "avoided costs." Avoided costs are simply the costs that the regulated utility would have had to incur if it had generated the same amount of electricity. The purpose of that provision was to stimulate the development of alternatives to traditional vertically integrated fossil-fuel, steam-electric generation that was expected to become terribly expensive.

The details of implementation of the PURPA provisions were left to the 50 states that actually regulated electric rates.[15] The states used a price-posting system under which a price was set by regulation or law and utilities had to sign contracts with all independent producers who offered power at that price.[16] As fossil-fuel prices dropped in the mid-1980s, the supply of power offered by independents rose dramatically because the prices that "reflected" avoided costs and were paid to the independents did not drop accordingly.[17] Many long-term contracts were signed with independent producers during the period after fossil-fuel prices started to decline but before the prices paid to independents declined.[18]

Governmental intervention, specifically the provisions enacted by California and New York to implement PURPA, is often blamed for the mismatch between prices paid to independents[19] and the market price for wholesale power. But hedging by utilities against long-term increases in fossil-fuel prices also played a large role.[20] The energy-price forecasting models used by utilities predicted very large increases in the price of oil and coal, and utilities signed long-term contracts with alternative independent producers, as well as coal producers, as a hedge against the predicted price increases. So even though the states implemented the provisions of PURPA in ways that were insensitive to market conditions, the desire of the utilities to hedge also played a significant role in their signing contracts with independents.[21]

The short-term effect of PURPA was to saddle utilities, primarily in New York and California, with costly obligations that compounded their nuclear-power cost woes. But the long-term effect was to stimulate the development and use of new natural-gas-turbine generating technologies.[22] The technologies undermined two of the governing economic premises of the circa-1965 utility industry: (1) the cost of generating power decreased with plant size, and (2) large coal-fired plants were cheaper than those powered by natural gas. As the result of changes in natural-gas generation technology, both conventional, coal-fired, steam-electric generators and natural-gas turbines now have long-run average costs of around 3 to 3.5 cents per kWh.[23] But optimal coal plants have 600 to 800 megawatts of production capacity while natural gas plants have only 40 to 150 MW, and units with only 3 to 10 MW of capacity are economically viable.[24]

The new economics of small gas plants allow large users of electricity to threaten to self-generate in order to obtain rate cuts from existing utilities.[25] The threats are credible because of the advancements in gas-turbine and cogeneration technology.[26] If the traditional utilities do not cut rates for large users, large commercial customers will generate their own power and sell their surplus under the provisions of PURPA and the Energy Policy Act of 1992.[27] With further advancements in small-turbine technology, even small residential users with access to natural gas may be able to generate their own power at costs lower than current average utility charges.[28]

If the existing coal-fired units of traditional utilities have long-run average costs that are similar to the costs of natural-gas units of independents, why are average retail rates 7 cents per kWh rather than the cost of generation and transmission, which is about 3.9 cents per kWh?[29] The answer has three parts. We have already discussed the first two--high-cost nuclear facilities and uneconomic PURPA contracts--but those factors are mainly relevant only to the Northeast and California. The third reason, which affects the entire country, is the underutilization of the generating capacity of conventional coal-fired baseload plants during off-peak times at night throughout the year and during the day in months other than July and August.[30] Full utilization of conventional steam-electric baseload facilities would result in a 25.5 percent increase in power production and a similar percentage decrease in price to an average 5.1 cents per kWh for the country.[31]

Summary

Recent developments in policy and technology have turned the economics of traditional utilities upside down. First, small gas-fired plants are now competitive with large coal generation facilities owned by traditional utilities. Second, retail electricity rates in the Northeast and California are well above the long-run costs of electricity from either coal or natural-gas generators. Large commercial users of electricity understand those facts and are therefore threatening to bypass the traditional utilities. Until the prices charged by traditional utilities are equal to the costs of gas-turbine and coal-fired electricity, the pressure from large users for rate relief will continue.

Who "Pays" for the Transition?

The difference between the current price of electricity in the Northeast and California and the long-run costs of electricity from coal-fired as well as natural-gas generators is large. The cost differences give rise to two questions:

1. In a deregulated electricity market, high-cost producers would have difficulty retaining customers and thus would suffer a loss in the value of their capital assets. Should taxpayers, electric customers, or the shareholders of the utilities bear the losses?

2. Given that the economic and technical developments of the past 30 years have eliminated the economies-of-scale and natural-monopoly rationale for the regulation of electricity generation, how should the country proceed to a deregulated market?

This section examines the first question. The next section deals with the second. In brief, the conclusion of this section is that losses in the market value of electric generation assets should fall on shareholders, not on electric customers or on the public at large.

In a deregulated market, high-cost electricity producers would continue to operate as long as the market price for electricity was above their marginal costs of production, but the market value of their generation assets would fall if the revenues of the generators were less after deregulation than before. The loss in the value of assets is known as "stranded costs" in the jargon of electricity policy. Estimates of stranded costs range from $70 billion to $200 billion; the higher figure is double the total shareholders' equity in the industry.[32]

Several prominent academics have argued that a "social contract" exists between investors in utilities and state regulators. In their view, those investors and the government agreed that if the investors would serve all customers in an area as a state-sanctioned monopoly, the investors would receive a regulated but reasonable return on their investment.[33] The academics argue that deregulation alone, without compensation to investors for the capital losses that they suffer as a result, breaches the contract; "takes" investors' property without compensation, a violation of the Fifth Amendment's takings clause; and raises the cost of capital in any other sector of the economy in which potential changes in public policy create risk.

Thus, requests for compensation for stranded costs raise two questions. Does the policy change involve a taking of property requiring just compensation under the Fifth Amendment? Is compensation required to ensure economic efficiency?

A taking arises only with reference to things that are owned.[34] Things that are not owned--such as value of a given asset--cannot be taken, strictly speaking, even though they can be "lost," loosely speaking. People own only their property and the rights of use, exclusion, and disposition that go with it; they do not own a given value in the property, which is a function of many factors. Thus, the fact that government (or anyone else, for that matter) takes an action that enhances the value of someone's property does not imply that the owner owns the enhancement.[35] A local government may build a school near a new development, for example, thus enhancing the value of the property in the development. If the school is later closed, the value of nearby property may be lowered. The closing of the school is not a taking, however, because it took nothing that was owned free and clear by the owners. It would be different, of course, if government regulations prohibited exercising certain rights of property owners, thereby reducing the value of the property; then we would have a taking. But in the case of the school closing, the owners are as free as they always were. They have simply suffered a loss as the result of others--in this case the government--exercising their rights.

Similarly, early this century the states granted electric utilities monopolies that enhanced the value of the utilities because the monopolies reduced the risk, uncertainty, and competition that characterized the early electric industry.[36] A strong case can be made that those electric utilities that ceased operations because they were excluded by the monopoly grant suffered a taking because the state eliminated their right to generate and sell electricity. But the elimination, much later, of the state-created monopoly franchise is not a taking[37] because the utilities given the franchise never had a right to restrict entry in the first place. That "right"--a very questionable gift from the regulatory state--was always enjoyed on the understanding that it was a grant from the state that might one day be withdrawn. Utility owners are not like independent contractors dealing at arms length with the state who now want the terms of their contract upheld. They are more like "coconspirators" who were given a privilege that is being taken back.[38] Thus, the case for compensation on takings grounds is simply not there.

Still, a number of prominent economists argue that, the takings issue aside, compensation is necessary for economic efficiency. But a thorough consideration of the economics of asset prices suggests that efficiency is best served, in this case, by no compensation.[39]

First, the market prices of assets at the time of purchase are discounted to reflect both business as well as policy risks that might subsequently materialize, such as the elimination of state-created monopoly protection. Additional explicit compensation now would be double compensation, in effect. Second, because the market prices of assets change continuously to reflect changes in expectations about future business and political risks, the prices of utility stocks have gradually reflected the possibility of changes in the value of assets brought about by deregulation. Compensation of all current owners of utility stock would reward those investors who bought electricity assets at a discount over the past several years knowing that they faced larger risks than previously existed.

The prices investors pay for assets reflect the possibility that the returns that owners receive from assets may not continue forever.[40] The risk of policy changes, other than takings, is a risk that alters the possibility of future gains. The market prices of capital, land, and labor reflect the possibility of such changes before they occur.[41]

Evidence for Compensation at the Time of Purchase

The claim that asset prices and investor returns reflect the likelihood of future uncompensated policy changes may seem difficult to believe. But assets that face a greater risk of policy change are priced lower than assets that face a lower risk. Let us first consider municipal bonds. James Poterba, an economist at the

Massachusetts Institute of Technology, shows that investors in one-year prime grade municipal bonds earned 40 to 45 percent less on a pretax basis than did investors in one-year Treasury bonds between 1955 and 1983.[42] Investors in 20-year tax-exempt municipal bonds earned only 20 to 25 percent less than did investors in 20-year Treasury bonds, however. The only difference between the two comparisons is the time period involved. Because the probability of changes in the tax-exempt status of assets is greater over a 20-year time period than it is over the course of only one year, investors in tax-preferred assets demand a premium to compensate them for the risk that the preference will be repealed or its value reduced.[43]

Similarly, consider the taxi medallion system used in New York City. Medallions in the early 1990s leased for $1,000 a month. If that rental cash flow were to last forever, willing investors would pay around $240,000 for such a stream of income.[44] Because of the possibility of deregulation of the taxi industry in New York, the actual market price of medallions is less than the $240,000 figure that would be paid for the income generated by the medallion in perpetuity. At the time I made these calculations, taxi medallions sold for only $100,000. If interest rates were 5 percent, a willing investor would pay $100,000 for a monthly cash flow of $1,000 that would last for 20 years, rather than forever.[45] In effect, investors behave as if the probability of deregulation of the taxi industry is 5 percent annually or 100 percent over a 20-year period, even though additional medallions have not been created since 1937.

In both the tax-exempt-asset and taxi-medallion cases, the owners are playing a "policy-change" lottery.[46] In every year in which negative policy changes do not take place, owners win the lottery. In every year in which negative policy changes do take place, owners lose the lottery. On average, the prices of both assets affected by the possibility of policy change are such that owners neither gain nor lose wealth because of policy changes.

Asset Values Change Continuously As Expectations Change

A very important implication of recognizing the role that expectations play in asset prices is that changes in the prices of assets occur long before policies actually change. Because no one can identify exactly when expectations form in investors' minds, we cannot identify whom to compensate for the losses of wealth that occur if change actually takes place. Three examples nicely support that argument.

Publicly traded real estate limited partnerships lost over 23 percent of their value relative to the stock market as a whole during the period May 7 through May 12, 1986. During that time the Senate Finance Committee approved a tax-reform bill that limited the deductibility of losses from passive investments, such as real estate limited partnerships.[47] At the time of the committee decision, the probability of enactment of changes in the tax code was not yet certain, because the bill still had to pass the full Senate and the House and be signed by the president, but the probability of policy change rose considerably as the result of the committee's action, and asset values changed accordingly.

Given that the tax reform was enacted into law in 1986, which investors should be compensated for the change in the tax treatment of real estate limited partnerships? The owners of such assets change daily because the stocks are publicly traded. On what day did the owners suffer a compensable loss of wealth because the price did not reflect a fair bet about the possibility of tax reform? The question, of course, has no answer.

Another example is the variation in price over time of tobacco quotas. The supply of tobacco grown in the United States is limited by quotas distributed during the Depression. The quotas have value because they allow the owner to grow and sell tobacco at an artificially high price. In the 1970s, the real value of tobacco quotas was approximately $9 to $10 per pound of quota allotment (in 1985 dollars). By the mid-1980s, when changes in the tobacco price-support system seemed much more probable because of President Reagan's attempt to terminate agricultural subsidy programs, the market value of tobacco quotas fell to $3 to $5 per pound (in 1985 dollars) even though Congress did not terminate the program.[48]

The electricity industry provides a final example. The possibility of deregulation of electricity has grown from zero to something greater than zero during the past 10 years. As markets have understood that possibility, utility stock prices have suffered relative to the market as a whole. Table 1 provides annual returns not including dividends for the Standard and Poor's 500, an index of the values of the stocks of the 500 largest U.S. corporations,

Table 1

S&P 500 vs. Dow Utility Index, 1986-97

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
S&P 500												
Index	236.3	286.8	265.8	322.8	334.6	376.2	415.7	451.4	460.3	541.6	670.8	872.7
Return (%)	26.5	21.4	-7.3	21.4	3.7	12.4	10.5	8.6	2.0	17.7	23.9	30.1
Dow Util.												
Index	206.0	175.1	186.3	235.0	209.7	226.2	221.0	229.3	181.5	225.4	232.5	271.1
Return (%)	17.8	-15.0	6.4	26.1	-10.8	7.9	-2.3	3.8	-20.8	24.2	3.1	16.6
Total return												
S&P 500	269%											
Dow Util.	32%											

Sources: 1998 Economic Report of the President (Washington: Government Printing Office, 1998), p. 390, Table B-95; Standard and Poor's Statistical Service, "Current Statistics," January 1998; and The American Almanac, 1996-1997 (Austin, Tex.: Hoovers, 1996), p. 521.

and the Dow Jones Utilities Index, an index of the values of electric utility stocks, for the period 1986 through 1997. The return over the entire time period is 269 percent for the S&P 500 and only 32 percent for the Dow Utilities Index. As the prospect of retail deregulation dramatically increased during 1996, utility stocks rose only 3.1 percent compared to 23.9 percent for the market as a whole.

Niagara Mohawk, an electric utility in upstate New York, is particularly affected by contracts it signed with independent producers that now require payments greatly in excess of the wholesale spot price for electricity. As markets have recognized that about 50 cents of every revenue dollar to Niagara Mohawk go to independent producers and taxes, the price of Niagara Mohawk shares has plummeted. At the start of 1994 the price was over $20 a share. In May 1996 it was around $7, a drop of 65 percent in just over two years.[49] The drop did not occur all at once. Some days were worse than others. In fact, by late March 1998 the price had bounced back to over $13.

For utility stocks in general, as well as Niagara Mohawk in particular, the losses of wealth that arise from changes in expectations have occurred continuously whenever significant changes in political or economic facts have prompted a change in market expectations about the future earnings of utilities. If ratepayers were to compensate shareholders, how would we decide which shareholders to compensate? Which investors suffered losses from a roll of the dice that really wasn't fair?

The electricity industry argues that the characteristics of typical utility shareholders mark them for special compensation protection. To be sure, the typical utility shareholder is a retiree who has held stock for more than nine years.[50] Those shareholders and their brokers have viewed utility stocks like high-paying bonds: an asset that pays high steady income and provides stability of principal. But corporate bonds historically have paid 5.6 percent, on average, rather than the 12 percent return earned by utility investors.[51] The extra payments to utility shareholders relative to corporate bondholders compensate them for the possibility of capital losses.

The possibility of capital losses for utility shareholders is now greater than in the past, but the transition from the traditional view of utility stocks as high-paying bonds to the new riskier reality has involved a gradual change in expectations. At each step of the transition, the purchasers of utility stocks were making fair bets, but after the fact they may turn out to have been poor bets.

To compensate current shareholders for deregulation would be to compensate some people who knew or should have known that those stocks were more risky than they used to be. The most conservative investors got out long ago and suffered losses at that time. If compensation for stranded costs were to become certain today, the price of utility stocks would rise, creating gains for all those who purchased them in the face of low probability of compensation and won the lottery. Those are not the people commentators have in mind when they recommend compensation.[52]

Have Utility Investors Received Inadequate Compensation?

Lawrence Kolbe and William Tye claim to have demonstrated that the return earned by utility investors is much too low to compensate them for the risks to their investment created by uncompensated deregulation.[53] They calculate that a 58 percent return would be necessary to make an investor indifferent about a certain 12 percent return (their benchmark for the return on utility stocks) and a 1/3 chance of losing the entire principal. Since the return on utilities has been less than 58 percent, they argue that investors have not been adequately compensated.

That analysis makes three fundamental errors. First it assumes that the appropriate risk-free benchmark for the calculation is 12 percent, the historic return on utility stocks. But the 12 percent historic return on utilities has embedded within it payment for the possibility of risks--many of which never occurred. The risk-free return, determined from U.S. Treasury bonds, on average, has not been much more than inflation over the past 70 years, or a zero real return. The average real return (after inflation) on the S&P 500 has averaged about 7.6 percent since 1926, but it is not without extensive risk because in individual years it has varied from -43 percent to +54 percent.[54] Utility stocks have done well relative to the S&P 500 until recently.[55]

The second error in the calculation is the implicit assumption that markets reward investors for incurring risks that are specific to a firm or sector of the economy. Such risks are diversifiable, however, through mutual funds. If investors choose to place a significant portion of their assets in one sector or company and, in effect, make an undiversified bet, they may earn large rewards, but they also may suffer large losses. Such losses do not deserve compensation because the same investors would have gladly kept large gains, had they occurred.

Baumol, Joskow, and Kahn argue that because rate-of-return regulation eliminated the possibility of large rewards for utilities, failure to compensate for large policy-induced losses would treat investors asymmetrically.[56] The authors are probably correct that regulation prevented large gains for utility investors, but that does not imply that investors deserve protection from losses. To be sure, investors probably have thought of utility stocks as the equivalent of a bond paying 12 percent, but corporate bonds pay 5.6 percent, on average, rather than 12 percent.[57]

The total average annual return on small-company stocks has been 12.6 percent since 1926. If that return has been sufficient, on average, to compensate investors for the very real risks inherent in making investments in small companies, then the "normal" 12 to 13 percent earned by utilities also seems reasonable compensation for the possibility of large losses. Utility investors should have no complaints.

The third error in the Kolbe and Tye analysis is the authors' use of 1/3 as the appropriate probability of a total loss of investment in utilities compared with certain returns available elsewhere. In the New York City taxi-medallion example, remember that investors behaved as if the possibility of deregulation and total loss of their investment in medallions was about 5 percent per year even though no changes in the number of taxi medallions had occurred since 1937, just as no changes occurred in the policy regime governing utilities for many years. If deregulation occurs in any of the first 20 years after purchase of a taxi medallion for $100,000, the investor will have lost the bet that the probability of deregulation was 1 in 20, but that does not imply that the market guess or the discount to the investor was incorrect. Similarly, even though the return on utilities has been about 12 percent and would have been higher if investors had known that deregulation without compensation was likely to occur, that does not imply that the return was inadequate. The utility stocks are just a bad draw from a population of stocks whose return is adequate, on average.

How to Deal with Political Reality

Despite the lack of normative or economic justification for compensating utility shareholders for the losses of wealth brought about by genuine deregulation of the electricity market, the deregulation proposals under consideration or enacted by various states provide for compensation of existing utilities. While such compensation is not justified, if compensation is to be made, the taxes or surcharges used to raise the revenues should be as efficient as possible. That is accomplished by separating the surcharges completely from electricity use. A flat fee per month per customer like the monthly fixed charge now found in many electric bills to pay for meters and other fixed infrastructure costs would be appropriate. Surcharges that vary with electric use are inefficient and signal users of electricity incorrectly about its true cost.

How Should We Proceed toward a Deregulated Electricity Industry?

Now that most analysts believe that electricity generation does not possess sufficient economies of scale to result in a natural monopoly, attention is focused on transmission and distribution,[58] the predominant view of which is still that economies of scale are large and therefore warrant regulation.[59] Rather than ask and answer the traditional economic question about the existence of economies of scale in transmission, I approach the economics of transmission by asking more fundamental questions:

1. Why do transmission and distribution exist at all? Small decentralized plants can generate at the same long-run average costs as larger plants. How interconnected should these generators be?

2. In an ideal world, how would efficient transmission prices be characterized?

3. How can we get from the current world of state-regulated electricity monopoly franchises to the ideal world of efficient transmission and generation?

Why Have Transmission (and Distribution) At All?

As a thought experiment, imagine a world in which no interconnections exist and each residence and business generates and consumes its own electricity. The downside of this design is that every customer must own and operate enough generating capacity to handle the largest amount of electricity used during the year.[60] The rest of the time that capacity is unused.

A completely decentralized electricity generation system with no interconnections is probably not optimal because economies of pooling exist as long as customers' peak demands for electricity do not occur simultaneously. The lack of simultaneous peak demand allows a series of generators connected to a grid with interconnections to have less peak capacity and lower expenses per customer than would a system of isolated self-generating customers. In addition, until recently, small power plants would have had costs that were much greater than those of large power plants.[61] Interconnection is optimal as long as the pooling gains (and whatever economies of scale exist in generation) exceed the costs of building the electric grid and managing the use of generators that are connected to it.[62]

Thus, in a hypothetical world in which users self-generated and interconnections did not exist, users of electricity would find it advantageous to interconnect. The interconnection could be provided by a private for-profit company, or the self-generators could form an electricity transmission group (or in economic jargon, a club) to obtain economies of pooling. The two institutions differ only in who gains the benefits or suffers the losses that result from changes in demand and supply that affect the value of transmission assets, shareholders in the former and club members in the latter.[63]

How would members structure prices in an electricity transmission club? Clubs typically cover their fixed costs through membership shares and their marginal costs through user fees that vary with the use of particular services within the club. The purpose of the fee structure is to allow people the advantages of sharing facilities without imposing costs and congestion on other users.

Electricity transmission clubs face additional difficulties in designing a fee structure that is efficient because of the physics of electricity transmission. Power added anywhere in an interconnected electricity transmission system affects lines and generators everywhere in the system. The output of all generators connected to a grid must exactly equal the demand of customers minus transmission losses at all times.[64] And changing supply and demand patterns invariably produce limits on the transmission capability of some lines within a transmission network.[65] The difficulties of designing efficient prices for the transmission of electricity are explored in the next subsection.

The Efficient Pricing of Transmission

Because generation and transmission are economic substitutes, the efficient pricing of each is terribly important. If transmission is underpriced, too much transmission will take place relative to local generation, and if transmission is overpriced, the opposite will occur. Efficient pricing of transmission has three components: a charge for access to the transmission network, a charge for line losses, and a congestion charge.

Access Charges. The costs of a transmission network are largely fixed. The capital costs of the towers, the rights-of-way, and even maintenance do not vary with the use of the lines to transmit electricity. In sectors of the economy characterized by large fixed costs and low marginal costs (like electricity transmission), marginal-cost pricing leads to bankruptcy because revenues are not sufficient to cover total costs, most of which are fixed rather than marginal. Two strategies exist to raise sufficient revenue: two-part tariffs and Ramsey prices.

Under a two-part tariff, each customer pays two charges to purchase a commodity. The first charge, which does not vary with the amount of a product a customer uses, pays for the fixed costs associated with a commodity, for example, an entrance fee for a flea market or antique show. The second charge varies with the amount of the commodity used, like the familiar prices in a supermarket or the prices paid for individual items within a flea market.[66]

Many states already set electricity rates in this manner: a $5 to $8 per month charge for access to the electricity transmission network and 5 to 12 cents per kWh for any electricity used.

Two-part tariffs make good economic sense because the marginal-cost charge conveys appropriate information to consumers about the costs of using one more unit of output, in this case one more kWh of electricity. Two-part tariffs are not efficient, however, if consumers' demand for access to the commodity (in this case, the electricity network) is price sensitive.[67]

If demand for access is price sensitive, then Ramsey prices rather than two-part tariffs are more efficient.[68] Under Ramsey prices, the additional revenue above marginal costs needed to pay for fixed costs is collected from consumers depending on the sensitivity of their demands to price rather than in a fixed manner that does not vary across consumers. To the extent firms can distinguish among consumers, those consumers who are price sensitive will be charged the smallest markup above marginal cost and those who are price insensitive will be charged the largest markups. Such prices are greater than marginal cost, but they are optimal because they minimize the cost of raising the revenue to prevent the bankruptcy that would occur with marginal-cost pricing.[69]

Line-Loss Charges. The marginal cost of transmitting electricity arises from the loss of power that occurs when electricity is transmitted by wire. The consumer of electricity that is transmitted by wire receives less power than was produced by the generator. Line losses become larger as the distance between generator and consumer grows and become smaller as the voltage used to transmit the power becomes higher. Thus, electricity is transmitted over long distances only at high voltages to minimize line losses.

Proper line-loss charges are important because they signal to consumers the costs of using power generated by distant rather than nearby sources. Once line losses become high enough, electricity generation closer to the point of consumption has lower costs and, thus, is more efficient.

Congestion Prices. Congestion arises when demand exceeds supply at existing prices. In such supply-demand imbalance situations, price increases ration demand to equal supply. In the long run, the economic profits created by the price increases convey information to members of the electricity transmission club (or private firm) about the potential benefits of additional generation or transmission capacity.

Scholars initially thought that electricity transmission congestion prices would resemble those in other transportation contexts.[70] But the physics of electricity flows and transmission-line constraints combine to create effects not present in other congestion settings. Thus, profitable bilateral contracts between any particular pair of generators and electricity consumers often directly and materially harm other generators and consumers elsewhere in the grid.[71] Such reductions in welfare are known as externalities.

Solutions to Externalities. Three generic approaches can be used to deal with the external effects of bilateral contracts: vertical integration; omniscient Pigouvian taxes and subsidies (in the electricity case implemented by an "independent system operator," who manages the operation of the grid); and decentralized Coasian bargaining and property rights.[72] Vertical integration solves the externality problems by placing all generators and transmission lines under one owner. That owner then internalizes the effects that various generators have on each other and the transmission network. In our hypothetical example, decentralized generators who contracted with a separately owned transmission and distribution company would eventually merge to form one vertically integrated utility.

Another solution is the operation of the transmission network by a governmentally imposed independent system operator (ISO), the mechanism to be used in California to implement omniscient Pigouvian policies. Theoretically, an ISO could arrange all gains to trade between generators and consumers using a separately owned transmission network. The ISO would do so by setting taxes and subsidies that would induce generators to alter their production schedules to the least-cost solution.[73]

The ISO would require much more knowledge than electric dispatch operators possess in the current system, including details about demand and supply schedules that independent generators are unlikely to reveal. In addition, the ISO would need to have such vast authority over the grid to optimize its operations that thick ex post audit regulation would be required to determine if authority was abused to favor some generators over others.[74] Additions of generation and transmission capacity would still be determined by regulators. Under an ISO, "the efficient equilibrium . . . is realized in a way that resembles how centralized economies were expected to realize efficient allocations. . . . 'Open access' is gained at the cost of instituting a system operator, who, in effect, determines the prices and quantities of power transactions that are permitted."[75]

The third solution uses property rights and bargaining. In this scenario, a "weak" ISO would tell generators and purchasers of power whether their requests to use the network violated physical or line-capacity constraints. If proposed bilateral transactions violated constraints, the ISO could tell the parties whose behavior would have to be modified to allow the least-cost supply of electricity to be executed.[76] As long as transactions costs did not become prohibitive, the external effects of bilateral contracts on other generators could be resolved through bargaining and side payments.[77]

The electric grid is for all practical purposes a commons, but the allocation of transmission property rights does not eliminate the underlying physical realities that create the commons. The allocation merely defines the rights that must be traded through subsequent bargaining.

Some energy analysts use the analogy of a lake to describe how bilateral arrangements alone would solve the commons problem in the electric transmission grid. "All around the lake are consumers drawing out water. At other points around the lake are suppliers who add water to the lake to keep the level of the lake constant and to maintain supply. When a consumer and a supplier agree to buy and sell water, water is added to the lake at one end by the supplier and drawn out at the other end by the consumer."[78] But the water taken out by the consumer is never the water added by a distant supplier.

The problem with this analogy is that it does not apply to electricity transmission. The addition of water to the lake by any particular supplier does not affect the ability of anyone else to also add water to the lake to satisfy bilateral contracts with customers as long as the flows match. In an electric transmission grid, however, additions of electricity by one generator easily can affect other generators' ability to add power to the grid.

Even in the very simple hypothetical electricity networks that scholars have constructed, numerous coordination problems exist if generators, consumers, and transmission link owners maximize their own benefits on the basis of only the prices that they observe.[79] For example, in normal market settings, if an asset does not earn the cost of its capital, market participants disinvest from the asset and transfer capital to more productive uses. But in an electric transmission network, even if an asset is not earning the costs of its capital, the net benefits to market participants can decrease if disinvestment occurs.

But the opposite is not true. The fact that the profits of a particular transmission link are very large does not imply that transmission capacity should be increased. Scholars have constructed examples in which individual generators would have incentive to improve the transmission capacity of a link even though such expansion would reduce the welfare of all other users and generators on the network.[80] Scholars have also shown that, once given access to the grid, generators can behave strategically to lower output and raise costs for all consumers on the grid.[81] Those coordination problems suggest that the imposition of mandatory access of decentralized generation to a transmission and distribution network developed within a framework of vertical integration is unwise.[82]

A contractual solution model for the coordination problems found in the electricity industry that combines the authority of vertical integration with decentralized ownership comes from petroleum production.[83] In the United States, property rights allow landowners to extract minerals, including oil and natural gas, from the land that they own. The flows of oil and natural gas, however, do not respect surface property rights. If every surface landowner attempts to maximize his own income from oil and natural-gas extraction, the resulting production from a petroleum reservoir will not be efficient. Under unitization contracts, surface property owners relinquish their rights to drill and operate wells to a welfare-maximizing operator in return for a share of the profits of the reservoir regardless of whether production takes place on their land.

In the context of electricity markets, the unitization model is illustrated by proposals that involve condominium-style ownership of the grid by consumers of electricity. Owners would be entitled to a prorated share of the profits from the operation of the grid in exchange for turning over the operation of the grid to a system operator who would determine the least-cost mix of generators.[84]

Summary

The appropriate mix of generation and transmission of electricity is an economic, not an engineering, matter. The appropriate combination of generation and transmission can arise only in a world characterized by efficient pricing of both. The efficient pricing of transmission would consist of three components: an access charge to pay the fixed costs of transmission, a line-loss charge to pay for the loss of power that occurs when electricity travels any distance, and a congestion charge to signal users of the opportunity costs of scarce transmission capacity.

An electricity transmission club that wanted to obtain the benefits from pooling generation capacity would have to choose from three organizational possibilities: vertical integration, a welfare-maximizing system operator, and a decentralized system in which generators and consumers attempted to make deals subject to transmission constraints. Even though most current deregulation proposals have adopted a welfare-maximizing system operator, this organizational form seems least likely to succeed economically. An efficient system operator would need to know more about supply and demand than do current utility dispatchers and have more authority than do current public service commission regulators.

In a decentralized system, if transmission constraints prevented generators and consumers from implementing bilateral contracts, side payments would occur to achieve the efficient use of the transmission and distribution network. Under vertical integration, the effects that bilateral relationships between consumers and generators have on other generators are resolved through authority within a firm. Unitization contracts in the oil industry are an example of a hybrid that combines vertical integration and decentralized bargaining.

In a world in which regulation had never occurred, which organizational form would predominate: vertically integrated utilities or separate generation, transmission, and distribution companies along with brokers who facilitated myriad bilateral transactions? The answer is unknown. But in the real world in which regulation did occur, we have vertically integrated electric utilities. Rather than use brute force to separate generation from transmission and distribution and regulate the grid as a common carrier, why not just eliminate federal and state regulation of the existing vertically integrated utilities and let market forces discover the "best" economic arrangements?

The Policy Puzzle of Vertical Integration

Most people will argue that complete deregulation would be unwise because of their belief that transmission and distribution of electricity are natural monopolies that will charge consumers above an efficient level.[85] The skeptics also believe that rate regulation by public service commissions is the appropriate policy remedy for the problem.

Fortunately, the natural-monopoly characteristics of transmission and distribution are overstated. But even to the extent such characteristics exist, the efficiency consequences may not be large, and evidence does not suggest that regulation by commission ameliorates any deleterious defects.

There are several reasons to believe that the market power of unregulated vertically integrated utilities would be less than conventional wisdom suggests:

- Competition might well arise from small turbines using natural gas to generate electricity. Electricity transmission owners have nothing to gain from alienating customers to the point at which they switch to the natural-gas alternative.[86]

- Before exclusive franchises were granted, multiple entrepreneurs were quite willing to generate and distribute electricity.[87]

- Competition between utilities still exists in some jurisdictions in the United States, and a recent statistical analysis suggests that such utilities have higher fixed costs but lower operating costs that result in total costs that are 16 percent lower, on average, than total costs of utilities that do not face competition.[88]

- If economies of scale do not prohibit multiple long-distance transmission companies, the threat of the creation of additional rights-of-way by federal and state governments should be sufficient to induce incumbent electricity transmission companies to price their services competitively.[89]

• Finally, recent statistical evidence suggests that costs are linear with size for vertically integrated utilities, but eventually diseconomies of scale arise that limit firm size.[90] Thus, vertically integrated utilities with large capacities do not have lower costs than smaller vertically integrated utilities and will not inevitably eliminate their smaller rivals.

But let us assume that vertically integrated electric utilities possess market power. What are the causes and consequences, and are the potential cures worse than the disease?[91]

The Causes and Consequences of Natural Monopoly

Natural monopoly occurs if the costs of production decrease as output grows larger.[92] If the costs of production vary greatly with the number of firms in the industry, then fewer firms have lower costs than more firms. In the extreme, a single firm has lower costs than any larger number of firms, the condition known as natural monopoly.

If a second firm enters a market characterized by natural monopoly, two outcomes are possible. In the first scenario, the second firm will go bankrupt because it charges more than the first firm (to cover the now higher costs of two firms) and no customers purchase its products. In the second scenario, the second firm prices its products the same as the first firm in anticipation of a larger customer base and the lower costs such a base would bring if the first firm exited the industry. In the short run, such tactics (often termed "destructive competition") imply that both firms lose money, but if the first firm declared bankruptcy, in this game of chicken, the price-cutting strategy would lead to the survival of the second firm.[93] If economies of scale were less severe, then three or more firms could exist in a stable oligopoly, but additional firms would result in similar destructive competition.

The essential difficulty created by economies of scale and the natural monopolies or oligopolies that result is that prices may be higher and the quantity of services provided may be lower than they would be if pure textbook competition existed. Under competition, prices charged by firms equal the marginal costs of producing one more unit of output. Under oligopoly and monopoly, prices are higher than marginal costs. That enriches firms at the expense of consumers and reduces the level of economic activity below its efficient level. But the solution cannot be simply to impose marginal-cost pricing because in the presence of economies of scale firms would go bankrupt if they priced output at marginal cost.[94]

Richard Posner argues that the alleged evils of monopoly (higher than efficient prices and lower than efficient output) may not occur because a monopolist may price discriminate.[95] Price discrimination exists if a firm charges different customers prices that vary with their willingness to pay. In competitive markets, firms normally charge all customers the same price for a product because the costs incurred by a firm to differentiate customers by their willingness to pay exceed the extra revenues created by price discrimination. In one-price markets, all customers who would have been willing to pay more than the market price for a product benefit by retaining the difference (called consumers' surplus in economics). If a firm were able to charge everyone their willingness to pay, consumers would have less money and firms more (a wealth transfer), but the quantity of product sold would be the same as in the competitive case and, thus, efficient. Posner speculates that concern over the pricing behavior of monopolies stems from the populist concern over corporate "price gouging" rather than concern for economic efficiency.[96]

Four Policy Remedies

Four strategies have been offered by scholars and used by governments to deal with economies of scale, natural monopoly, and the discrepancy between marginal and average costs. The first is public ownership and operation. In theory, under this scheme, the public sector prices at marginal cost and subsidizes the difference between marginal and average cost with tax revenues.

Despite the trend away from government ownership and operation of firms in the world economy, this is an important mode of intervention in the electricity market. More than 2,000 public-sector utilities supply about 23 percent of the nation's electric power.[97] The two largest public-sector utilities, the Tennessee Valley Authority and the Bonneville Power Authority, however, have not been models of economic efficiency. Both invested in large nuclear facilities that were not completed. Bonneville's were so costly that they resulted in one of the largest public-sector debt defaults in U.S. history.[98]

Public utilities' costs do not differ substantially from those of private utilities,[99] but they price their output differently. As one would expect of a firm driven by electoral concerns, publicly owned utilities have lower residential and higher industrial electric prices than do investor-owned utilities.[100] That is, publicly owned utilities raise revenues to cover the difference between average and marginal costs from industrial rather than residential customers.

The second option maintains private ownership but uses public subsidy generated through the tax system to cover the difference between marginal-cost pricing and total costs. Regulatory economists have developed schemes to implement such subsidies, but they have not been used in the United States to my knowledge.[101]

The third option is traditional regulation by a public commission whose purpose is to allow rates to cover costs with zero excess profits although the prices charged would be more than marginal cost. This type of intervention is the subject of much scholarship, most of it very critical. The criticisms fall into two main categories. Traditional regulation does not suppress prices below what they would be in the absence of regulation.[102] And traditional regulation induces regulated firms to be much less concerned about the costs of inputs such as labor, fuel, and plant and equipment than are typical competitive unregulated firms.[103] Advances in the theory as well as the practice of regulation by commission have attempted to induce regulated utilities to worry about the cost of inputs.[104]

The fourth policy option is the use of natural or induced competition to create, in theory, the same result as regulation by commission--a set of prices that results in zero excess profits but avoids bankruptcy for the firm. Such competition transforms natural monopolies into what are known as contestable markets.[105]

A market is naturally contestable if entry and exit are relatively easy even in the presence of strong economies of scale. In a naturally contestable monopoly, any attempt by a monopolist to raise prices above long-run average costs will result in excess profits. Those profits, in turn, will result in entry by a competitor. The competition will reduce prices to average, though not marginal, costs because marginal-cost pricing would result in bankruptcy.

In theory, the effects of contestability do not depend on actual competition.[106] As long as a monopolist knows that prices that are above average cost will induce entry, he will price at average cost because pricing above average cost will create no benefits for the monopoly and potentially lead to a destructive game of chicken with new entrants.[107]

The markups above marginal costs will vary among classes of consumers depending on the sensitivity of their demands to price. To the extent firms can distinguish among consumers, those who are price sensitive will be charged the smallest markups and those who are price insensitive will be charged the largest markups. Such departures from marginal-cost pricing are optimal because they minimize the cost of raising the revenue to prevent the bankruptcy that would occur with marginal-cost pricing.[108]

Thus, markets with natural-monopoly characteristics, as well as easy exit and entry, need not be regulated to obtain optimal outcomes because pricing above average cost will attract competitors who will force average-cost pricing. And average rather than marginal-cost pricing is optimal because marginal-cost pricing would lead to bankruptcy. In the presence of easy exist and entry, consumers will be well served even if only one firm exists.

How contestable are electric transmission and distribution? The historical record suggests that before entry regulation was instituted by the states in the early decades of this century, entry was quite vigorous. Whether such competition would occur again is anyone's guess. The existence of a few electric duopolies as well as the possibility of competition from natural gas both suggest optimism is in order.[109]

Induced Competition through Bidding

If a market with natural-monopoly characteristics is not easily contestable because of significant barriers that make the entry of firms or their exit without bankruptcy difficult, the desirable results of contestability may be achieved through the use of franchise bidding in which competitors bid for the right to be a monopolist.[110] In this scenario, the bids consist of the set of prices to be charged rather than a sum of money found in conventional auctions. With a sufficient number of bidders and reasonably frequent auctions for the renewal of the franchise, the prices charged by the winner will be prices consistent with zero excess (economic) profits, the same result as with natural contestability and, in theory, regulation by commission.[111]

Some economists are skeptical of the ability of bidding to substitute for natural contestability.[112] They argue that the interaction between government and the winner of the bidding procedure will resemble the interaction between the Defense Department and its contractors rather than competition.[113] In the defense context, winning a contract is just the start of a long bargaining game between the firm and the government in which the government's ability to use potential alternative bidders to discipline the initial winner is severely limited in practice. Williamson and Priest both argue that franchise bidding for public utilities is similar to defense contracting, rather than the idealized version envisioned by Posner and Demsetz.

Despite those flaws, franchise bidding has become the conventional wisdom in public administration.[114] Enlightened public managers now believe in the necessity of contracting for services, such as refuse collection, in which the local government acts on behalf of taxpayers to arrange local services at lowest cost rather than provide the service directly.[115] But contract bidding has been used mainly for the provision of those local public services, like refuse collection, whose assets are not specific or long-lived, as are those of electric utilities.

Summary

Three imperfect policy mechanisms exist for dealing with the higher-than-marginal-cost prices that result from severe economies of scale: public ownership, regulation by commission, and franchise bidding.[116] Public ownership is quite common in the United States although an overwhelming majority of public systems distribute electricity only locally and do not generate or transmit power over long distances. Public utilities charge residential customers lower prices than their private competitors. Given the elasticities of demand among customer classes, such pricing is not economically efficient.

The belief that traditional regulation constrains the pricing behavior of electric utilities is not supported by strong empirical evidence. In addition, regulation probably induces firms to be insensitive to costs. Price-cap regulation is a currently popular policy innovation whose purpose is to induce regulated firms to control costs, but it has not existed long enough to have received extensive academic evaluation.

Franchise bidding would seem to be the most promising alternative. It is now established orthodoxy in public administration, but the successes are mostly in those services that are not natural monopolies in the first place, like refuse collection, that could be privately provided quite easily. The experience with industries in which economies of scale seem likely to exist, such as cable television, has resembled contracting outcomes in the defense industry and appears to differ little from the actual experience of regulation by commission.

The good news is that none of those imperfect policy mechanisms may be necessary. Both the early history of the industry and modern statistical evidence suggest that electricity transmission and distribution are naturally contestable.[117] Economies of vertical integration are strong, but large vertically integrated utilities do not enjoy lower costs than do much smaller vertically integrated firms and, thus, are not natural monopolies. Eliminating the current state-created franchise protection would allow newcomers to challenge incumbent utilities. And even if electric transmission and distribution are not that contestable, unregulated vertically integrated utilities would raise their income relative to that under textbook competition, not by raising the price of power for everyone, but by raising prices in accord with consumers' willingness to pay. Would contestable markets or price discrimination be worse than the results produced by regulation?[118]

In contrast to the simple deregulation proposal presented in this paper, all deregulatory proposals under active consideration at the state or federal level include a system of mandatory access under which deregulated generators of electricity would compete for the right to sell electricity to the grid, which is managed as a common carrier by an ISO. Those proposals view the allocation of transmission capacity among users as an engineering rather than an economic problem. Hence, the use of price signals to allocate scarce transmission capacity is suppressed.

But such signals are a very important component of efficient transmission prices. Without them, inappropriate decisions about the relative use of local and distant power will be made. For example, both the British and

Argentine mandatory access systems lack appropriate transmission prices. The result has been high prices (relative to costs) for electricity.[119] The high prices, in turn, have induced entrepreneurs in Argentina to enter the market for generation, resulting in excessive generation capacity relative to the capacity of the transmission system to transport the power. In one area of Argentina, for example, 5,100 MW of generation capacity exist but only 2,600 MW of transmission capacity connect the generators to the major consuming area of Buenos Aires.

Transitional Issues

The possibility of policy change always results in opposition from those who perceive that they will lose market privileges that they currently posses as well as from those who do not think that their share of future benefits will be appropriate. Electricity is no exception to that rule. Those who are subsidized in the current regime worry about the loss of subsidies if deregulation occurs.

Such wealth effects should not be allowed to impede the transition to the efficient pricing of electricity through market forces. An effective political system develops a system of one-time transfers (political bribes) that allows for reasonable democratic consent to moving from an inefficient status quo to a more efficient future. Ineffective political systems often remain at an inefficient status quo and bicker over distributional issues, as is the case in the current stalemate in telecommunications policy. Inefficient systems also may change but only by moving from one inefficient status quo to another, a feature of many electricity deregulation proposals. Only time will tell how our political institutions handle wealth issues in the context of electricity, but the track record in other policy areas does not inspire confidence.

Cross Subsidies

Cross subsidies exist if some customers are charged prices that are above marginal cost in order to allow other customers to be charged less than marginal cost. Cross subsidies are possible under monopoly because the "taxed" consumers may not choose an alternative supplier who charges them less.[120] Cross subsidies are not sustainable in competitive markets because the "taxed" customers may choose an alternative supplier who does not "tax" them.

The prices of regulated monopolies often exhibit cross subsidies because of political pressure to favor one class of consumers over another. For example, under the Bell System monopoly, residential local phone rates were much lower than costs while long-distance rates were kept substantially above cost; rural local rates were below cost while urban local rates were above cost.[121] In electricity markets, cross subsidies flow to suppliers of renewable energy and energy-demand reduction (DSM) services and residential customers in public systems.[122]

The good news is that cross subsidies are not viable in deregulated markets. Cross subsidies distort prices and serve equity goals very imperfectly.[123] Means-tested vouchers for individuals can serve equity goals better with fewer price distortions.[124]

Cross subsidies redistribute wealth among broad classes of people on the basis of dubious premises about relative need. For example, the implicit tax on long-distance calls to subsidize local telephone service was premised on the incorrect belief that the poor made few long-distance calls. More efficient telephone pricing since 1984 has had little effect on the distribution of income.[125] Cross subsidies to rural telephone and electric users aid all rural people, most of whom are not poor.

Subsidies in the form of vouchers are more compatible with market innovations. If conventional electric service to rural areas was expensive when correctly priced and the political system responded with means-tested rural-electric vouchers, recipients might buy microturbines with their subsidy to save some of the money they spend on correctly priced, expensive, conventional electric service.[126] Under cross subsidies no such incentives for innovation exist.

Vouchers would be subject to much more public scrutiny. By contrast, cross subsidies are embedded invisibly within existing rates in ways that voters do not perceive. Under closer public scrutiny, many cross subsidies would not survive.

An additional reason to subsidize individuals rather than institutions, such as rural electric companies, is that subsidies to institutions create one-time increases in the value of land. Taxes and subsidies in markets become embedded in the prices of the least mobile parts, usually land, not labor and capital.[127] Thus subsidies that are regionally based, such as those to rural electric service, simply cause land prices to increase in rural areas. Lower electric prices appear to benefit consumers, but they pay for the privilege of lower electric prices in the form of higher land prices. Electric subsidies that are geographically based simply result in one-time increases in the wealth of the owners of sites that benefit from the existence of cheaper electricity.

Annual, transparent, sliding-scale voucher subsidies are more compatible with markets than are cross subsidies. To be sure, the rationales for these subsidies (with perhaps the exception of the low-income program) will not survive close public scrutiny, but if they do, explicit congressional or state appropriations are more efficient than invisible cross subsidies that alter the price of electricity at the margin.

Real-Time Pricing

The marginal cost of electricity varies by time because units with low capital costs but high marginal costs are used in the current system to meet peak demand. In addition, transmission constraints limit the ability to deliver power across all parts of a transmission network, even within regions. Thus, temporary mismatches exist between electricity demand and locally generated supply that must be equilibrated by changes in price.[128]

Very few residential customers of electric utilities currently face real-time marginal-cost prices. Instead they face average costs that vary at most twice a year between winter and summer. In a completely deregulated market, consumers would presumably face lower off-peak prices and higher peak prices. That, in turn, might create political pressure to protect residential consumers from "too high" peak prices. States facing such pressure might mandate that residential customers be offered an average-pricing plan.

The economics of average or flat-rate versus marginal-cost pricing have been explored in the context of local telephone prices.[129] If all customers are allowed to choose between flat-rate and marginal-cost pricing, those peak users who would have to pay more under marginal-cost pricing will select the flat-rate option. This self-selection, in turn, requires that off-peak prices be higher than costs. Those two results undermine the economics of marginal-cost pricing schemes. Unless the flat-rate option is set fairly high, and there is always considerable political resistance to high flat-rate prices, the users of peak power will choose average pricing and undermine the gains from marginal-cost pricing.

States that have enacted or are contemplating deregulation of electricity markets designate the incumbent utility as the supplier of power if a customer does not choose an alternative during the deregulatory supplier-selection period. And no state yet has mandated that the incumbent utility offer real-time pricing, so residential customers are not likely to experience real-time pricing in the near future.[130] Furthermore, the transition to real-time pricing will not be rapid even if full deregulation takes place because residential meters will have to be changed.

The Distribution among Users of the Benefits from Competition

Some consumer advocates worry about the distribution of the benefits of deregulation. They believe that the bulk of the gains will go to industry because it is more price sensitive than are the residential and small business sectors.[131] To be sure, the main users of power at off peak may turn out to be industry, but even if industry reaps most of the initial benefits, competition in product markets will force the firms to pass along their savings in the form of lower product prices.

If different classes of electricity customers have different sensitivities to changes in price (different elasticities of demand) and firms can easily differentiate among such classes, then firms will charge different prices to the different classes of customers. Electricity prices are highest for residential users (about 8.0 cents per kWh) and lowest for industrial users (about 4.5 cents per kWh).[132] That difference reflects both real differences in the services provided (interruptible service to industry) and higher fixed costs of residential service relative to the amount of power consumed.[133]

Some portion of the difference is also Ramsey pricing, the recouping of fixed costs from those customers whose demands are least price sensitive. Consumer advocates worry that residential and small business power prices will remain stubbornly high even after deregulation. Such a pessimistic view assumes that the current low elasticity of demand that characterizes those classes of consumers is an innate behavioral characteristic. Instead, it is likely that the current insensitivity to changes in price is a product of the last 70 years during which consumers have not had choices and self-generation has not been economically feasible. In a competitive world, underutilized off-peak baseload power plants will sell electricity at prices that cover marginal costs.

Competition among marketers, who will bundle and resell electric service, will increase the responsiveness of consumers to price by offering them choices.[134] Those consumers that become more price sensitive will be charged less of the fixed costs than they are under the current Ramsey-pricing regime.[135]

The Distribution of Benefits among States

In a competitive market, price differences across space that exceed transportation costs cannot persist. Entrepreneurs will enter the low-price market and ship the product until the difference in prices between the two regions equals transportation costs. Current average electricity prices across all users vary from a high of 11.6 cents per kWh in New Hampshire to 4.0 cents per kWh in Kentucky.[136] Some analysts predict that, in the short run, deregulation will lead to price increases for those states that are below the national average of 6.6 cents per kWh, primarily in the Rocky Mountain region.[137] If the price differences across states are less than transportation costs, then this prediction will likely come true in the short run.

A constraint on higher-than-average prices falling and lower-than-average prices rising is the absence of transmission capacity between regions. As noted earlier, severe constraints, relative to their internal generating capacities, exist in the interconnections between the 10 regional systems that make up the U.S. and Canadian transmission system.[138]

Even if regional interconnections were not a constraint, the movement of power from low- to high-cost regions would occur only if the cost differences exceeded transportation costs. But the true economic costs of electricity transmission are neither an explicit part of econometric predictions about future power prices nor an explicit concern of any mandatory open-access policies pursued so far at the state level. So a more intellectually honest answer to the question of what will happen in the short run to the current variation in prices across states is that we don't know. In the long run, the answer is much clearer because the long-run average cost of new generation capacity is about 3 cents per kWh. Prices will converge at that level (plus the costs of distribution) everywhere.[139]

Will Deregulation Increase Air Pollution?

A major reason that power today is more expensive than it should be is the underutilization of conventional base-load coal-fired generation capacity during off-peak periods. Full utilization of that resource would increase total electric production by approximately 25 percent. Some observers have concluded that this must invariably increase air pollution.[140] The net effect of increased use of coal-fired facilities depends on pollution reductions from decreased use of other generators and the air-quality regulations that govern the coal-fired plants whose production increases.[141]

The emissions of utilities are governed by several different standards. Title IV of the 1990 amendments to the Clean Air Act,[142] sets limits on SO_2 emissions from virtually all fossil-fuel utility generating units in the United States.[143] To increase emissions above their initial allowances and any banked credits, the operators of generating units will have to purchase emissions allowances. Thus, the price of electricity from such units will include the cost of extra emissions. In the aggregate, SO_2 emissions from utilities cannot exceed the limits set by the 1990 Clean Air Act.

The 1990 Clean Air Act Amendments also establish controls on nitrogen oxide (NO_x) emissions but leave some of the details to the Environmental Protection Agency.[144] As of January 1, 1996, large coal-fired generators are subject to EPA-issued emissions limitations.[145] In December 1996 the EPA issued emission rules for phase II of the NO_x emissions reduction program to commence on January 1, 2000. Phase II limits allow slightly fewer emissions than phase I limits, and Phase II limits affect almost all fossil-fuel generators rather than just large units.[146] The phase II rules also allow the EPA administrator to waive the emissions limitations if states develop emissions cap-and-trade programs similar to the SO_2 emissions program. In 1995 the EPA established the Ozone Transport Assessment Group (OTAG), composed of representatives from 37 eastern states, to develop an NO_x emissions-reduction strategy. An emissions cap-and-trade program, similar in nature to the plan that governs SO_2 emissions, is being considered by OTAG, but as of February 1998 no plan had been finalized.

Thus, the claim that deregulation will increase air pollution is a claim that the aggregate use of coal-fired units will increase and that an increase in NO_x logically results from an increase in the use of coal. Palmer and

Burtraw estimate that the increased emissions will increase ambient concentrations of NO_X by .1 percent to .3 percent of the National Ambient Air Quality Standard of 50 micrograms per cubic meter.[147]

Even that small increase deserves three qualifications. First, the projected increase will not result in an absolute increase in ambient concentration because the increase is relative to the underlying trend, a projected decrease of over 2 million tons per year in NO_X emissions.[148] Second, an important assumption in the modeling exercise used to make the projection was that no Phase II controls would exist, but in February 1998 the D.C. Circuit Court of Appeals ruled that the Phase II rules could go forward. Third, the effect of such a small increase in particulate matter on human health is not at all clear and is the subject of very intense debate.[149] Thus, the bottom line would appear to be that electricity deregulation will not add significantly to air pollution problems.

Do Public Power Producers Create an Uneven Playing Field?

Publicly owned power companies receive a variety of subsidies including access to capital at below-market rates, loan guarantees, and exemption from various taxes.[150] In addition, many of the low-cost hydroelectric facilities are publicly owned and sell power preferentially to publicly owned electric distribution systems. Investor-owned utilities thus argue that, unless those advantages are eliminated, public utilities will gain market share in a deregulated market not through true cost savings but through taxpayer subsidies.[151]

In competitive markets, prices reflect marginal costs. Thus, subsidies affect prices only if the subsidies lower the costs of production inputs at the margin or induce new firms to enter an industry and increase the total supply of output. Subsidies that do not affect the decision to produce or enter at the margin simply increase profits for the firms that receive them. Such subsidies are the equivalent of lump-sum gifts. Profit-maximizing firms that receive lump-sum gifts make more profits than companies that do not receive such gifts, but unless the costs of increasing output one more unit are reduced by subsidies, firms that receive capital and tax windfalls do not charge lower prices.[152]

The capital and tax subsidies received by public power firms do affect their long-run decisions at the margin and thus affect prices. If those subsidies were eliminated, how much would public power prices increase? Professor John Kwoka of George Washington University has estimated the effects of various factors, including subsidies, on the costs and prices of public and private electric utilities. Using his estimates, I calculate that if public utilities, on average, paid the same price for capital and the same tax rates as private utilities, average as well as residential public power prices would rise an average of 1.02 cents per kWh.[153] The increase is about 17.6 percent for all customers and 16.3 percent for residential customers.

Hydroelectric power is not the source, at the margin, of increased electric output.[154] If public utilities need to increase power by 1 kWh, the power will come from more costly sources, and those costs rather than hydro costs determine the price for power. Thus, low-cost hydropower is a windfall gift for public firms rather than a subsidy at the margin.

What do public firms do with their windfall gift, since they do not maximize returns to shareholders? They distribute their subsidies in ways that maximize their political support. Kwoka finds that average residential power prices charged by publicly owned utilities are 15.4 percent (1.2 cents per kWh) less than average residential prices charged by private utilities even after controlling for taxes, subsidies, and numerous other factors.[155] He finds that public power prices for industrial customers are 3.1 percent higher than private power prices.[156]

Those findings suggest that an important factor in the uneven playing field of electricity is the widespread public ownership of hydropower. How would electricity pricing be altered by the privatization of hydroelectric generation facilities?

In competitive markets, firms with the highest costs (whose product is needed to meet market demand) set prices for all other producers in that market. Firms with lower costs receive excess profits (rents). The existence of rents, in turn, induces other firms to search for ways to lower their costs. If the cost factors that lead to the rents are not easily reproducible, then the rents become capitalized in the value of the low-cost firms' assets.

Hydropower is a perfect example of those forces at work. Hydropower is cheaper than other sources of electricity, but fossil-fuel sources of electricity (whose costs are higher than hydro's) are necessary to supplement hydropower to meet market demand. Thus, in a competitive market, the owners of hydropower generation firms would price their power to be competitive with that from fossil-fuel sources and hydro firms would receive rents. If entry into hydro is not easy because only a limited number of sites are available, then the owners of existing hydro sites receive lump-sum increases in the value of their facilities that reflect the present value of the rents.

The five federal Power Marketing Administrations that own dams and produce hydropower currently do not sell their power at market rates. Instead, they sell power to public power distributors at rates that reflect low hydro costs.[157] In a deregulated world, that practice would likely continue if the dams remained under public ownership because the political forces that support the practice are unlikely to change. In contrast, if the dams were privately owned, the electricity they produced would be priced to be competitive with fossil-fuel generation costs. Thus, in the case of hydropower, public ownership does alter the price at which power is sold.

To summarize, public power subsidies that affect the price of power at the margin create economic distortions in a deregulated world. The subsidies promote the consumption of the power of particular generators, not because their costs are genuinely lower, but because their costs are subsidized. Hydropower, however, is lower cost power, but hydrogeneration is not a source of power at the margin. Thus, the pricing of hydropower does not produce economic distortions. Instead, hydropower pricing is like a one-time gift, for which, not surprisingly, numerous interests jockey.

Public power would be used efficiently in a deregulated environment if all federal capital and tax subsidies were terminated for new projects as well as the expansion of old projects. Continued subsidies for existing projects would not distort decisions because new power at the margin would not be subsidized. While privatization is desirable, continued subsides for existing projects with no subsidies for new or expanded projects would cause less political dispute than full privatization and promote efficiency in a deregulated environment.

State versus Federal Jurisdiction

Should states have the right to impose restrictions on entry (create franchises) in the electric utility market? More generally, may the federal government prevent states from harming consumers? Investor-owned utilities and their trade association argue that the federal government may not prevent states from regulating utilities.[158] Others, including Paul Ballonoff and Roger Pilon, argue that federal preemption of state regulation of market processes is constitutional.[159]

Whatever the constitutional authority, the reality is that Congress has intervened previously in state regulatory matters. Congress deregulated interstate trucking in 1980, but state regulation of intrastate trucking continued.[160] The main effect of continued state regulation was to restrict entry by new firms and raise the price of shipping for consumers. For example, a shipment of tobacco from Texas to Louisiana (125 miles) cost $450 in 1994; transporting the same shipment 85 miles within Texas cost $750.[161]

The seeds of change in those cozy cartel arrangements were sown by a court case affecting Federal Express.[162] California attempted to regulate Federal Express's extensive trucking operations within that state. Federal Express sued, saying it was regulated under federal airline regulation. The lower court's judgment went against Federal Express, but the Ninth Circuit Court of Appeals overturned the California regulations in 1991, and the Supreme Court refused to hear the case, letting the court of appeals' decision stand. United Parcel Service was regulated as a motor carrier rather than an airline, but it wanted the same exemption as Federal Express. In 1994 other trucking firms also wanted an exemption (they did not want the two giants to gain an advantage), and Congress exempted all motor carriers, except household movers, from state regulation.

Two lessons for electricity, one normative and one positive, flow from the case of intrastate trucking regulation. First, Congress intervened to overturn the anti-consumer state regulation of trucking firms and no constitutional questions were raised. Second, the policy status quo quickly switched from regulation to deregulation once one firm was given the right by the courts to be treated differently from its competitors. The role of unregulated cogenerator facilities in electricity is analogous to the role of Federal Express in changing the regulation of intrastate trucking. An initial exception leads to an unraveling of political support for regulation.

Conclusion

The existing regulated vertically integrated electric utility industry wastes resources. High-cost nuclear and independent sources of electricity supply electricity even though their prices are above current market rates and 25 percent of coal-fired baseload capacity is not used at off-peak times.

Policymakers have decided to restructure rather than eliminate the monopoly-franchise state-regulated system that gave us our currently inefficient electric power system. The usually correct belief that choice is good has led policymakers to believe that generators and consumers should meet in a stock-exchange-like setting and buy and sell power using the existing grid as the equivalent of United Parcel Service to ship the product between generator and consumer.

The problem is that transmission and generation are substitutes. The proper mixture of generation and transmission is an economic, not an engineering, question, and little attention has been given to the development of efficient transmission prices. Without efficient transmission prices, appropriate choices between transmission and generation will not be made.

A more promising alternative is to respect the economic benefits of vertical integration but not use regulation to manage vertically integrated utilities. Just repeal the monopoly-franchise restrictions that prevent competition and eliminate public utility regulation.

Both electric utilities and consumers object to that proposal. Utilities object because, without the guaranteed revenue stream provided by state regulation, the market value of certain high-cost electric generation assets would drop. But markets compensate investors ex ante for the risk of policy change, particularly in regulated markets, because everyone knows that the privileges granted by government can also be withdrawn. Compensation after the fact is neither efficient nor equitable.

Consumers object because they believe that market forces will not constrain the behavior of the current monopoly transmission and distribution systems. Scholarly evidence suggests that regulation does very little to constrain utility pricing. In the few areas of the country where actual competition exists, electric prices are lower than they are elsewhere. In addition, decentralized natural-gas-fired electric generators seem likely to be a viable alternative to conventional electric service.

Even if consumer and electric utility objections to deregulation are unwarranted, other objections are raised by various groups, but those objections also do not undermine the case for true deregulation. Cross subsidies to rural customers, real-time prices, the distributions of benefits between commercial and residential customers and between states, increased air pollution, and public power subsidies present obstacles of varying difficulty to genuine deregulation.

The costs of rural service may be higher than those of urban service, although research suggests that rural telephone costs are not higher. If subsidies to rural customers are politically necessary, the subsidies should be transparent, like food stamps, rather than hidden in overcharges to other utility customers.

Current electricity prices reflect average rather than marginal costs. Peak power prices are now too low and off-peak prices are too high. If efficiency gains from deregulation are to be realized, the political pressures to maintain a flat-rate pricing option should be resisted.

In the short run, the bulk of the explicit gains from electricity deregulation will probably go to industrial users that alter their operations to take advantage of low off-peak prices. But the gains will be passed through to other consumers in the form of lower product prices. In the long run, electricity prices will converge at 3 or 4 cents per kWh for all users.

Current low-cost states worry that their electricity costs will rise as their cheap power is shipped elsewhere. Indeed, price differences across space in excess of transportation costs cannot persist, but constraints in the transmission connections between regions will prevent all prices from converging at the current U.S. average of 6.6 cents per kWh in the short run.

Air pollution concerns are motivated by the likely increased use of coal-fired plants under deregulation. Aggregate SO_2 emissions are already capped under provisions of the 1990 Clean Air Act. NO_x emissions may rise slightly but relative only to an underlying downward trend.

Public power subsidies present the greatest obstacle to true deregulation. Subsidized consumers, those who use food stamps for example, are compatible with market competition, but subsidized firms are not. If current public ownership and subsidies cannot be terminated for political reasons, then subsidies should be limited to existing operations so that expansion occurs on a level playing field.

Notes

I would like to thank Gary Torrent and Richard L. Gordon for their extensive comments on earlier drafts of this paper.

1. James F. Wilson, "ISOs: A Grid-by-Grid Comparison," Public Utilities Fortnightly, January 1, 1998, pp. 44-45.

2. Peter Fox-Penner, Electric Utility Restructuring: A Guide to the Competitive Era (Vienna, Va.: Public Utility Reports, 1997), pp. 159, 168.

3. Leonard W. Weiss, "Antitrust in the Electric Power Industry," in Promoting Competition in Regulated Markets, ed. Almarin Phillips (Washington: Brookings Institution, 1975), pp. 138-73.

4. Clyde Wayne Crews Jr., "Electric Avenues: Why 'Open Access' Can't Compete," Cato Institute Policy Analysis no. 301, April 13, 1998; and Fox-Penner, p. 43.

5. A few hundred vertically integrated investor-owned utilities account for over 75 percent of the electricity generated in the country. Three thousand public and cooperative utilities serve the remaining customers, but they generate very little power. See Timothy J. Brennan et al., A Shock to the System (Washington: Resources for the Future, 1996), pp. 15-35; John E. Kwoka Jr., Power Structure (Boston: Kluwer Academic Publishers, 1996), pp. 1-12; and Fox-Penner, pp. 119-53.

6. The findings in the literature are quite mixed. The discrepancies between the studies are technical, numerous, and difficult for the nonspecialist to disentangle. See Paul L. Joskow and Richard Schmalensee, Markets for Power (Cambridge, Mass.: M.I.T. Press, 1983), pp. 48-54; and Fox-Penner, pp. 88-92. Kwoka, Power Structure, p. 71, finds that economies of scale do not exist in 1989 data.

7. Joskow and Schmalensee, pp. 45-48.

8. See Fox-Penner, p. 38; and Kwoka, Power Structure, p. 66.

9. The term "national grid" is misleading. Severe constraints exist in the interconnections between the 10 regional systems that make up the U.S. and Canadian transmission system relative to their internal generating capacity. "Transmission capacity between adjoining regions typically runs much less than 5 percent of generating capacity within either region." David E. Wojick, "Regional Power Markets: Roadblock to Choice," Public Utilities Fortnightly, October 1, 1997, p. 29. Average power flows between regions are highest from Quebec to New England (about 7 percent). Temporary flows may reach 28 percent of generation capacity in the Indiana-Michigan region. Author's calculations using data from North American Electric Reliability Council, "1997/98 Winter Assessment Reliability of Bulk Electricity Supply in North America," p. 11, Figure 1, http://www.nerc.com.

10. See Irvin C. Bupp and Jean-Claude Derian, The Failed Promise of Nuclear Power (New York: Basic Books, 1981), pp. 42-50. Joskow and Schmalensee, p. 46, Table 5.1, report that fuel costs of nuclear plants were indeed smaller than the fuel costs of coal plants in 1981, but other capital and safety costs made the total costs of nuclear generation much greater.

11. It is not clear whether nuclear power was imprudent from the start or was made excessively costly by federal safety regulation (in the form of the Nuclear Regulatory Commission). In 1975 Resources for the Future projected that the total costs of nuclear plants in 1985-88 would be cheaper than the total costs of equivalent coal plants. See William Spangar Peirce, Economics of the Energy Industries (Westport, Conn.: Praeger, 1996), pp. 216-17. A set of costly nuclear plants came on line during the early 1980s, and electricity rates rose 60 percent from 1978 to 1982. See Caleb Solomon, "As Competition Roils Electric Utilities, They Look to New Mexico," Wall Street Journal, May 9, 1994, p. A1. Peirce reports that by 1990 nuclear plants had total costs that were about double those for coal plants. Not all nuclear plants are more expensive than coal-fired plants, and the least expensive nuclear plants have total costs lower than the cheapest coal plants, but at every other point in their respective distributions, nuclear plants are more expensive. Peirce, pp. 216, 217-18.

12. 16 U.S.C. §§ 2601-45 (1978).

13. See U.S. Department of Energy, Energy Information Administration, 1981 Annual Report to Congress, vol. 2, p. 97, for the price of Saudi "light" crude oil in 1972 and 1975. See U.S. Department of Energy, Energy Information Administration, Annual Energy Review 1996, Table 5.17, "Landed Costs of Crude Oil Imports," for the 1982 price. Prices are in nominal dollars for each year and not corrected for inflation. For overviews of the history of the petroleum industry and its regulation, see M. A. Adelman, The Genie Out of the Bottle (Cambridge, Mass.: M.I.T. Press, 1995); and Robert L. Bradley Jr., Oil, Gas, and Government: The U.S. Experience (Lanham, Md.: Rowman and Littlefield, 1996).

14. Typical was the Ford Foundation study, Energy: The Next Twenty Years (Cambridge, Mass.: Ballinger, 1979), p. 19, which used a doubling of real (inflation-adjusted) oil prices from 1979 to 2000 in its models. The actual price of Saudi oil in real dollars in September 1997 was only 47 percent of the 1979 price.

15. Section 210 of PURPA required utilities to purchase power from qualified independent producers at prices that did not exceed the incremental costs to the utility of alternate electric energy.

16. See Fox-Penner, pp. 138-39; Paul L. Joskow, "Expanding Competitive Opportunities in Electricity Generation," Regulation, Winter 1992, p. 29; and Michael K. Block and Thomas M. Lenard, Creating Competitive Markets in Electric Energy (Washington: Progress and Freedom Foundation, 1997), chap. 7.

17. The glut of independents stimulated by PURPA also cast great doubt on a central tenet of electricity economics: the existence of large economies of scale that reduced the costs of large generators relative to the costs of small generators. See Fox-Penner, pp. 89-92, 139.

18. Such mismatches in prices create what are called arbitrage opportunities that clever investors exploit. For example, an ice rink in Escondido, California, signed a contract in 1985 for excess power from its cogeneration facility to be sold for 30 years at 5.38 cents per kWh, approximately 70 percent higher than the 3 cents per kWh market rate for power in 1995. "Mr. Gerst is a canny investor who took full advantage of a regulatory mistake where rates were set too high," said Greg Barnes, assistant general counsel for San Diego Gas. Dean Nelson, "Engineer's Ice Plant Helps Power County," New York Times,

July 5, 1995, p. C2. The arbitrage opportunities were so extensive that 53 percent of the new generating capacity in the United States from 1990 to 1994 was provided by independents. See Agis Salpukas, "Electric Utilities Brace for End of Regulation and Monopolies," New York Times, August 8, 1994, p. A1.

19. New York legislatively set the avoided incremental cost at 6 cents per kWh, and utilities signed long-term contracts at that rate from 1981 through 1992 when the state dropped the minimum price requirement. Agis Salpukas, "Utilities See Costly Time Warp in '78 Law," New York Times, October 5, 1994, p. C13. According to Block and Lenard, p. 7-4 n. 17, the states with the largest discrepancies between current market and PURPA-contract prices are in the Northeast and California.

20. The article describing the Escondido ice rink attributed the rate obtained by the owner to utility projections in 1985 that the price for power would skyrocket. Nelson, p. C2.

21. A 1981 Southern California Edison study forecast 1995 avoided electricity costs at 16.73 cents per kWh, so the company willingly signed contracts to buy solar power at 15 cents per kWh even though the actual wholesale price of power in 1995 was about 2 to 3 cents per kWh. See Jeff Bailey, "Carter-Era Law Keeps Price of Electricity Up in Spite of a Surplus," Wall Street Journal, May 17, 1995, p. A1.

22. Fox-Penner, p. 139.

23. Michael T. Maloney, Robert E. McCormick, and Raymond D. Sauer, "Customer Choice, Consumer Value: An Analysis of Retail Competition in America's Electric Industry," Citizens for a Sound Economy Foundation, Washington, 1996, p. 38; and Block and Lenard, p. 1-1. Block and Lenard, p. 3-1, report that if the waste heat from the turbines is used for heating, the 3.5 cents per kWh is reduced to 2 to 3 cents per kWh. Two economists in the Energy Information Administration claim that the present value of natural-gas electricity costs is lower than the present value of coal-fired electricity costs over a 30-year time period, but they acknowledge their results are very dependent on assumptions about utilization rates and fuel costs. Coal-fired costs go down much more than gas-fired costs as utilization rates of generators approach 100 percent. In contrast, gas-fired costs are more affected than are coal-fired costs by changes in fuel costs. See J. Alan Beamon and Steven H. Wade, "Energy Equipment Choices: Fuel Costs

and Other Determinants," Monthly Energy Review, April 1996, pp. vii-xii.

24. Block and Lenard, p. 3-1. The economic viability of natural-gas microturbines is the subject of intense debate. One stumbling block is the need for gas-supply pressures that are double the pressures found in the gas lines of local distribution companies. The installation and maintenance costs of a gas compressor offset the cost advantages of the microturbine. See Robert Swanekamp, "Distributed Generation: Options Advance, but toward What Pot of Gold?" Power, September-October 1997, p. 52.

25. The most famous cases involve Tosco Corp. in Linden, N.J., which received a 23 percent rate cut; the Champion Paper Company and Central Maine Power Company, which cut its rates 15 percent; and the Raytheon Corporation, which spearheaded the movement to lower industrial electricity rates in Massachusetts. Dave Kansas, "For Electric Utilities, the Future Is Less Than Bright," Wall Street Journal, February 10, 1994, p. B3; David Stipp, "Central Maine's Response to Tough Times: Slash Rates," Wall Street Journal, December 21, 1994, p. B4; and Ross Kerber, "Massachusetts Utilities Propose Cuts in Rates of As Much As 11 percent by 1998," Wall Street Journal, February 20, 1996, p. B7A.

26. Economist Richard Gordon, however, believes that the threat from natural gas is overstated. Complete conversion of electricity production from coal and nuclear to natural gas would exceed total consumption of natural gas in the United States. In 1996, 25 quadrillion British Thermal Units (Btu) of coal and nuclear energy were used in electricity generation but only 2.8 quadrillion Btu of natural gas. Total natural-gas consumption for all uses in 1996 was 22.5 quadrillion Btu. See Richard Gordon, "Don't Restructure Electricity: Deregulate," unpublished paper on file with author, p. 10.

27. See Jon Hockenyos, Brian O'Connor, and Julius Wright, "Potential Economic Impacts of Restructuring the Electric Utility Industry," Small Business Survival Committee, Washington, November 1997, p. 11; and Fox-Penner, p. 138.

28. Stuart Brown, "Here Come the Pint-Size Power Plants," Fortune, April 29, 1996, p. 64C.

29. Block and Lenard, p. 1-1; and Maloney, McCormick, and Sauer, p. 38.

30. Ibid., pp. 29-32. Richard Posner first discussed this point 29 years ago. Richard A. Posner, "Natural Monopoly and Its Regulation," Stanford Law Review 21 (February 1969): 610.

31. Maloney, McCormick, and Sauer, p. 32. Full utilization would require an off-peak price for power lower than current prices, which, in general, are time-invariant "average-cost" prices. Lower off-peak prices would induce customers to shift use so as to fully utilize generating capacity.

32. Peter Passell, "A Makeover for Electric Utilities," New York Times, February 3, 1995, p. C1. A Department of Energy study in 1997 placed the figure at between $72 billion and $169 billion. U.S. Department of Energy, Energy Information Administration, Electricity Prices in a Competitive Environment: Marginal Cost Pricing of Generation Services and Financial Status of Utilities (Washington: Government Printing Office, August, 1997), p. ix. Fox-Penner, p. 387, lists estimates of between $72 billion and $163 billion.

33. See Alfred Kahn, "Let's Play Fair with Utility Rates," Wall Street Journal, July 25, 1994, p. A15; James Q. Wilson, "Don't Short-Circuit Utilities' Claims," Wall Street Journal, August 23, 1995, p. A12; William J. Baumol and J. Gregory Sidak, Transmission Pricing and Stranded Costs in the Electric Power Industry (Washington: American Enterprise Institute Press, 1995); William J. Baumol, Paul L. Joskow, and Alfred E. Kahn, The Challenge for Federal and State Regulators: Transition from Regulation to Efficient Competition in Electric Power (Washington: Edison Electric Institute, 1995); and J. Gregory Sidak and Daniel F. Spulber, Deregulatory Takings and the Regulatory Contract (New York: Cambridge University Press, 1997). For a summary of the arguments, see Fox-Penner, pp. 390-97. The implicit view of these authors is that the regulatory compact guarantees a reasonable return on capital, but Gary Torrent, senior economist with the Texas Public Utility Commission, points out that the relevant language from the Public Utilities Regulatory Act of Texas provides only for a reasonable opportunity to earn a reasonable return. Personal communication, February 8, 1998. Moreover, the authors say nothing about any time limitations on the "social contract." Does the contract run forever?

34. The takings argument that follows draws heavily on Roger Pilon, "Are Property Rights Opposed to Environmental Protection?" in The Moral High Ground, ed. Carol W.

LaGrasse (Stony Creek, N.Y.: Property Rights Foundation of America, 1995), pp. 18-23; and Roger Pilon, "Private Property, Takings, and a Free Society," Harvard Journal of Law and Public Policy 6 (Summer 1983): 165-95.

35. Ibid.

36. Harold Demsetz, "Why Regulate Utilities?" Journal of Law and Economics 11 (April 1968): 59; Marvin Olasky, Corporate Public Relations: A New Historical Perspective (Hillsdale, N.J.: Lawrence Erlbaum Associates, 1987), pp. 33-43; Vernon Smith, "Regulatory Reform in the Electric Power Industry," Issue Analysis Report no. 3, Goldwater Institute, Phoenix, March 1995, p. 2; Robert Bradley, "The Origins of Political Electricity: Market Failure or Political Opportunism?" Energy Law Journal 17, no. 1 (1996): 59-102; and Crews. For dissenting views, see George L. Priest, "The Origins of Utility Regulation and the 'Theories of Regulation' Debate," Journal of Law and Economics 36 (April 1993, Part 2): 289-323; and Geoffrey P. Miller, "Comments on Priest, 'The Origins of Utility Regulation and the "Theories of Regulation" Debate,'" Journal of Law and Economics 36 (April 1993, Part 2): 325-29.

37. The deregulatory policy changes (mandatory open access) enacted by California and other states go far beyond the mere elimination of state-created monopoly franchises. The assertion that deregulation does not constitute a taking does not apply to those more complicated and coercive policies.

38. See Paul Ballonoff, Energy: Ending the Never-Ending Crisis (Washington: Cato Institute, 1997), pp. 73-102.

39. Richard Sansing and Peter M. VanDoren, "Escaping the Transitional Gains Trap," Journal of Policy Analysis and Management 13 (Summer 1994): 565-70; Louis Kaplow, "An ex ante Perspective on Deregulation, Viewed ex post," Resource and Energy Economics 15 (1993): 153-73; and William Niskanen, "A Case against Both Stranded Cost Recovery and Mandatory Access," Regulation, no. 1 (1996): 16-17.

40. The financial instrument that offers a return that will last forever is the inflation-indexed U.S. Treasury bond. Economists refer to the return given by such bonds as the risk-free return.

41. Portfolio diversification, the ownership of assets in many different sectors of the world economy, provides investors with additional "policy-change" insurance.

Prudent investors own assets in all sectors of the economy to avoid random shocks, including policy changes, that affect any one sector. The market prices of assets compensate investors only for those risks that cannot be handled through diversification.

42. That is because the interest from municipal bonds is not taxable while the interest from Treasury bonds is taxable.

43. James M. Poterba, "Explaining the Yield Spread between Taxable and Tax-exempt Bonds: The Role of Expected Tax Policy," in Studies in State and Local Public Finance, ed. Harvey A. Rosen (Chicago: University of Chicago Press, 1986), pp. 5-51.

44. Principal of $240,000 would generate $12,000 a year ($1,000 a month) in income if interest rates were 5 percent per year, so the market price of an asset that yields $12,000 a year in income, forever, is $240,000.

45. The present value of $1,000 a month for 20 years at 5 percent interest is $100,000.

46. Kenetech Corporation is a supplier of wind energy in California. In 1995 the Federal Energy Regulatory Commission revised some rules governing purchases of renewable power under PURPA in California that reduced the demand for Kenetech's electricity. Kenetech stock went from $29.50 a share in 1994 to $11.75 in April 1995. Commenting on those events, a utility analyst said, "They basically made a regulatory bet, not a market bet, and they lost." Agis Salpukas, "70's Dreams, 90's Realities," New York Times, April 11, 1995, p. C8.

47. See Myron S. Scholes and Mark A. Wolfson, Taxes and Business Strategy (Englewood Cliffs, N.J.: Prentice Hall, 1992), pp. 446-49.

48. Valerie L. Vantreese, Michael R. Reed, and Jerry R. Skees, "Mandatory Production Controls and Asset Values: A Case Study of Burley Tobacco Quotas," American Journal of Agricultural Economics 71 (May 1989): 319-25.

49. Jonathan Auerbach, "Niagara Mohawk Wrestles with Conflicting Priorities," Wall Street Journal, May 7, 1996, p. B6

50. The profile of the typical utility investor comes from the Edison Electric Institute, http:/www.eei.org /industry/structure/4profile.htm.

51. Total annual average return on long-term corporate bonds was 5.6 percent from 1926 to 1996. See Herman, p. C1.

52. An additional difficulty exists because of the separation of management from ownership in stock corporations. Even if compensation for stranded costs is provided, shareholders may never receive it. Managers may use the cash flow in unproductive ways. Robert J. Michaels, "Stranded Investments, Stranded Intellectuals," Regulation, no. 1 (1996): 47-51.

53. See Fox-Penner, p. 396.

54. The average return on 30-day Treasury bonds has averaged 3.7 percent since 1926, and inflation has averaged 3.1 percent for a real return before taxes of .6 percent. Tom Herman, "How to Decide What to Do Next Week When 'Inflation-Indexed' Bonds Debut," Wall Street Journal, January 24, 1997, p. C1.

55. From 1977 through 1991 the annual total return (dividends plus capital gains) was 13.3 percent per year for a sample of 81 utilities measured by Public Utilities Fortnightly while the total return on the S&P 500 during the same period was 13.2 percent per year. Michaels, pp. 50-51.

56. Baumol, Joskow, and Kahn, pp. 39-44.

57. Total annual average return on long-term corporate bonds was 5.6 percent from 1926 to 1996. Herman, p. C1.

58. Transmission is the term for shipment of electricity across long distances at high voltages. Distribution refers to the shipment of electricity at the local level at low voltages. See Fox-Penner, p. 88, for a review of the economies of scale in transmission and distribution.

59. An early advocate of deregulation of transmission and distribution as well as generation was Richard L. Gordon, Reforming the Regulation of Electric Utilities (Lexington, Mass.: Lexington Books, D. C. Heath, 1982).

60. Block and Lenard, p. 3-1.

61. Joskow and Schmalensee, pp. 38, 48-54, 64; Fox-Penner, pp. 45-46, 88-92; and Kwoka, Power Structure, p. 71.

62. Interconnection also provides insurance against unexpected changes in supply and demand and allows generation assets to be built far from consumption centers.

63. Private companies have provided most transmission in the real world; electricity transmission clubs or cooperatives have not. I discuss the incentive dilemmas from the viewpoint of members of an electricity transmission club or cooperative. I do so because the incentive dilemmas that exist in the market for transmission services arise in both private companies and user-owned clubs and do not arise because of corporate ownership and other populist concerns that have dominated U.S. electricity policy.

64. Joskow and Schmalensee, p. 36; and Block and Lenard, p. 4-3.

65. The constraints arise from the need to dissipate the heat generated from the flow of current through a wire. Too much current generates more heat than can be dissipated safely and raises the possibility of fire and line failure. See Felix Wu et al., "Folk Theorems on Transmission Access: Proofs and Counter Examples," Journal of Regulatory Economics 10, no. 1 (1996): 5-23.

66. For a discussion of multipart tariffs, see Kenneth E. Train, Optimal Regulation (Cambridge, Mass.: M.I.T. Press, 1991), pp. 191-237.

67. Train, p. 198, reports that while the demand for access probably always varies somewhat with price, treating access demand as fixed (inelastic) with respect to price is consistent with the facts, particularly with respect to telephone network access.

68. Ibid., p. 196.

69. William J. Baumol and David F. Bradford, "Optimal Departures from Marginal Cost Pricing," American Economic Review 60, no. 3 (1970): 265-83. The arguments of Baumol and Bradford are equivalent to those made years ago by Frank Ramsey, "A Contribution to the Theory of Taxation," Economic Journal 37, no. 1 (1927): 47-61.

70. For a complete description of congestion prices and examples of how they would work, see William W. Hogan, "Contract Networks for Electric Power Transmission," Journal of Regulatory Economics 4, no. 3 (1992): 211-42.

71. For example, scholars easily have constructed examples in which efficiency is served if consumers buy power

from a generator at a price higher than they are willing to pay, a bilateral result not usually associated with efficiency. Shmuel S. Oren et al., "Nodal Prices and Transmission Rights: A Critical Appraisal, Electricity Journal, April 1995, p. 29; Wu et al., pp. 15-17; and William W. Hogan, "A Market Power Model with Strategic Interaction in Electricity Networks," Energy Journal 18, no. 4 (1997): 107-41. Hogan argues that the effects are likely to be much more complicated in real-world transmission systems.

72. The idea of optimal externalities produced by taxes and subsidies was first discussed in Arthur Pigou, The Economics of Welfare (London: Macmillan, 1920). The necessity of government intervention via taxes and subsidies to resolve externalities dominated academic thinking until Coase's critique. See Ronald H. Coase, "The Problem of Social Cost," Journal of Law and Economics 3 (October 1960): 1-44.

73. Wu et al., p. 17.

74. Ibid., p. 11. Also see Reinier Lock, "Power Pools and ISOs," Public Utilities Fortnightly, March 1, 1998, pp. 26-31; and Jeremiah D. Lambert, "ISOs as Market Regulators: The Emerging Debate," Public Utilities Fortnightly, April 15, 1998, pp. 48-53.

75. Wu et al., p. 22.

76. Oren et al., p. 28.

77. In a simple example provided in ibid., p. 27, two generators are linked to each other and a third site where power is consumed. The transmission link connecting the generators is constrained while the links connecting each generator to the consumption site are not constrained at current demand. Simple bilateral contracts between consumers and each generator result in more power produced than consumers demand and too much power transmitted over the constrained link between the generators. Simple bilateral contracts that comply with the transmission constraint result in less power produced than consumers demand.

The Coasian solution to this problem involves recognition that gains to trade exist if power is injected by the generators at a ratio that reflects the relative resistance of the transmission links to power flow. From the status quo contracts in which the transmission constraint is not violated but too little power is produced, gains to trade exist if generator one subsidizes generator two to produce power at the rate that reflects the relative resistance of the lines until market demand is satisfied.

78. John R. Hodawal, in the "Perspectives" section, Harvard Business Review, May-June 1996, p. 11.

79. The examples that follow in the text come from Oren et al., p. 34.

80. Ibid.

81. Hogan, "A Market Power Model with Strategic Interaction in Electricity Networks," pp. 120-27.

82. Baumol, Joskow, and Kahn, p. 31.

83. Peirce, pp. 134-36; and Stephen L. McDonald, Petroleum Conservation in the United States (Baltimore: Johns Hopkins University Press, 1971).

84. Douglas Houston, "User-Ownership of Electric Transmission Grids: Towards Resolving the Access Issue," Regulation, no. 1 (1992): 48-57.

85. An exception is Gordon, Reforming the Regulation of Electric Utilities.

86. Suppliers of electricity would have the incentive to price just below the price at which substitutes become viable.

87. See Demsetz, p. 59; Olasky, pp. 33-43; Smith, p. 2; Bradley, pp. 59-102; Crews; Priest, pp. 289-323; and Miller, pp. 325-29.

88. Kwoka, Power Structure, pp. 43-49, 65.

89. See Crews, n. 5.

90. Kwoka, Power Structure, p. 73.

91. Posner, "Natural Monopoly and Its Regulation," pp. 548-643.

92. See W. Kip Viscusi, John M. Vernon, and Joseph E. Harrington Jr., Economics of Regulation and Antitrust (Lexington, Mass.: D. C. Heath, 1992), pp. 330-31, for a discussion of natural monopoly.

93. The same game of chicken may also result in the second firm's declaring bankruptcy first. See Theodore E.

Keeler, Railroads, Freight, and Public Policy (Washington: Brookings Institution, 1983), pp. 43-61; and Gabriel Kolko, Railroads and Regulation 1877-1916 (Princeton, N.J.: Princeton University Press, 1965).

94. Keeler, pp. 44-46.

95. Posner, "Natural Monopoly and Its Regulation," pp. 557, 569-73, 642.

96. Ibid., pp. 550-51.

97. Fox-Penner, pp. 119-20; and David Shapiro, Generating Failure: Public Power Policy in the Northwest (Lanham, Md.: University Press of America, 1989).

98. James T. Bennett and Thomas J. DiLorenzo, "The WPPSS Default: Not the Only Off-Budget Boondoggle," Cato Institute Policy Analysis no. 28, October 14, 1983.

99. Kwoka, Power Structure, pp. 75-79.

100. Such pricing is probably not consistent with apportioning fixed costs among the least elastic customers in accord with second-best economic efficiency. See Joskow and Schmalensee, p. 36; and Block and Lenard, p. 4-3. Kwoka estimates residential demand elasticities at .12, commercial at .62, and industrial at .84. Kwoka, Power Structure, pp. 114-15.

101. See Train, pp. 177-90.

102. See George J. Stigler and Claire Friedland, "What Can Regulators Regulate? The Case of Electricity," Journal of Law and Economics 5 (1962): 1-16; Gregg A. Jarrell, "The Demand for State Regulation of the Electric Utility Industry," Journal of Law and Economics 21, no. 2 (1978): 269-95; Thomas Gale Moore, "The Effectiveness of Regulation of Electric Utility Prices," Southern Economic Journal 36 (April 1970): 365-75; and Walter Mead and Mike Denning, "New Evidence on Benefits and Costs of Public Utility Rate Regulation," in Competition in Electricity: New Markets and New Structures, ed. James Plummer and Susan Troppmann (Arlington, Va.: Public Utilities Reports Inc., 1990), pp. 21-40.

103. See Ballonoff, pp. 60-64; and Train, pp. 1-113. Costly nuclear power plants would not have been adopted by utilities that worried about their ability to pass excessive costs on to their customers.

104. Under "price-cap" regulation, regulatory commissions restrict allowable price increases rather than profits, which allows the regulated firms to keep any "extra" profits that result from cost containment. See Train, pp. 317-28. States are increasingly adopting price-cap regulation. See Kyle Marshall, "Telephone Changes Are Playing Out in North Carolina," Raleigh News and Observer, March 28, 1995, p. 3D. For early insight into the pitfalls of incentive regulation, see Posner, "Natural Monopoly and Its Regulation," pp. 627-32.

105. See William J. Baumol, "Contestable Markets: An Uprising in the Theory of Industrial Structure," American Economic Review 72, no. 1 (1982): 1-15; and William J. Baumol and John C. Panzer, Contestable Markets and the Theory of Industrial Structure (New York: Harcourt Brace Jovanovich, 1982).

106. Potential competition disciplines incumbents if new firms can enter a market, make profits, and exit before an incumbent can react. In a series of articles, William G. Shepherd argues that such conditions are unlikely to be met in the real world. Thus, the practical importance of contestability for antitrust policy is questionable. See William G. Shepherd, "Contestability vs. Competition--Once More," Land Economics 71 (1995): 299-309.

107. For a discussion of the effect of potential versus actual competition in the airline context, see Severin Borenstein, "The Evolution of U.S. Airline Competition," Journal of Economic Perspectives 6 (Spring 1992): 45-73.

108. Baumol and Bradford, pp. 265-83; and Ramsey, pp. 47-61.

109. Remember that Posner argues that natural monopolies would price discriminate even without contestability. On the possibility of competition from natural gas, see Ballonoff, pp. 46-48.

110. Demsetz, pp. 55-65; Posner, "Natural Monopoly and Its Regulation," pp. 548-643; and Richard Posner, "The Appropriate Scope of Regulation in the Cable Television Industry," Bell Journal of Economics and Management Science 3, no. 1 (1972): 98-129.

111. The prices will either be two-part tariffs or Ramsey prices depending on the elasticity of demand for access to the electricity network.

112. Oliver E. Williamson, "Franchise Bidding for Natural Monopolies--In General and with Respect to CATV," Bell Journal of Economics and Management Science 7, no. 1 (1976): 73-104.

113. Williamson, p. 90, and Priest, p. 308, argue that after the physical plant is in place, the relationship between a utility and a local government resembles a bilateral monopoly.

114. See E. S. Savas, The Organization and Efficiency of Solid Waste Collection (Lexington, Mass.: Lexington Books, 1977); and E. S. Savas, Privatizing the Public Sector (Chatham, N.J.: Chatham House, 1982).

115. According to the 1995 International City/County Management Association survey, 37 percent of responding local governments in the United States had refuse contracts with private firms. Daniel R. Mullins and Chia-Yin Chou, "The Solid Waste Crisis: Is Recycling a Response?" 1997 Municipal Yearbook (Washington: International City/County Management Association, 1997), p. 17, Table 3/1.

116. Public subsidy exists as a fourth possibility in the literature but is not used in practice.

117. Ballonoff, pp. 36-42, argues that electric and natural-gas utility costs are not consistent with economies of scale. Capital costs are not the largest cost component, and average costs do not decrease as the customer base increases.

118. Posner, "Natural Monopoly and Its Regulation," pp. 638-39.

119. Block and Lenard, pp. 4-5 and 4-6; and John E. Kwoka Jr., "Transforming Power," Regulation, Summer 1997, pp. 50-57.

120. Posner, "Natural Monopoly and Its Regulation, pp. 608-9.

121. Robert W. Crandall, After the Breakup (Washington: Brookings Institution, 1991), pp. 23-29.

122. On demand-side management programs, see Franz Wirl, The Economics of Conservation Programs (Boston: Kluwer Academic Publishers, 1997); on renewable energy, see Robert L. Bradley Jr., "Renewable Energy: Not Cheap, Not

'Green,'" Cato Institute Policy Analysis no. 280, August 27, 1997; and on residential customers, see Kwoka, Power Structure, p. 115.

123. Posner, "Natural Monopoly and Its Regulation," pp. 606-16.

124. Lester Thurow, "Government Expenditures: Cash or In-Kind?" Philosophy and Public Affairs 5 (Summer 1976): 361.

125. Crandall, pp. 113-15.

126. Research on the costs of rural telephone companies suggests that rural service may not be as high cost as most analysts assume. Rural phone companies have higher fixed costs but lower marginal costs than other phone companies. See Joseph P. Fuhr Jr., "Should the U.S. Subsidize Rural Telephone Companies?" Journal of Policy Analysis and Management 12 (Summer 1993): 582-88.

127. William T. Bogart, David F. Bradford, and Michael G. Williams, "Incidence Effects of a State Fiscal Policy Shift: The Florio Initiatives in New Jersey," National Tax Journal 45, no. 4 (1992): 377-79.

128. For early work on the development of spot pricing of electricity, see Fred C. Schweppe et al., Spot Pricing of Electricity (Boston: Kluwer Academic Publishers, 1988).

129. James M. Griffin and Thomas H. Mayor, "The Welfare Gain from Efficient Pricing of Local Telephone Services," Journal of Law and Economics 30 (October 1987): 487-564.

130. Personal conversation with Ken Malloy, senior consultant for Hagler Bailly Consulting, Arlington, Virginia, December 15, 1997.

131. Hockenyos, O'Connor, and Wright, p. i. If elasticities are low, then the reduction in price that occurs to accommodate any given amount of excess capacity is actually larger as long as firms cannot distinguish the elasticities among consumers. Michael T. Maloney and Robert E. McCormick, "Customer Choice, Consumer Value Setting the Record Straight: The Consumer Wins with Competition," Citizens for a Sound Economy Foundation, Washington, January 30, 1997, p. 9.

132. Hockenyos, O'Connor, and Wright, Appendix C, Table 1.

133. The cost of meters and meter reading does not vary significantly with the amount of power used.

134. Hockenyos, O'Connor, and Wright, p. 11, recognize this possibility but are skeptical that it will work.

135. The choice is not simply between deregulation, accompanied by the likely use of Ramsey prices, and the current regime. Two-part tariffs in which the fixed costs of the network, meters, and meter reading are billed separately from the variable marginal cost of electricity used are also a possibility.

136. Hockenyos, O'Connor, and Wright, Appendix C.

137. Ibid., p. 28 and Appendix C.

138. Wojick.

139. Maloney, McCormick, and Sauer, p. 38.

140. Allan Freedman, "Kyoto Agreement Complicates Electricity Deregulation," Congressional Quarterly Weekly Report, January 10, 1998, p. 74.

141. See Natural Resources Defense Council, "Benchmarking Air Emissions of Electric Utility Generators in the Eastern United States," Washington, April 1997; Karen Palmer and Dallas Burtraw, "Electricity Restructuring and Regional Air Pollution," Resources for the Future Discussion Paper 96-17-REV-2, July 1996; and Palmer and Burtraw, p. 8, who note that transmission constraints between regions will limit the flows of power across regions and thus increases in NO_x emissions.

142. Clean Air Act Amendments of 1990, 42 U.S.C. § 7651.

143. Reinier Lock and Dennis P. Harkawik, eds., The New Clean Air Act: Compliance and Opportunity (Arlington, Va.: Public Utilities Reports, Inc., 1991), pp. 19-48; and Palmer and Burtraw, p. 1.

144. Lock and Harkawik, pp. 19-48.

145. One-half pound of NO_x per million British thermal units (mmBtu) of coal burned for dry bottom wall-fired boilers and .45 pound NO_x per mmBtu for tangentially fired boilers. See Environmental Protection Agency, "Nitrogen Oxide (NO_x) Reduction Program Factsheet for Phase I of the NO_x Program (Group 1 Boilers)," p. 2, http://www.epa.gov /acidrain/noxfs.html.

146. Forty-six hundredths pound of NO_x per mmBtu of coal burned for dry bottom wall-fired boilers and .40 pound NO_x per mmBtu for tangentially fired boilers. See Environmental Protection Agency, "Nitrogen Oxide (NO_x) Reduction Program Final Rule for Phase II (Group 1 and Group 2 Boilers)," pp. 2-3, http://www.epa.gov/acidrain/noxfs3.html. The Phase II rules were upheld by the D.C. Circuit Court of Appeals on February 13, 1998. Until Phase II rules become effective, older coal units in operation before 1970 and, thus, not covered by the New Source Performance Standards of the Clean Air Act Amendments of 1970 are regulated only by the states. See Paul R. Portney, "Air Pollution Policy," in Public Policies for Environmental Protection, ed. Paul R. Portney (Washington: Resources for the Future, 1990), pp. 37-38.

147. Palmer and Burtraw, p. 35.

148. Ibid.

149. A 1991 study by the National Research Council concluded that NO_x reductions in some urban areas could actually increase ground-level ozone levels. See National Research Council, Rethinking the Ozone Problem in Urban and Regional Air Pollution (Washington: National Academy Press, 1991), pp. 167-68. For a discussion of the health effects of exposure to small particulate matter, see Claudia H. Deutsch, "Cooling Down the Heated Talk," New York Times, May 27, 1997, p. D1; Wendy L. Gramm and Susan E. Dudley, "The Human Costs of EPA Standards," Wall Street Journal, June 9, 1997, p. A18; and Alan Murray, "Clintonites Debate Cost of a Bad Air Day," Wall Street Journal, June 9, 1997, p. A1.

150. Kwoka, Power Structure, pp. 18-35.

151. For an early example of this controversy, involving the Salt River Project in Arizona selling power in California's deregulated market, see Kathryn Kranhold, "Quasigovernmental Utility in Phoenix Spurs Outcry by Joining California Gold Rush," Wall Street Journal, April 2, 1998, p. B2.

152. An example of this insight in the context of petroleum markets is provided by Joseph P. Kalt, The Economics and Politics of Oil Price Regulation (Cambridge, Mass.: M.I.T. Press, 1981), p. 35.

153. Page numbers herein are to Kwoka, Power Structure. The average cost of capital is 5.04 percent for public companies and 8.1 percent for private companies, a differ-

ence of 3.06 percentage points (p. 30). The average tax rate for public companies is .329 cent per kWh and for private companies it is .712 cent per kWh, a difference of .383 cent per kWh (p. 30). The coefficient that describes the effect of changes in the cost of capital on total costs is 233 x 10^6 (p. 107). Thus, the estimated effect on the average utility of differences in capital costs is $7.13 million (.0306 x 233 x 10^6).

The average public utility sold 918,000 megawatt hours (mWh) of electricity in Kwoka's data set. Thus, the effect on the average public utility of the elimination of capital subsidies is costs (7.13 x 10^6 dollars) divided by average sales (918,000 mWh, or 918 x 10^6 kWh), which equals .7767 cent per kWh.

The coefficient that describes the effect of average costs on prices is .982 (p. 110). Thus, the estimated effect of the difference in average costs on prices is .76 cent per kWh (.7767 x .982).

The coefficient that describes the effect of differences in tax rates is .647 (p. 110). Thus, the estimated effect of the difference in tax rates on prices is .2478 cent per kWh (.647 x .383).

The total effect is the sum of the capital and tax effects, or 1.02 cents per kWh (.7767 + .2478). The residential effect is calculated in the same fashion with the coefficients given on pp. 107 and 115.

154. This is certainly true at peak demand.

155. Kwoka, Power Structure, p. 114.

156. Ibid.

157. Block and Lenard, p. 5-2.

158. "The Schaefer Legislation: Where the Stakeholders Stand," Electricity Daily, July 15, 1996, p. 2.

159. Roger Pilon, "Freedom, Responsibility, and the Constitution: On Recovering Our Founding Principles," Notre Dame Law Review 68 (1996): 507-47; and Ballonoff, pp. 90-102.

160. Paul Teske, Samuel Best, and Michael Mintrom, Deregulating Freight Transportation (Washington: American Enterprise Institute, 1995).

161. Ibid., p. 116.

162. Ibid., pp. 128-45.

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