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Routing

Vertical Integration and the Restructuring of the U.S. Electricity Industry

by Robert J. Michaels

Executive Summary

Debates on restructuring the U.S. electricity industry are often about the degree to which market relationships should replace transactions that formerly took place within regulated, vertically integrated utilities. Markets for the purchase of energy by vertically unintegrated distribution utilities are clearly feasible, but vertical deintegration of existing systems may eliminate some operational and reliability benefits that are important in light of the unique characteristics of electricity.

Politicians and policy analysts have almost totally disregarded a large body of academic literature regarding the efficiencies that are gained through vertical integration in the electricity sector. At the same time, those parties have enthusiastically embraced other studies that purport to estimate the benefits of switching to a so-called restructured regime consisting of independent generation and integrated transmission and distribution. The result has been the passage of electricity utility restructuring laws that may create production inefficiencies that shrink the net benefits of any move toward market provision of power supplies.

A review of the debate surrounding electric utility restructuring in California—the first state to embrace restructuring—reveals that legislators and regulators regarded vertical integration primarily as a tool that incumbent utilities could use to perpetuate their market power. They thus disregarded the benefits that might accrue from vertical integration and used the force of regulation to encourage the sale of generating plants to independent power producers. The idea was to create a competitive market structure in the electricity generation sector. Unfortunately, the costs associated with this experiment in California and elsewhere have yet to be compared with benefits in any economically meaningful way.

A proper comparison of the two suggests that restructuring is presently off course.

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Introduction: Vertical Integration and Electricity

The past 30 years have transformed the economic theory of the business firm.[1] Instead of assuming that the scope of a firm's activities is fixed, economists now treat its boundaries as matters of choice. The economics of organization asks such questions as whether the firm should purchase its raw materials in markets or produce them in a facility that it owns and whether its product should be sold by salaried employees or by independent retailers. A rational decision about producing raw material or buying it from a third party requires that the firm consider alternative ways to hedge price uncertainty and ensure deliveries, its ability to coordinate production and use of the raw material in question, and its competence in managing the dissimilar activities of raw material and output production.

Almost since their origin, electric utilities have been vertically integrated, with generation, transmission, and distribution combined in a single firm. The operational rationale for vertical integration was largely related to the physics of electricity delivery. In order for electricity to be transmitted from the generator to the consumer, electricity supply and electricity demand must remain in precise balance at every instant over a wide area. That challenging task requires a central authority to govern both the supply of and the demand for electricity along the power grid.[2]

There were also economic incentives for vertical integration. Low-cost production requires the simultaneous optimization of both generator dispatch and transmission capacity. Long-run efficiency requires the coordination of investment decisions at all stages of the chain from generators to low-voltage distribution lines.

In the mid-1970s scholars first argued that generation could be organized as a competitive market.[3] Superficially, the case for vertical deintegration is clear: changes in technology have turned generation into a potentially competitive market, and efficiency would be enhanced if that market were allowed to operate. Transmission and distribution, however, remain most efficiently organized as monopolies, and those activities should continue to be regulated.

In reality, the case for deintegration is problematic. Its advocates often argue from inappropriate analogies with other industries or nations and disregard a large body of econometric research on the efficiencies of vertically integrated utilities.[4] If both integration and competitive markets have desirable economic properties, industry restructuring should focus on facilitating the most efficient mix of the two. Unfortunately, the value of integration between generation and transmission has been conspicuously unexplored, and thus restructuring threatens to produce institutions that foreclose the realization of important efficiencies.

The economically efficient degree of deintegration is not obvious. Vertical deintegration could remedy discrimination against competitors by an integrated utility, but so could a policy that requires integrated utilities that transmit their own power to honor requests from others to use their lines on the same terms. Note that the latter remedy does not change the organizational structure of the company whereas the former does just that. Of course, there may not be a problem to remedy in the first place—favoring generators that one owns may be efficient.

Various gradations of deintegration have been proposed. The least extreme form mandates a functional separation of generation, transmission, and distribution into different administrative divisions within the firm. A step beyond that lies structural separation, which creates subsidiaries that must deal at arm's length and in a nondiscriminatory manner with each other. A step beyond that lies the preferred policy of the Federal Energy Regulatory Commission, which encourages an operational separation of generation and transmission services and a surrender of the control of the power grid to a nonprofit, public-private independent system operator (ISO) or regional transmission organization (RTO).[5] The most extreme deintegration breaks generation and transmission into separate corporations, as occurred in the United Kingdom.

To better understand vertical integration and electricity markets, this paper summarizes the economics of vertical integration and its application to electricity. I then confront the record of economic and legal thought on restructuring with the econometric evidence concerning integration. That research almost unanimously concludes that vertical integration is an efficient form of organization for electric utilities. Research on the role of competitive markets in electricity has been less complete and often less rigorous.

The Economics of Vertically Integrated Utilities

Economic activity can be organized in three basic ways: markets, contracts, or vertical integration. The merits of each vary depending on the nature of the enterprise.

Markets are places or institutions where buyers and sellers compare their valuations of goods. Prices are discovered as information about offers and other market conditions becomes public. The cost of using a market instead of contracts or vertical integration will be lower the easier it is (1) to contact potential counterparties, (2) to compare their offers, and (3) to perform the transaction, whose costs may include the determination of product quality and buyer creditworthiness.

Buyers and sellers are more likely to use markets to exchange relatively standardized goods in situations in which information about their characteristics and the characteristics of counterparties is easy to obtain. The cost of using markets is also affected by the cost associated with changing buyer-seller relationships. Markets characterized by substitutable products and uncommitted buyers and sellers work smoothly. For instance, a seller who stops dealing with buyer A and starts dealing with buyer B does not need to make any investments specific to the relationship with B or lose any that were specific to the relationship with A.

Contracts will supersede markets, however, when a nonstandardized product is particularly valuable, when durable and specific investments are necessary to realize that value, or when the allocation of risk the parties prefer cannot be obtained in the market. For instance, assume a buyer wants a fuel supply with flexible deliveries, which requires that the supplier construct a specialized storage facility the cost of which is unrecoverable if the buyer stops taking fuel from the firm (there are no comparable buyers nearby). The buyer gets value only if the facility is built, and the seller builds it only if the buyer commits to a long relationship. A contract between them may prohibit the buyer from procuring fuel elsewhere and the supplier from selling it to others when the buyer expects delivery.

Vertical integration is an efficient organizational choice if (1) assets are highly specific to a given use or location, (2) assets are utilized in activities that must be coordinated, and (3) if the best uses of an asset depend on contingencies that are hard to predict.[6]

Whether governance of a relationship will be by integration, markets, or contracts depends on the benefits and costs of each option, possibly including the cost of changeover from one to another of the three. Markets may become more attractive if they offer better alternatives than the buyer could self-provide at the same cost or if the cost of using markets decreases (Internet access, for instance, allows quick worldwide shopping with lower risks of nondelivery). The benefits of contracting may likewise rise (health insurance is more valuable to me, for instance, if medicine is more advanced) if its costs become lower (without standardized automobile insurance, for instance, liability risks are so high that I choose not to drive). Integration can become a more attractive organizational form (if the market for a raw material input, for example, becomes more unstable and the costs of writing contracts to manage that instability are prohibitive). It can also become less attractive (for example, if growth of

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an industry implies that external specialist suppliers can make a component more cheaply than users can if they do the job themselves).

Electricity

Generation, transmission, and distribution of electricity are highly interdependent. With minor exceptions, power cannot be stored and must be produced the instant it is consumed. Failure of generation to meet demand will result in blackouts. The demand for electricity has both random elements and predictable hourly and seasonal characteristics. Efficient response to both predictable and unpredictable events requires centralized operation of generation and transmission.[7]

Electricity can be produced and delivered economically only if highly specialized assets are in place. Distribution lines must physically reach users, and transmission lines must cover the distance between distribution lines and generation. For reliability, some generators must be close to consumers while for economical production others may be more distant. Investment in generation and transmission is a long and costly process, and, once in place, the equipment cannot be cheaply redeployed to some other location or use.

Such characteristics suggest contract or vertical integration as the likely industrial organization for electricity. Contracts govern some vertical relationships in electricity, for example, between a utility and an independent power producer or between a transmission-owning utility and a small municipal utility that depends on the other's lines for deliveries. But even if a highly specific asset is under contract, its owner may act opportunistically (e.g., a generator may attempt to overcharge the utility if it knows that refusal to cooperate will cause a blackout). The utility may, of course, sue the generator, but its probability of success will depend on how a court interprets the details of a complex contract. A contract will be more difficult to negotiate and enforce if there is uncertainty about when the utility will require power from the generator and how much it will require.

Several attributes of electrical service make vertical integration an efficient organizational choice.[8]

- *Vertical Integration and the Hold-Up Problem.* The dedicated nature of electricity assets implies that generators need transmission to get their product to consumers and that transmission assets need generators. Thus either side can "hold up" the other.[9] That is, once assets are in place and independently owned, transmitters might refuse to pay anything above a generating plant's marginal costs and generating firms might accept such demands. Generation requires transmission to reach consumers, the power plant's assets cannot be dedicated to other uses, and the plant itself cannot move to a more lucrative service territory. A solution to this possibility is vertical integration, which ends the fight between generation and transmission over the division of the economic surplus from their interaction.
- *Coordination of Investments in a Complex System.* Vertical integration facilitates the coordination of highly specific and interdependent investments in generation and transmission. The two are substitutes in the production of bulk power (since transmission allows access to a larger universe of power plants) and complements in the delivery of electricity from generators to consumers. Any new facility affects the economic value of all other facilities on the system, and an organization that owns most such facilities may also be most likely to understand their interactions and invest optimally in them.
- *Risk Reduction and Risk Management.* A vertically integrated utility may have less risk than one that operates under long-term contracts with generators. The probability of a blackout will be lower with coordinated operation of a large system. Greater certainty may lower the company's cost of capital, potentially important in such a capital-intensive industry.

Electricity's Changing Environment

Do changes in the fundamental characteristics of electricity production warrant a reconsideration of vertical integration as the default organizational design? To better understand vertical changes in the electricity sector, first consider the unchanging interface between transmission and distribution, where restructuring has had no substantial impact. Both are highly specific assets, restricted as to location and transferable to nonelectrical uses only at high cost. Competitive duplication of either is costly and sacrifices the scale economies and diminished line losses of larger conductors. The process of transforming voltages across the transmission-distribution interface is little changed, and second-by-second coordination of flows across the grid remains necessary. Vertical integration between transmission and distribution may in fact have become more valuable if the emergence of wholesale markets has increased uncertainty about fluctuating flows across the interface.[10]

Vertical deintegration between generation and transmission is more economically defensible. FERC's "open access" rules (see below) require transmission owners to carry the output of independent power producers (IPPs) in a nondiscriminatory manner. IPPs now make up 45 percent of U.S. generation capacity.[11] Although the assets are highly specific and require coordination, other attributes of electric energy may make markets desirable. It is a homogeneous commodity, it can be centrally traded, and bilateral contracts are common between buyers and sellers who choose not to use the central exchange. Market size is growing with FERC's RTO initiatives, and the technologies of long-distance transmission and wide-area system controls are improving. Finally, economists and others have devised new market institutions to facilitate trade. Some short-term markets operate under "two-settlement" systems for day-ahead and real-time transactions; ancillary services (load following and reserve generation) can also be traded, and some grids use Locational Marginal Pricing of transmission.[12]

Such facts imply that markets are more desirable today than in the past. They do not, however, by themselves, imply that vertical deintegration is warranted because they do not consider its costs. Deintegration's net value also depends on the benefits of integration that will be forgone. So, the policy question is "What is the optimal degree of deintegration?" American restructuring, however, has not approached the problem this way despite the availability of some relevant research findings.

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Restructuring and Economics

Until the 1960s U.S. courts often ruled that vertical mergers by large firms could extend market power at one stage of production into otherwise competitive stages.[13] In the 1960s and 1970s economists came to the conclusion that the judicial view was generally incorrect.[14] First, a monopolist in one stage of a vertical chain (diamonds) does not need to merge with or acquire other competitive businesses in the chain (jewelry stores) to capture all the monopoly gains possible. The more efficiently the diamonds are retailed, the higher the wholesale price the monopolist can charge and the higher its profit. Second, if vertical mergers or restrictions cannot increase a seller's market power, their probable purpose is to turn the firm into a better competitor by reducing the transaction costs between stages of production.

Regulatory evasion provides a potential exception to this benign view of vertical relationships. In 1973 the Supreme Court decided *Otter Tail Power v. U.S.*, holding that a vertically integrated utility with market power in transmission had violated the antitrust laws by refusing municipal distribution utilities the use of its lines to deliver inexpensive power they had purchased for themselves.[15] Because the municipal utilities had no transmission alternatives, they had to take higher-cost service from Otter Tail. The Court concluded that the vertically integrated utility

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company was attempting to monopolize distribution in its area, when competition for franchises was in fact possible. It further ruled that the government could order Otter Tail to transmit power to the towns if necessary.

Guided by the *Otter Tail* ruling, scholars began to make the case for the vertical deintegration of electricity. Over the 1970s and 1980s lawyers and economists produced several proposals for deintegration, some still cited today.[16] They differ in numerous details, but all begin by considering long-distance transmission and local distribution as natural monopolies. All of them want greater competition between corporate utilities and local governments for franchises to distribute power.

The reasons for encouraging franchise competition are unclear. Distribution is a standardized technology the costs of which, in most areas, are under 15 percent of the delivered cost of power, and few if any *real* savings would result if a small municipality were to take over the operation of lines within its boundaries.[17] The authors of these studies also intended to facilitate the growth of energy markets by introducing competition by nonutilities for contracts with distributors and shared participation in new projects. At the time of their writings, however, continuing technological progress in large power plants and other factors actually made generation an unpromising market.[18]

The radical deintegrations that these authors proposed were based on a belief that even relatively small market benefits were worth pursuing since they could be obtained by the simple (so the authors believed) step of breaking up corporate utilities. In particular, they unanimously asserted without proof that vertical deintegration would produce few if any efficiency losses:

> The reduction of competition at the distribution stage might be acceptable if vertical integration made utilities more efficient. That, however, is not the case. Utilities strive to integrate forward to obtain a dependable supply of bulk power. But vertical integration does not significantly reduce the cost of operation at any stage of the industry.[19]

Some tried to prove their cases by analogy:

> [I]n other industries, production has not, for the most part, been integrated with distribution. There is today no compelling reason for such integration in electric power either.[20]

References such as these continue to guide many policymakers. They do so despite the fact that, shortly after these studies were published, economists began attempting to estimate the benefits of vertical integration. Almost uniformly, their findings would contradict the claims these studies made about deintegration.

Econometric Studies of Vertical Integration

There are at least 11 published studies that investigate the relationship between the vertical integration of electricity generation, transmission, and distribution and utilities' costs.[21] They cover the United States and Japan, both of which are served by regulated, vertically integrated corporate utilities with assigned territories. Their data cover subsets of years between 1970 and 1997, all taken from utilities' annual filings with regulatory agencies under standardized reporting systems.[22]

The Appendix to this paper summarizes their methods and findings.[23] The only study to find that vertical integration worsened economic efficiency is the most questionable on several grounds.[24] Only one author finds no statistically significant economic advantages to integrated generation, transmission, and distribution.[25] Because the authors utilize different samples and research techniques, it is impossible to compare their numerical estimates of the savings from integration, but with the exceptions mentioned above they are all significantly positive.[26]

Vertical Integration, Fuel Supplies, and Generator Performance

Research on electricity generation, transmission, and distribution primarily concerns the effects of vertical integration on production cost. Research on the integration of fuel supplies and the outsourcing of generator engineering and construction, by contrast, is about the transactions costs associated with vertical integration.[27] For example, MIT economist Paul Joskow has examined the factors that may incline a coal-fired generator to enter into long-term contracts for coal from mining companies rather than to purchase coal from a third party.[28] The more particular the needs of the power plant or the coal producer, the more likely—in theory—that coal production and consumption will be integrated within the same firm. Greater specificity (in either the generator or the coal supply) should be more likely to entail integration between the mine and the utility. His findings are generally consistent with this theory:

- Only a small amount of coal is traded in spot markets, and trades are primarily in the East, where there are more mines and more generators than in the West.[29]
- Mine-mouth plants are more often designed to burn a specific type of coal than are non-mine-mouth plants, and more likely to be integrated with utility-owned mines.[30]
- Coal supply contracts are on average 12 years longer for unintegrated mine-mouth plants than for plants not located there. Longer-term contracts tend to exist for the generator's full requirements and they contain complex market-based price adjustment terms.[31]
- Long-term contracts are more common in the West, where a plant must burn low-sulfur coal compatible with the details of a generator's engineering, than they are in the East, which has numerous interchangeable coal sources.[32]

Regulation can change the costs and benefits of the integration of mining and power generation. Economist John Filer found that the most important factor influencing the decision to integrate is the presence of a fuel cost adjustment provision in rates, which might allow utilities to opportunistically overstate the costs of mining to obtain higher rates.[33] Likewise, economist John Gonzales found that productivity is lower in utility-owned coal mines than in independent ones. Some utility-owned mines, however, are unregulated, and their productivity is the same as that of independent mines.[34] By contrast, economist Joe Kerkvliet found that vertically integrated mines were more technically efficient than unintegrated ones. With a given mix of inputs, Kerkvliet argued, an integrated mine would produce more than an unintegrated one, other things being equal.[35]

Generator performance provides a more indirect but less conclusive test of the transaction-cost model. Economists Paul Joskow and Richard Schmalensee examined the operational heat rates and unit availability of low-pressure "subcritical" and high-pressure "supercritical" coal-fired units. Their regressions included indicator variables for the four utilities that were the largest owners of these plants, which performed their own design and engineering work; the other utilities outsourced those functions. For both types of generators, two of the four integrated owners enjoyed significantly better availability and heat rates than average, while the other two companies were at the average.[36]

Vertical Integration and Reliability

There are no publicly available studies that estimate the actual or potential impact of vertical deintegration on reliability. Noteworthy outages are rare in the United States, and reliability analysts are justifiably more interested in their proximate causes (equipment malfunction, trees touching lines, etc.) than in their relationships to changes in industry structure.

Structural changes in the industry such as vertical deintegration, the formation of RTOs, the growth of existing wholesale markets, and direct access of final customers to nonutility suppliers could affect system reliability. All of those changes make operations more complex and possibly riskier, but there is no clear way

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to apportion the causation of outages among them. Concerns have also been expressed that more extensive restructuring will adversely affect investment in transmission because cost recovery may be at risk if unforeseen market changes leave a new line underutilized. These effects could worsen already-existing problems that have been caused by 20 years of low transmission investment.[37]

The North American Electric Reliability Council has for some time been concerned about the effects of restructuring on reliability.[38] Its annual reliability assessments discuss the consequences in general terms:

> The responsibility for coordinating operations between generating plants and transmission systems traditionally has been assigned to the utility transmission system operators and system planners. Administrative separation [i.e., vertical deintegration of generation and transmission] as well as the growing number of [independent power producers] demands a more standardized and formal understanding of the bulk electric grid control and reliability criteria by all.[39]

NERC also sees inefficiencies resulting from uncoordinated planning and investment decisions:

> The close coordination of generation and transmission planning is diminishing as vertically integrated utilities divest their generation assets and most new generation is being proposed and developed by independent power producers. Once new generation is announced the necessary transmission additions to support it must still be designed, coordinated with other generation and transmission, and constructed. Since these activities are no longer carried out within a single organization, more time will need to be allowed to coordinate and perform these tasks to properly integrate the new generation to ensure reliability before it can come into service.[40]

NERC's concerns about operating difficulties may be justified, but its reports do not discuss any actual outages or operating crises that it believes were caused by vertical deintegration or increased reliance on markets. The organization's data, however, show increases of several hundred percent between 1998 and 2004 in emergencies that required the use of extraordinary procedures for redispatch and curtailment known as Transmission Loading Relief.[41]

The increase in TLR probably has multiple causes. There has certainly been increased stress on the transmission system due to low investment in new and upgraded facilities. NERC also blames changes in the pattern of grid use, as systems designed for predictable transfers between utility-owned generation and captive loads have been required to accommodate the less predictable flow patterns that result from market transactions.[42] Some observers worry that a vertically integrated utility can exercise market power if it calls for TLR in a nonemergency situation. That's because TLR protocols on capacity reservation and service curtailment can at times give priority to the transmission owner's own generation over transactions by competitors that use the same lines. Attorney Diana Moss concludes that determining whether emergencies or market power explain TLR growth will require further research.[43] If vertically integrated utilities actually do invoke TLR for strategic reasons, however, it will more likely be as a consequence of the particular TLR rules in effect than of vertical integration itself.

Moss's work more generally addresses potential conflicts between competition and reliability that may have been aggravated by deintegration and market growth. She recognizes, however, that inefficiency and threats to reliability can also result from the absence of market forces. For example, if transmission is sold at regulated rates that recover average cost rather than priced in a market to reflect its scarcity, there may be little investment in new lines, and those that are actually built may be inefficiently located.[44] By contrast, NERC appears to believe that engineering standards should generally take precedence over market outcomes:

> [Due to vertical deintegration] generation additions cannot be planned in an integrated fashion with transmission expansion, resulting in sub-optimal transmission expansion in some areas. Generation is not locating close to demand centers, but rather is locating close to a fuel supply, adequate cooling water, and a transmission line interconnection.[45]

The interrelationship between investments in generation and transmission leads NERC to favor planning by utilities over reliance on markets. Beyond this statement, however, NERC provides no discussion about which decisions it thinks are best made in markets. In electricity, the choice between planning and markets is a matter of degree: vertical integration and centralized planning yield reductions in operating costs, but markets may at times provide other sources of cost reduction benefits that outweigh the losses from less comprehensive planning.

An alternative perspective that emphasizes the benefits of independent transmission, however, has recently surfaced at FERC, which is considering several proposals to allow "participant funding" of additions to RTO grids by generators and others.[46] One of the most important proposals was a 2002 application to form SEtrans, an RTO in the Southeast, which envisioned participant funding as one of two types of transmission investment.[47] The SEtrans applicants argued that lines linking new generators to the grid should generally be funded by the new participants in the system because the benefits accrued primarily to those parties. Some other lines (often planned by the RTO) would bring more general benefits in the forms of increased reliability and improved access to markets. Their costs would be prorated ("rolled in") according to agreed-upon formulas.

SEtrans had good reason to propose participant funding. Its area contained fuel supplies and generator sites that might produce power for distant consumers, but those generators would add little to system reliability. Further, some people argue that mandatory cost sharing might allow inefficient transmission investments that would not be made if beneficiaries had to bear their full costs.

One representative of a large utility in SEtrans saw the failures of past planning as further reason to institute participant funding. In his view, the ability of grid planners to make efficient long-run choices is doubtful. Seeing that today's industry faces unprecedented uncertainty about load growth, market development, new technologies, and fuel prices, he said, "We cannot optimally plan the transmission grid any longer, and we should not try and pretend that we can."[48] That statement is well-founded. A centrally planned RTO must choose which lines to build or upgrade from numerous alternatives, each of which might be consistent with reliability. Participant funding leaves those decisions to the market, where pressure to make efficient choices may be greater. Lines that create benefits for the entire region might still best remain under the ownership of vertically integrated utilities.

Harvard economist William Hogan, however, has raised concerns about a participant funding scheme. He observed that a "free-rider" problem might well arise if some lines were funded by new participants while others were funded by all users as a group. That's because an entity that would normally propose a participant-funded line may prefer to wait until its absence begins to affect reliability, at which time the RTO might authorize collective funding.[49] Thus far, the search for a clear distinction between lines that should be participant funded and those needed for reliability has produced no operational criteria for making that distinction.[50]

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Summary

The movement to restructure electricity began with generalities about the desirability of markets coupled with claims that vertical integration in utilities was either unimportant or that its effects could easily be duplicated in markets. The econometric evidence, however, makes clear that there are substantial economic advantages associated with vertical integration.

The case for deintegration and restructuring has implicitly been founded on a belief that the savings and other benefits obtainable from markets exceed those that are associated with vertical integration. It is quite possible that utilities invest or operate inefficiently. Rate of return regulation may induce them to overcapitalize or to extend themselves excessively into unregulated businesses. As regulated monopolies, they may feel less pressure to cut costs than do firms in competitive markets.

If rate of return regulation is retained during the process of vertical deintegration, however, deintegration by itself is unlikely to produce more efficient operation or investment. Performance-based or price cap regulations are less drastic alternatives to deintegration and have shown some success in practice. Moreover, the latter reforms are easily reversible—deintegration is much more difficult to reverse.

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Deintegration in California

The campaign for vertical deintegration went into high gear on April 20, 1994, when the California Public Utilities Commission instituted a rulemaking on electricity.[51] Its radical proposal to allow consumers "direct access" to suppliers of their choice generated volumes of testimony from interest groups, most of which is no longer available on the Internet.[52] The CPUC held hearings in 1994 and early 1995 and issued its initial order in December 1995. The California legislature enacted that order into law in September 1996 and established the California Power Exchange (PX)—the market in which wholesale power was to be traded—and the Independent System Operators to facilitate the new regulatory regime. The newly created electricity market opened for business on April 1, 1998.[53]

Perhaps the most frequently expressed opinion on vertical integration before the CPUC was that it was undesirable in a regulated world. In a deregulated system, vertical integration was thought to facilitate the exercise of market power by utilities. Testifying for municipal utilities, economics professor William Shepherd either rejected or was unaware of the research discussed in the previous section of this paper. He claimed that, in order to achieve economies of scale and scope, "[t]here may need to be separation of the core functions into distinct entities."[54] Shepherd provided no evidence, however, that integrated utilities failed to exhibit economies of scale and scope. Others proposed radical restructurings along the same lines, not necessarily restricted to California. They included energy law professor Richard Pierce, who failed to mention any possible costs of deintegration in a scheme to separate generation from transmission and transmission from distribution.[55] The trade press was full of similar arguments.[56]

The two founders of independent power producer AES attempted to make the quantitative case for vertical deintegration by citing the postprivatization drop in UK generation costs, but they failed to identify the key factor in that drop: lower fuel prices.[57] They also described but failed to cite an "analysis [that] suggests divestiture of generation will lower overall costs per kWh by 15 percent" and an unpublished consultants' report that the saving would be from 20 to 40 percent.[58] Perhaps the most surprising views were those of economist Irwin Stelzer, the retired founder of a consulting firm whose clients include many integrated utilities. He asserted that competition was impossible as long as utilities were vertically integrated and proposed that utilities deintegrate as a precondition for stranded cost recovery.[59] None of those people even brought up the possibility that integration could also be beneficial.

A few experts were a bit less hostile to vertical integration. Two economists from the University of California Energy Institute wrote:

> If the vertically integrated utilities remain largely intact . . . their coordination abilities could enhance reliability and reduce transaction costs. However, the utilities would also have a correspondingly large capacity for the exercise of [horizontal] market power. If the utilities are dismantled along the lines of the UK model, then new mechanisms for coordination would have to be developed.[60]

MIT engineering professor Marja Ilic and her associates described the requirements for operating methods and software that had yet to be developed if an ISO in a vertically deintegrated system was to operate a well-functioning set of wholesale and direct access markets for both energy and ancillary services.[61] And only two analyses by economists prior to the opening of California's markets brought up any of the econometric studies of integration discussed above.[62] Both of them provided cautionary discussions on the value of integration, and one noted that prior to deintegration its advocates should show that "cost savings exceed foregone economies."[63]

After more than a year of hearings and negotiations, the CPUC issued its initial decision in December 1995. The wholesale power market and retail access aspects of that decision would be altered before markets opened, but its generation divestiture provisions would remain. They required that the state's two largest corporate utilities divest themselves of 50 percent of their fossil fuel generating capacity located in California.[64] A commission majority justified this radical step by stating (without evidence) that "the vertically integrated electric utility is not compatible with the institutions of a competitive market for electric services" and that utility structure is "rooted in the past and incompatible with emerging markets."[65] The decision cited no testimony or other evidence regarding the benefits of vertical integration or the possible costs of a breakup.

The utilities accepted the decision primarily because it would guarantee revenue to recover the costs associated with the construction of power plants that had yet to be recovered through the rate base (so-called stranded costs) and allow the utilities to maintain some competitive advantages even after direct access began.[66] The 1996 legislation authorizing the PX, ISO, rate freeze, and stranded cost recovery imposed the same divestiture requirements, again with no discussion of the costs and benefits of integration.[67]

California then applied to FERC for approval of its market-based PX and ISO-managed transmission system. Testimony before FERC's market-based rate proceedings emphasized the ability of vertically integrated utilities to leverage market power from transmission to generation and distribution. The standards for market-based rates require an applicant to delineate geographic markets for short-term energy and capacity, and possibly other commodities. The applicant must then show that it (in this case, California's three large corporate utilities as a group) controls a small enough part of the market and that its power over price is minimal. The utilities, however, were unable to meet FERC's standards. Intervenors (protesting parties) compounded the problem with testimony claiming that the utilities' horizontal dominance of generation left them ideally suited to use their transmission to exercise vertical market power, and that even independent operation of the transmission system (the ISO) might not suffice to neutralize it, at least prior to actual divestiture of the generating plants. The utilities responded by proposing additional market power mitigation measures, including an independent monitor and special contracts for the pricing of generation required to operate for reliability.[68] The utilities were the only parties one would expect to defend vertical integration, and in more normal circum-

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Prior to the opening of California's markets, most interested parties viewed vertical integration as a tool for the exercise of market power by utilities.

stances they might have done so. Here, however, stranded costs were their prime concern and they would reluctantly accept vertical deintegration as the price for recovering them. Thus the record at FERC is essentially devoid of any discussion of vertical integration beyond conjectures about market power.

In sum, prior to the opening of California's markets, most interested parties viewed vertical integration as a tool for the exercise of market power by utilities. The utilities also enjoyed horizontal market power as owners of most existing generation. Regulators and others believed that the combination of divestiture and an ISO might suffice to mitigate both types of market power; particularly during the limited time California gave its utilities to recover most of their stranded costs.[69]

The CPUC required the two largest utilities to divest half of their in-state gas-fired plants, but ultimately they chose to divest all of them to six different independent power producers and marketers.[70] By FERC's standards for horizontal market power, the area was now sufficiently competitive that the prices arising at the PX and ISO would not be subject to further regulation.[71]

The reforms initiated by the CPUC set the stage for the crisis that was to follow. During the two years of the operation of the new California market, prices hovered near marginal cost. By the spring of 2000, however, they had begun their rise to crisis levels. Numerous factors contributed to the problem and are still the subject of litigation and academic debate.[72] One possible factor that simple measures of seller concentration could not predict was market power exercised by the owners of divested generation. If generation is near its limits, transmission is scarce, and demand is highly inelastic, a single generator might move the market price with a small change in output, and others would have reason to bid above their marginal costs as well.[73]

Vertical Integration after the California Collapse

Three years after California's markets began operating, its Power Exchange was bankrupt and its utilities in disastrous shape. Only after their deintegration did economists begin rethinking the relationship between vertical integration and market power. This time their conclusions were quite different.

New models showed that integration could actually constrain rather than enhance a generation owner's market power. A generator required to serve final demand has little reason to cut the output of plants that it owns unless it can obtain power more cheaply from a market.[74] Forward contracts that commit generators and users to fixed delivery prices likewise diminish the incentive for a generator to exercise market power with its uncommitted plants.[75] Vertical deintegration was not solely responsible for California's problems, but a consensus arose that it facilitated the exercise of market power by owners of the divested plants in ways that would not have happened if the utilities had remained vertically integrated.[76] As this was happening, the utilities began their long journey back to financial health and found themselves with an opportunity to vertically reintegrate.

Between 1998 and 2003 a binge of merchant power-plant construction had left many nonutility generators either bankrupt or in poor financial health. The markets they had expected to materialize as states restructured had largely failed to appear. Over those years, total U.S. generation increased from roughly 800 GW to 1,000 GW; 150 GW of that increase had been built by Independent Power Producers.[77]

Over only 10 years, the ownership structure of generation had changed dramatically. In the mid-1990s approximately 90 percent of generating capacity was owned by utilities. Today, new plants and divestitures have left only 55 percent of the national total under cost-based regulation. Approximately 60 percent of the remainder is owned by unregulated affiliates of utilities. Overoptimism from all parties allowed IPPs (usually under project finance) to be funded largely by debt. By 2004, 90 GW of them had been turned back to lenders, 23 GW had been bought by private investors, and 10 GW had been purchased or repurchased by regulated utilities.[78] Those changes may be evidence that vertical integration is returning to the industry.

As the finances of the IPP sector deteriorate, the distressed assets have often been priced so attractively that purchase by utilities or their affiliates is clearly efficient. According to some observers, however, these purchases raise antitrust concerns because they needlessly reconcentrate suppliers in regional energy markets.[79]

Vertical integration is also being pursued more directly. Two of California's three large utilities are building new generation and the third is applying to the CPUC for permission to do the same. Under new state laws, California intends to reregulate and reverticalize utilities in hopes of avoiding a repetition of the 2000–01 crisis.[80] Utilities must now file short-term and long-term resource plans with state regulators, who approve individual investments, set reserve requirements, and impose "renewable" resource quotas on them. California utilities are also attempting to slow the growth of distributed generation (very small facilities on end-user sites). They claim that restriction of its scope is necessary for reliability, while others claim that the utilities are trying to eliminate competitors.[81]

Lessons Learned about Vertical Integration

There has been little pressure for reintegration by either utilities or the public in those states where deintegration has been accompanied by relatively successful market outcomes (e.g., Texas, Massachusetts, and New York). These market outcomes may reflect no more than temporarily advantageous supply and demand situations, as California's did during its first two years. In particular, there are no available research findings about the effects of either deintegration or RTO membership on the operating efficiency of utilities. One recent study has shown that fuel efficiency has increased for both divested generators and utility-owned units, with the largest improvements occurring in those generators that were divested to utility affiliates.[82]

It may be possible to perform studies comparing utilities before and after they became members of RTOs. The only available related study is by economists Magali Delmas and Yesim Tokat, who found that deregulation of retail access has a generally negative effect on utilities' productive efficiency.[83] Consistent with the predictions of organization theory, they found that vertically integrated utilities that supply the full requirements of their retail customers experience smaller efficiency losses from the opening of retail markets, and so do those that purchase their entire power supplies on wholesale markets. Utilities that must mix market purchases with internal production suffer efficiency losses greater than those at the extremes.

California's performance has brought a general agreement on the value of requiring transitional contracts between utilities and the owners of divested generation.[84] A transition from integration to unbundling gives rise to new price risks for both generators and retailers because generators sell at the wholesale price while retail rates are usually fixed. In an integrated utility, these cancel out, but a deintegrated system will probably require contracts to allocate the obligations and risks.[85] Such contracts may be difficult to formulate because independent plants can obtain capital more cheaply if their contracts contain commitments for both prices and outputs, while utilities prefer discretion about their economic dispatchability under changing fuel prices and system conditions. Utility CEO John Rowe and his coauthors believe that a major difference between California and Rowe's utilities in Philadelphia and Chicago was that regulators in his states allowed divestitures to be determined by the utilities themselves, and they also allowed contracts and hedging.[86]

Rowe also discusses the value of a properly planned transition. In Pennsylvania, the time paths of stranded cost recovery were determined in settlements with individual utilities and surcharges to their rates were set in advance. Only one of Pennsylvania's utilities

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Some retrospective studies have asked why restructuring attracted so much support, given its goal of moving a vital industry into largely unknown territory.

chose to divest.[87] Instead of a discontinuous institutional break like California's, the regional transmission organization known as the PJM (so called because it is an interconnected system incorporating utility service in Pennsylvania, New Jersey, and Maryland, although it also manages utility service in parts of Delaware, Illinois, Indiana, Kentucky, Michigan, North Carolina, Ohio, Tennessee, Virginia, West Virginia, and the District of Columbia) imposed wholesale markets on a "tight" centrally dispatched regional power pool that had operating and settlement mechanisms in place. As a further safeguard, generators were required to submit only cost-based bids during the first year after PJM's markets opened. New York, however, offers a potential counterexample to Pennsylvania. Its regulators increased utilities' uncertainty by requiring divestitures prior to formulating any stranded cost policy. They did, however, allow (but not require) contracts between utilities and owners of the divested plants.[88] Most of those contracts will expire in the near future.

Partial vertical integration may be a sound strategy for utilities that expect to serve substantial amounts of load that have chosen not to leave regulated service.[89] In the future, many utilities will have some customers who obtain their own power supplies and others who are either "captives" legally prohibited from using the market or who choose not to do so. Economist Jamie Read observes that their "provider of last resort" functions are no longer expected to be transitional, and vertically deintegrated utilities must design efficient procurement plans for their core customers.[90] Utilities that have sold their power plants and lost their safe monopolies will have lower-quality credit, which will affect their decisions to build generation or buy energy. Read sees reverticalization by asset ownership at one extreme, providing the hedge that only physical assets can provide but also inviting regulatory scrutiny about prudence. That scrutiny will be more likely if the load served by these assets chooses to depart.

An alternative to reintegration is a portfolio model in which the utility holds nothing but contracts and uses the spot market to provide for any excess load or to dispose of excess contracted power.[91] California's utilities are in transition toward an intermediate mix between the two, but one that will be heavily weighted in favor of utility-owned assets and longer-term contracts. Utilities will have a continuing interest in well-functioning bulk power markets, although the degree of interest may depend on whether existing customers can also depart and use those markets.

Summary

Some retrospective studies have asked why restructuring attracted so much support, given its goal of moving a vital industry into largely unknown territory. A slower opening of markets to direct access by large customers would certainly have been feasible. As the difficulties of administering the limited market were resolved, transactions could have been opened to smaller customers. The market's scope would have been market determined rather than regulator imposed.[92] A few economists even question whether markets should have been opened at all. Richard Rosen has attempted to make a qualitative showing that the cost of creating and using markets in a deintegrated system is probably not worth the economies of integration that were sacrificed.[93] Rosen believes that many industry analysts were blinded to the costs of massive restructuring by a long-standing and sometimes justifiable dissatisfaction with the performance of regulation.[94] Other economists argue that restructuring has been a success in most states and nations that have carried it out. Lynne Kiesling believes that deintegration itself can and should be market driven:

> The encouragement of restructuring of utilities created substantial flexibility in Pennsylvania's electricity market. Divestiture is likely to occur to some extent as a part of restructuring, when utilities refine their "core competencies." Allowing retention of at least some generation capacity enables com-

panies and consumers to reap the benefits of vertical integration where they exist.[95]

The California restructuring process could have been a forum for reasoned discussion on the future of vertically integrated utilities. The old view held that integration was an obstacle to competition and the coming of energy markets would allow regulators to specialize in what they allegedly did well—controlling natural monopolies. The market could be left to do what regulators probably did poorly—applying competitive pressure to produce and invest efficiently.

The newer view holds that the continued existence of vertical integration is evidence of its efficiency. The fact that generation was technologically separable from other aspects of power delivery did not imply that separation was economically desirable.

Economists had a great deal to say about the efficient design of energy markets during the restructuring, but the design of utility organizations has been primarily a political question. In California the utilities' prime interests lay in recovering stranded costs and positioning themselves for post-transition competition. After they made the bargains that brought the PX, ISO, and divestiture, there were no parties interested in undoing the political compromise by attempting to make the case that some degree of continuing vertical integration might in reality be efficient.

During the 2000–01 crisis, energy prices in the California spot markets tracked short-term energy prices at other locations in the West quite closely. The major difference was that California's utilities had a far greater exposure to this market than utilities that remained integrated, and the CPUC did not allow them to use other risk management tools. Utilities elsewhere in the West would appear in the short-term markets as either buyers or sellers depending on the day's operating conditions, but California's utilities would always be massive buyers.

The state's disastrous transition was a failed gamble by utilities that for the next five years demand would not catch up with the state's largely unchanged generation capacity. At the peak of the crisis, the state government signed long-term contracts for nearly all of the power that its insolvent unities could not generate from resources that they still owned. A few weeks after the signing, supply and demand conditions changed and energy prices fell below those in the contracts, but by then California's utilities were in effect reintegrated.

Over three years, California regulators were given two lessons on the hazards of thoughtless decisions about integration: a quick divestiture aggravated the effects of dependence on highly volatile energy markets, and a panic-driven reintegration through state contracts brought very high but stable prices. Those lessons about integration went either unlearned or misinterpreted, and new laws continue to expand the scope of state activity in utility planning.

Transmission Operations in a Restructured Industry

The regulatory restructuring undertaken in the electricity sector has been more ambitious than the regulatory restructurings undertaken in other industrial sectors. That's because, in the case of electricity, both market institutions *and* governance institutions have been subject to politically induced change.[96]

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The previous section described the changes in industrial organization in California. This section describes changes in the transmission system's governance institutions. Robust wholesale markets require that buyers and sellers have access to a wide region, but access had historically been obstructed by both utilities and regulators. Utilities preferred monopolies in their service territories and external transactions only with other utilities, and prior to 1992 FERC had no powers to order them to transmit for eligible third parties.

Regulated transmission rates also stood in the way. When two transmission-owning utilities traded power, a fictitious "contract path"

Economists on all sides had much to say about California's market designs and transmission pricing, but none questioned the institutional structures being proposed.

between them would determine the allocation of transmission charges. In reality, the power flowed everywhere in the region, but as long as transactions were few and excess transmission capacity was common, they could neglect the consequences of power flows along the grid. Regulators set transmission charges on an average cost basis, and principles of nondiscrimination treated utilities on the contract path symmetrically. If utility A sent power to utility C on a contract path that went through B, C would be expected to pay both A's and B's filed transmission charges. From a regional standpoint, this was only a slight alteration in power flows, but under contract path ratemaking the cost of transmission over multiple systems was a barrier to the growth of markets.

In late 1995 FERC began to study open access transmission policy. FERC embodied its findings in Order 888 of 1996.[97] It expressed the commission's preference for ISOs that met certain standards of independence but did not compel their formation. FERC would consider proposals for both nonprofit and for-profit ISOs, but stated that the latter could not be closely affiliated with generation. FERC then held technical conferences at which corporate utilities envisioned ISOs as regulated corporations while public entities preferred that they take the form of nonprofit entities.

Economists were quick to weigh in. MIT economist Paul Joskow envisioned a nonprofit joint venture whose board of directors would contain representatives of utilities, nonutility generators, regulators, and "others representing the public interest."[98] The appropriate functions of an ISO were also debated, with Harvard's William Hogan favoring locational marginal pricing of transmission and full integration with a PX. Some attendees, however, were concerned that they were planning the details of an institution that had never before existed, and that once such an institution was in place it could not adjust to changes in technology and markets.[99]

Transmission in California

At the same time that FERC was formulating Order 888, the CPUC released its December 1995 decision on restructuring.[100] Virtually all interested parties, including competitive producers and traders, agreed with its plans for an ISO. They believed that if the utilities continued to operate transmission they would schedule the flow of electricity on the grid in order to advantage themselves against competitors. The ISO, on the other hand, would take no market positions and have no interests in load or generation. A separate institution, the Power Exchange, would administer the energy markets, and bilateral transactions outside the PX were possible for all parties other than the utilities. The ISO would integrate PX and bilateral transactions and administer a zonal pricing system for transmission. The decision took no position on whether it should be a regulated corporation, a nonprofit, or a governmental operation.[101]

After having helped to create the design of the PX and ISO, in mid-1996 California's utilities applied to FERC for market-based rates and argued that those markets were sufficiently competitive that their prices would satisfy its "just and reasonable" legal standard. The PX and ISO would both be nonprofit institutions, governed by boards of interest group representatives.[102]

Economists on all sides had much to say about California's market designs and transmission pricing, but none questioned the institutional structures being proposed.[103] Only one economist, Dennis Carlton of the University of Chicago, testified as to the governance rules and independence of ISOs. The Sacramento Municipal Utility District retained Carlton to argue that transmission-owning utilities would dominate the ISO (their personnel were in some cases the only ones knowledgeable enough to operate it) and that they would use that knowledge to advantage their own generation. Acting as planners at the ISO, the utilities would not want to build transmission that would decrease the value of their generators, many of which were "must-run" units whose operation was at times required for reliability. Carlton also questioned the voting rule that required a two-thirds majority, since it would allow utilities to form coalitions with allies to veto proposals beneficial to a majority of the board.[104] Municipal utilities including Sacramento's also protested that in the "collaborative" process to form the ISO and PX, the only parties allowed to vote were the three corporate utilities.[105]

Shortly after the ISO began operation, the president of the CPUC told a trade journal that the CPUC actually believed that transmission divestiture and the formation of a single transmission-only corporation would have been a superior alternative to ISOs. "Political reality," however, stood in the way because a divestiture would have been legally difficult and would have required three to five years and extensive financing.[106] This episode further points up the difficulty of designing rational economic institutions in a political setting. At the time, there were no prospective transmission-only firms in existence to offer expert testimony favoring such a structure.[107] Ten years later, a few transmission-only companies exist, but they operate under ISOs whose governance is heavily influenced by the remaining integrated utilities.[108]

Cost/Benefit Studies and Order 2000

Two years after the formation of ISOs in California and the Northeast, only one other ISO had opened, in Texas. FERC's interest in regional coordination remained strong, but its legal ability to compel membership in RTOs is still in doubt.

On December 17, 1999, the commission issued Order 2000, which offered additional inducements to join RTOs. Still faced with resistance, FERC next proposed a set of regional RTOs, and in 2001 it commissioned a cost/benefit study of ISOs and the markets that would result. The study estimated that the RTO markets would create benefits in the form of lowered production costs with a present value of $40.9 billion between 2002 and 2021, approximately a 2 percent annual saving over their base case.[109] Critics quickly determined that the model's assumptions about technology, as opposed to markets, drove most of its results. Approximately 85 percent of the alleged benefits came from its assumptions about the increased efficiency of new generation. Some of the remainder was due to assumptions that reserve margins could decline from 15 to 13 percent and that transmission transfer capability would increase by 5 percent per year at no cost.[110]

One of the most important flaws in this and most later studies was the lack of any description of the trading institutions that were being assumed and how those trading institutions might affect the calculation. The benefit estimate in the FERC study, for instance, was the solution of a linear programming problem, derived from a model of least-cost dispatch rather than a model of the operating practices that might occur in actual markets. Moreover, the study's authors determined that the cost of forming RTOs would be between $1 billion and $5.75 billion.[111] If 85 percent of their projected benefits are in fact due to improved generator efficiency, this implies that RTOs may not be worth forming. In practice, those costs have proven quite high and have been increasing over time. Between 2000 and 2003, the operation and maintenance costs of RTOs and ISOs in California rose by approximately 35 percent; in New York they rose by 100 percent; and in the PJM they rose by 250 percent. The corresponding figures per megawatt-hour of electricity were 23 percent, 73 percent, and 181 percent. All of those ISOs had initiated their basic market operations before or during 2000.[112] Their setup costs ranged from $250 million to $500 million.[113]

A substantial number of other studies have used methods similar to FERC's. In 1996 a group of pro-market organizations examined a least-cost dispatch model for wholesale power markets and estimated a saving of up to 40 percent.[114] The U.S. Energy Information Administration estimated savings of 8 to 15 percent from competitive markets, again on the basis of dispatch algorithms.[115] A number of others exist, most of little individual interest.[116] Their complex modeling techniques and large data requirements make it extreme-

Two years after the formation of ISOs in California and the Northeast, only one other ISO had opened, in Texas.

ly difficult to pinpoint the reasons for their differing results.[117]

Even if we accept the calculations as accurate, many of their treatments of economic efficiency are theoretically questionable. Often they identify increased efficiency with decreased customer bills, but some (possibly much) of that decrease must be netted against the loss of wealth by generators, whose incomes will be lower. The only study that adequately accounts for the transfer is economist Ellen Wolfe's work on the proposed RTO West. She estimates a 2004 reduction in marginal costs of $1.3 billion, from which lowered generation revenues of $900 million must be subtracted. The report is also noteworthy because unlike others it analyzes the situation with and without a specific institutional innovation—the RTO's proposed locational pricing system for transmission.[118]

The quality of the decisions that an ISO's governing board makes will be critical to the success of the markets it operates, but no experts on voting or committee structures provided input during proceedings on ISO designs.

Profits, Voting, and Monitors

FERC Orders 888 and 2000 state that FERC will consider applications by both nonprofit and profit-seeking ISOs or RTOs. The original ISO proposals (made at a FERC technical conference) by economists William Hogan and Paul Joskow envisioned a nonprofit organization with representative government. They said little about the difficulties in governance such an organization might actually encounter (and which California's ISO did see during the 2000–01 crisis). Neither they nor FERC gave noticeable weight to economists' findings of more efficient operations by profit-seeking firms in other industries that contained a mix of them and nonprofit organizations (e.g., hospitals).[119] On the other side, supporters of nonprofit organizations largely disregard the efficiency findings and conclude that an investor-owned transmission company with even minimal interests in generation will act monopolistically. This author's work is the only work to examine the nonprofit controversy in the light of recent developments in organizational and financial economics.[120] My case for the efficiency of investor-owned transmission firms is based on several applications of principal/agent theory and the economic theory of voting.

Economists and political scientists have extensively analyzed rules for collective choice.[121] Their work has shown the innate imperfections of nearly all voting systems in aggregating individual preferences and the general impossibility of controlling strategic voting. That work, however, has also shown that some decisionmaking mechanisms are superior to others in important ways, such as the ability of the person who sets the agenda to influence results by choosing a sequence of votes.

The quality of the decisions that an ISO's governing board makes will be critical to the success of the markets it operates, but no experts on voting or committee structures provided input during proceedings on ISO designs. The literature, however, suggests that the constellation of interest groups on an ISO board may render it relatively vulnerable to manipulation by strategic voting.[122] "Nonprofit" ISOs may show no profit in their books, but the votes of their governors affect the wealth of the interests they represent. Some of California's difficulties in 2000–01 stemmed from the growing inability of its ISO's governors to reach decisions, which ultimately led FERC to order a reconstitution of the board, which has since been ruled an impermissible extension of the commission's authority.[123]

Economists with an understanding of corporate organization and collective choice could have usefully contributed to the RTO debate in a third area. Order 2000 requires that all RTO applicants include a description of their proposed market monitoring institutions (MMIs). These institutions use market data to detect activities believed to be exercises of market power, have further powers of investigation, and are also charged with pointing out any flaws they might find in market design. Existing MMIs have produced numerous reports and testimonies of varying quality, a discussion of which is beyond the scope of this paper.

MMIs are both political and economic institutions. They were not suggested by FERC or by consumer groups. Instead, they were originally proposed by the California utilities as amendments to their PX and ISO applications after FERC ruled them ineligible for market-based rates. In some cases MMIs are staffed by RTO employees and in others by appointed committees of external experts. Their functions are at least in part political.

Economists often disagree over whether certain behavior is anti-competitive, but all MMI reports on record have been unanimous.[124] California's MMIs reported some seller scheduling practices as anti-competitive attempts to raise price by submitting bids that did not reflect their true demands. They made no similar reports about attempts by utilities, however, to submit false schedules whose effect would be to lower prices.[125] In another vein, arbitrage between the day-ahead and real-time markets known as virtual bidding (simultaneous buy and sell orders in the two markets) is a generally desirable and efficient practice. PJM's monitors were not under pressure from utilities to keep prices artificially low, and they encouraged virtual bidding. California's monitors were under such pressure, understood that virtual trading would interfere with attempts to manipulate prices downward, and made the practice illegal. Economists have yet to perform an impartial study of the costs and benefits of alternative methods of monitoring the competitive behavior of markets. Had they done so, market monitoring might be less politicized than it is today.

Summary

Economists have provided significant input on the details of RTO market design, and their contributions have undoubtedly improved market performance.[126] Whether by accident or intent, their contributions to the design of RTOs and their governance were minimal. Over the past 40 years there have been significant advances in the analysis of organizations, transaction costs, and collective choice that were directly applicable to the design of ISOs and RTOs. That new learning has convinced much of the economics profession that the design of institutions is as important as the design of markets themselves, and that economics offers insights that could not have been obtained from any other discipline. It might have been quite useful at the outset for economists to simply remind FERC and others that rational persons in nonprofit organizations will seek to advantage themselves just as they would in for-profit ones. Instead, much of U.S. electricity is now governed by organizations for which there are no precedents in any industrial context as important as electricity. Where those organizations have been stressed, as in California, they have failed to produce coherent policy.

Conclusion

The analysis of vertical integration became an integral part of economic theory only quite recently. As this happened, economists came to understand that vertical integration often had desirable effects on economic efficiency because it reduced the costs of coordinating economic activities relative to the alternatives of markets or contracts. Vertical integration became a common organizational form in electricity because of technological requirements that supply equal demand at all times everywhere on a network. In addition, the industry's specialized plants were less vulnerable to opportunistic conduct if they were owned by the same organization rather than under contract.

The old economic view saw vertical integration as a tool that a monopolist could use to extract profit from competitive activities. Modern theorists discredited that argument in unregulated situations, but it might still apply to regulated ones. In the 1970s and 1980s lawyers and economists created a literature that made the case for vertical deintegration of utilities by simply assuming that integration served no useful function. If true, the separation of generation from transmis-

Much of U.S. electricity is now governed by organizations for which there are no precedents in any industrial context as important as electricity. Where those organizations have been stressed, as in California, they have failed to produce coherent policy.

Politics saw to it that the most important thing for the market to decide would be off limits—what the market itself would actually look like.

sion could bring the benefits of competition at no cost in efficiency. Econometric research proved that this was not so. Studies in the 1980s and 1990s almost invariably concluded that vertical integration produced efficiencies that would be lost in a breakup. These economies of integration applied to both the generation-transmission interface and to the ownership of generators and fuel supplies.

This scholarship was almost totally forgotten as California and other states began to restructure their power industries in the mid-1990s. A few economists argued that there were both costs and benefits to vertical integration and a rule of reason was needed. Many others simply chose to assert that integration was worse than useless. If not constrained, transmission monopolists integrated into power production could destroy the benefits of competitive generation. The ISO came into being as a midway point between full integration and full deintegration.

In California ISOs were supplemented by divestiture. Generators that would often set market prices at the PX and ISO were sold off without contracts that would have given the utilities security of supply and prices. Two years after California's markets began operation, the growing imbalance of supply and demand combined with a constellation of other forces to bring about a pricing crisis. In its aftermath, utilities and regulators are investigating the possibilities for reverticalizing utilities, possibly with a separation of core and noncore customers.

The ISO and RTO were envisioned as institutions that could operate and price regional power flows efficiently. They were also charged with administering markets for portions of that power. A series of questionable quantitative studies estimated that large benefits would be forthcoming, but the studies were calculations of optimum dispatch rather than projections of the behavior of markets. Numerous interested parties were concerned about discrimination by transmission owners, but the ISO concept was formulated without an adequate appreciation of the economic incentives of the institution's managers and clients.

Some economic experts displayed the same naiveté as noneconomists in their expectation that nonprofit organizations would operate benignly and efficiently. There was never a real debate over whether RTOs should be for-profit or nonprofit, in large part because the nonprofit ISO was a politically expedient compromise rather than a thoughtfully planned institution. As economists would have predicted, ISOs governed by representatives of interest groups have at times had difficulty reaching coherent decisions and have instituted highly imperfect and politicized monitoring procedures.

If economists and others had better understood the significance of vertical integration in the industry, restructuring would have produced better policies and better institutions. Contracts and vertical integration are substitutes, but California left its utilities to divest their plants and rely on short-term markets without any hedging possibilities. Markets have virtues, but the question of whether or not to rely on them is really a question about the costs and benefits of vertical integration. Economists have a great deal of useful knowledge in this area, but they have played at best a peripheral role in the design of the institutions that will determine the industry's future.

Ultimately, the question of how best to organize the electricity industry is a question that should be answered through trial and error by market actors, rather than be decided by politics. Unfortunately, while longer-term power contract markets arose almost spontaneously during the 1970s and 1980s, short-term electricity markets that balance hourly supply and demand require some planning and design prior to the start of operations, which renders some governmental role unavoidable. Decades of scholarship on vertical integration were largely ignored in the restructuring and market design process, and both producers and consumers will pay for that neglect for some time to come. As states and regions reorganized their institutions, almost every interested party went on record as favoring one or another type of market, and regulators often heard that they should "let the market decide." But politics saw to it that the most important thing for the market to decide would be off limits—what the market itself would actually look like.

Appendix: Summary of Vertical Integration Studies

Author (date)	Sample and Data Year	Method	Findings	Comments
Henderson (1985)[127]	160 U.S. utilities, most vertically integrated, 1970	Marginal cost of steam, hydro, and purchased power is used as energy transfer price in estimate of trans-log cost function that includes labor, capital, and energy; tests coefficients for separability	Estimate of model that excludes produced power yields, downwardly biased estimate of scale economies; concludes costs are not separable due to vertical economies	Only addresses effect of generation costs on transmission/ distribution and not reverse
Roberts (1986)[128]	65 U.S. electric-only utilities, no holding company units, 1978	Estimates translog cost function for distribution to examine effects of territory size and density, tests for separability of distribution from generation and transmission	Coefficient restrictions implied by separability of distribution and generation/transmission costs are rejected (author notes this in passing since study was intended to estimate effects of service area density)	Article primarily about effects of territorial size and customer density on distribution cost; does not contain information for numerical estimate of integration effect
Eftekhari (1989)[129]	61 U.S. non-nuclear utilities, 1986	Estimates multioutput translog cost function with labor, capital, fuel inputs	Finds very few economies of scale but substantial diseconomies of joint production; concludes that smaller, vertically deintegrated utilities would be more efficient	Variables said to measure output include number of ultimate customers, fraction of generated power they buy, and statistically unreliable measure of interchange
Kaserman & Mayo (1991)[130]	74 U.S. electric-only utilities, vertically integrated, 1981	Estimates quadratic multiproduct cost function that allows tests of economies of scope between generation and transmission/ distribution	Finds 12 % cost savings from vertical integration for average-sized utilities; extremely small utilities are the only ones not to benefit from it.	Estimates of scope economies require use of a sample containing distribution-only utilities
Gilsdorf (1995)[131]	72 U.S. vertically integrated utilities, 1985	Estimates translog cost function for generation and transmission/ distribution [combined], with fuel, capital, and labor costs, also customer density, capacity utilization, and percent of sales to ultimate customers	Performs Evans-Heckman subadditivity test for those utilities whose location on estimated function has normal economic properties [20 were excluded]; fails to reject null hypothesis of additivity for any utilities; also finds stage-specific economies of scale	Author notes that failure to pass subadditivity test need not support a divestiture policy, since there may be economies of scope between stages without subadditivity

Continued on next page

Summary of Vertical Integration Studies (*Continued*)

Author (date)	Sample and Data Year	Method	Findings	Comments
Lee (1995)[132]	70 U.S. "electric utility firms," 1990	Estimates translog production functions for generation, transmission, distribution; also estimates final output as function of all variables	Tests for complete separability of generation, transmission, and distribution, and for separability of generation and distribution alone; all null hypotheses of no separability rejected	Also estimates efficiency losses from various forms of deintegration between 4.1 and 18.6 percent
Hayashi et al. (1997)[133]	50 U.S. electric utilities, annual data 1983–1987	Estimates translog cost functions for generation and transmission/ distribution, and for total	Rejects null hypothesis of cost separability; also finds that both large and small firms operate in range of scale economies in generation	Estimates economies of vertical integration for firms ranging from 9.2 percent to 24.2 percent
Thompson (1997)[134]	83–85 U.S. "all major investor-owned utilities" 1977, 1982, 1987, 1992	Estimates translog cost function with input prices and number of customers, territory size, and sales at different voltages	Rejects separability of either distribution or power supply from remaining utility services over entire time period	Finds that in later years the difference between unrestricted and restricted estimates is smaller but remains significant
Goto & Nemoto (1999)[135]	9 Japanese vertically integrated electric utilities, annual data 1980–1997	Estimates shadow cost and input demands from Symmetric Generalized McFadden (SGM) function, inputs include purchased power; tests for effect of generation capital on transmission/distribution costs and estimates allocative distortions	Finds that generation enters transmission/distribution cost function positively in unintegrated case; concludes that unintegrated costs are higher because of overinvestment in generation relative to integrated firms	Method also allows estimation of allocative distortions in input mix; finds that average percentage that costs could be reduced over sample period ranges from 0.13 % to 2.97 % for individual utilities
Kwoka (2002)[136]	147 U.S. corporate utilities, some unintegrated, 1989	Estimates quadratic cost function in generation and distribution to test for economies of scope	Negative interaction term between generation and distribution cost is evidence of complementarity; comparison with standalone costs indicates that only very small utilities show diseconomies of vertical integration	Concludes that most utilities have chosen to operate where they can best realize these economies, with generation close to but less than distribution output
Nemoto & Goto (2004)[137]	9 vertically integrated Japanese utilities, annual data 1980–1999	Estimates SGM for variable and fixed costs on assumption that capital is incompletely adjusted to optimum	Compares variable costs for integrated and standalone production of stages; finds average economies of integration over period for individual companies range from 4.5 % to 13.9 %	Authors note questions about their additive allocation of capital between stages, state need to verify that observed cost structures are sufficient for natural monopoly

Notes

1. The traditional topics of efficient input choice, profitable output choice, and optimal competitive strategy are now subsumed in a more general theory of economic organizations. A contemporary textbook that follows this approach is James A. Brickley, Clifford Smith Jr., and Jerold Zimmerman, *Managerial Economics and Organizational Architecture*, 3d ed. (New York: McGraw-Hill Irwin, 2002).

2. Demand is managed centrally and automatically by relays that cut off (black out) customers in defined geographic areas when imbalances between supply and demand occur that cannot be remedied from backup generation.

3. See, e.g., 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. Regarding other nations, deintegration is sometimes posited as an explanation for the fall in power costs after the formation of the United Kingdom's markets; see, for instance, Roger Sant and Roger Naill, "Let's Make Electricity Generation More Competitive," *Electricity Journal* 7 (October 1994): 49–72. Shortly after the UK market was organized, real fuel prices decreased by 20 percent (coal) and 45 percent (gas) while labor productivity doubled. Increases in productivity are more likely a consequence of privatization than of deintegration. David Newbery, "Privatisation and Liberalisation of Network Utilities, *European Economic Review* 41 (1997): 374.

5. RTOs have superseded ISOs in FERC's terminology. Although their legal definitions differ, the text uses them interchangeably.

6. Oliver Williamson, "The Vertical Integration of Production: Market Failure Considerations," *American Economic Review* 61 (May 1971): 112–23; and Brickley, Smith, and Zimmerman, p. 531.

7. Small on-site "distributed generation," however, can be scheduled by its users under certain conditions.

8. John Landon, "Theories of Vertical Integration and Their Application to the Electric Utility Industry," *Antitrust Bulletin* 28 (Spring 1983): 101–30. For application of transaction-cost economics to the restructuring of other energy industries (and also electricity), see Samuel Van Vactor, *Flipping the Switch: The Transformation of Energy Markets* (Ph.D. Dissertation, University of Cambridge, 2004).

9. 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.

10. In the United States, the lines on the two sides of the interface between a large transmission-owning utility and a small municipal distribution utility are separately owned. Power deliveries are usually under an all-requirements contract. If the municipal system owns generation elsewhere, the transmission operator integrates its output into the regional system and accounts for it in the price of deliveries to the city. The contracts governing this relationship limit the options of both parties with effects similar to those of vertical integration.

11. U.S. Federal Energy Regulatory Commission (FERC), "Minutes of Technical Conference on Public Utilities' Acquisition and Disposition of Merchant Generating Assets," Docket No. PL04-9-000, June 10, 2004, p. 5, available in eLibrary at www.ferc.gov.

12. LMP is a computer algorithm that assigns prices to locations on the grid that correspond to differences in the marginal cost of producing power at those locations. If at point A the cost is 5 cents per kilowatt-hour and at B it is 11 cents, then the implied value of additional transmission capacity between them is 6 cents. If production capacity were available and transmission were unconstrained, then B would get all of its power from the cheaper plant at A and save 6 cents on every kWh delivered. The 6-cent difference in their LMPs is the value per kWh of increasing the capacity of that link. There are financial instruments known as firm transmission rights (FTR) or congestion revenue rights (CRR) that allow their holders to hedge against unpredictable changes in LMP as system conditions change.

13. The key case is *Brown Shoe Co. v. U.S.*, 310 U.S. 294 (1962). There the Supreme Court held that a shoe manufacturer's attempt to purchase a chain of retail stores was an attempt to use its market power in manufacturing to monopolize retailing.

14. Richard Posner, *Antitrust Law: An Economic Perspective* (Chicago: University of Chicago Press, 1976), pp. 147–211.

15. 410 U.S. 366. It appears that the Court disregarded numerous facts that might have led it to a different decision. See Andrew Kleit and Robert Michaels, "Antitrust, Regulation, and Rent-Seeking: The Past and Future of *Otter Tail*," *Antitrust Bulletin* 39 (Fall 1994): 689–725.

16. Edward Berlin, Charles Cicchetti, and William Gillen, "Restructuring the Electric Power Industry,"

in *Electric Power Reform: The Alternatives for Michigan*, ed. William H. Shaker and Wilbert Steffy (Ann Arbor: University of Michigan, Institute of Science and Technology, 1976), pp. 231–35; Matthew Cohen, "Efficiency and Competition in the Electric-Power Industry," *Yale Law Journal* 88 (1979): 1511–49; Philip Fanara Jr., James Suelflow, and Roman Draba, "Energy and Competition: The Saga of Electric Power," *Antitrust Bulletin* 25 (Spring 1980): 125–42; John Landon and David Huettner, "Restructuring the Electric Utility Industry: A Modest Proposal," in *Electric Power Reform: the Alternatives for Michigan*, pp. 217–30; James Meeks, "Concentration in the Electric Power Industry: The Impact of Antitrust Policy," *Columbia Law Review* 72, no. 1 (1972): 64–130; Richard Pierce, "A Proposal to Deregulate the Market for Bulk Power," *Virginia Law Review* 72 (October 1986): 1183–1235; and Weiss.

17. There are, however, opportunities for cities to take advantage of certain legal provisions. Municipal debt in the United States is largely tax-exempt, and municipal utilities have priority over corporate utilities in the allocation of inexpensive power from federal dams. The latter fact motivated the requests for transmission service from Otter Tail. Municipal utilities do not pay taxes, but most of them contribute fractions of their gross revenue (usually 10 percent or less) to city budgets and provide local government with free power. Partisans and opponents of public power differ over whether these contributions are larger or smaller than the taxes that a corporate utility would pay.

18. Economies of scale in coal-fired plants were near their highest point, nuclear facilities were still feasible, hydroelectric sites were becoming scarce, and natural gas was in shortage because of price controls. The technologies and laws that allowed independent power production to thrive were not operative at the time of most of these writings.

19. Cohen, p. 1524. His footnoted references are to Meeks, who also provided no useful sources; Weiss, who acknowledged that studies were needed; and prepared testimony by an economist, who still testifies today on behalf of municipal utilities at FERC.

20. Meeks, p. 82. His evidence was to note the existence of power contracts between utilities and between utilities and the federal government.

21. In the United States, a utility's vertical integration can be quantified as its degree of self-sufficiency in generation. Some companies own generation in excess of their own loads, others are purchasing some power at all times, and still others are the operating units of holding companies that control several utilities. There are a few unintegrated utilities that generate only for wholesale sales or distribute only purchased power. Several of the researchers exclude the unintegrated systems from their data sets. Some of the samples treat a holding company as a single observation, while others include each of their operating companies. This paper does not discuss some other forms of integration examined by economists. They include cost comparisons between utilities that sell only electricity and those that sell electricity and gas. See John Mayo, "Multiproduct Monopoly, Regulation and Firm Costs," *Southern Economic Journal* 51 (July 1984): 208–18; and Raymond Hartman, "The Efficiency Effects of Electric Utility Mergers: Lessons from Statistical Cost Analysis," *Energy Law Journal* 17, no. 2 (1996): 425–57. This paper also does not discuss estimates of economies of scope due to serving several types of customer. See Douglas Gegax and Kenneth Nowotny, "Competition and the Electric Utility Industry: An Evaluation," *Yale Journal on Regulation* 10 (Winter 1993): 63–87.

22. This is the case in the United States. The authors of the Japanese studies do not comment on the consistency or accuracy of their data, which may mean that they, too, have few such problems.

23. One remaining study is not directly comparable to those on the Appendix. Economist Faye Steiner uses 1986–96 annual data from 19 OECD countries to examine the effects of restructurings. She attempts to explain variation in capacity utilization, deviations of actual from optimal (assumed 15 percent) reserve margins, prices to industrial users, and the ratio of industrial to residential prices, using random effects regressions that include measures of restructuring and privatization. Vertical deintegration is associated with significantly higher rates of generator capacity utilization and smaller deviations of actual from ideal reserves, as is her measure of privatization. She finds that prices to industrial users are not significantly associated with vertical deintegration, but the ratio of industrial to residential price is significantly lower in nations that have unbundled generation and transmission or that have a power pool. Results like these are almost surely sensitive to regression specification, particularly with international data. Her only published results, however, are summaries of single regressions for each of the four performance measures. Faye Steiner, "Regulation, Industry Structure and Performance in the Electricity Supply Industry," OECD Economics Department Working Papers no. 238, April 2000.

24. That study, by economist Hossein Eftekhari,

defines some variables in unorthodox ways. His measure of interconnection activities includes the algebraic sum of interchanges into and out of a utility's territory, which could be zero for a large trader. One of his output variables is sales to ultimate customers as a fraction of total sales, rather than an amount. In any case, his estimated cost function carries the implication that utilities should always either specialize completely in retail sales or in sales of power to other systems, rather than any mix of the two. Hossein Eftekhari, "Vertical Integration and Power Generation in the United States," *Journal of Economics* 15, no. 1 (1989): 25–31.

25. The author found that there was no cost complementarity to be found in vertical integration. "Cost complementarity" means that the marginal cost of producing one good decreases when output of the other is increased. Keith Gilsdorf's findings of no cost complementarity are still potentially consistent with economies of scope and economies of vertical integration, and his estimates show unexploited returns to scale in generation, transmission, and distribution. Keith Gilsdorf, "Vertical Integration Efficiencies and Electric Utilities: A Cost Complementarity Perspective," *Quarterly Review of Economics and Finance* 34 (Fall 1994): 261–82; and Keith Gilsdorf, "Testing for Subadditivity of Vertically Integrated Electric Utilities," *Southern Economic Journal* 62 (July 1995): 126–39.

26. All of the studies use variants of two basic strategies to estimate vertical economies. The first is to estimate a cost function (usually translog, otherwise quadratic) on the assumption that the output of each stage (generation, transmission, and distribution) is from a multiproduct firm. The sizes and signs of the coefficients of their interaction terms then provide evidence on economies of vertical integration. Some formulations allow tests for economies of scope (i.e., whether the sum of costs of standalone firms producing each of the stages exceeds the cost of final output in an integrated firm) and invariably find them. The second strategy estimates cost or production functions for each stage and then tests for vertical separability by examining whether output of an earlier stage significantly lowers the costs of a later one. If it does, vertical effects are present and the production process is not separable. It is possible but not likely that these results are tainted by selectivity bias. Perhaps integrated utilities have been formed by merger or are tolerated by regulators because of higher efficiency, as suggested in Michael Pollitt, *Ownership and Performance in Electric Utilities* (Oxford: Oxford University Press, 1995), p. 33. The implication is that these estimates should include unobserved characteristics of individual firms that lead some of them to vertically integrate and others not to. Most if not all U.S. utilities have been vertically integrated since their formation, instead of being created by mergers of generation and distribution operators.

27. In addition to the works discussed below, one study details the range of data on utility operations required to optimize and evaluate a demand-management program and makes clear that a vertically integrated utility minimizes difficulties in obtaining and analyzing those data. See Ren Orans, Chi-Keung Woo, and Brian Horii, "Case Study: Targeting Demand-Side Management for Electricity Transmission and Distribution Benefits," *Managerial and Decision Economics* 15 (1994): 169–75.

28. Paul Joskow, "Vertical Integration and Long-Term Contracts: The Case of Coal-Burning Electric Generating Plants," *Journal of Law, Economics, and Organization* 1 (Spring 1985): 33–80.

29. Ibid., p. 51; and Paul Joskow, "Contract Duration and Relationship-Specific Investments: Evidence from Coal Markets," *American Economic Review* 77 (March 1987): 172. Most generators in the eastern United States operate with pollution control technologies that allow them to burn coal with a range of sulfur content. Those in the West are more often engineered to use low-sulfur coal from a particular mine.

30. Joskow "Vertical Integration and Long-Term Contracts," p. 65.

31. Ibid., p. 54.

32. Keith Crocker and Scott Masten, "Regulation and Administered Contracts Revisited: Lessons of Transaction-Cost Economics for Public Utility Regulation," *Journal of Regulatory Economics*, January 1996, pp. 5–39, citing Joskow, "Contract Duration and Relationship-Specific Investments."

33. John Filer, "Impact of Regulation on Vertical Integration in the Electric Industry," *Review of Industrial Organization* 1 (Fall 1984): 219.

34. John Gonzales, "Efficiency Aspects of Electric Utility Coal Operations," *Energy Economics* 4 (April 1982): 131. He also finds that productivity is lower when a regulated mine operates under a cost-plus contract with the buyer. He cautions readers that his findings do not by themselves make a case for deintegration, since he has not studied the possible benefits of integrated mines.

35. Joe Kerkvliet, "Efficiency and Vertical Integration: The Case of Mine-Mouth Electric Generating Plants," *Journal of Industrial Economics* 39 (September 1991): 467–82.

36. Paul Joskow and Richard Schmalensee, "The

Performance of Coal-Burning Electric Generating Units in the United States: 1960–1980," *Journal of Applied Econometrics* 2 (April 1987): 85–109.

37. Eric Hirst, *U.S. Transmission Capacity: Present Status and Future Prospects*, Report prepared for Edison Electric Institute, Washington, 2004, http://www.ehirst.com/PDF/TransmissionCapacityFinal.pdf; and North American Electric Reliability Council (NERC), *Reliability Assessment*, 1998, p. 7, http://www.nerc.com/~filez/rasreports.html. By most measures, a construction boom in the 1960s and 1970s allowed the industry to enter the 1980s with significant unused transmission capacity. By the early 1990s most of that capacity was in use, thanks to the growth in industry size and the growth of wholesale markets that began in the 1980s. There was, however, no increase in new investments during the 1990s. Since 2003 transmission investment has increased in most parts of the country.

38. NERC is the coordinating agency for 10 regional electric reliability councils that cover most of the continent. Members of those councils include corporate utilities, independent power producers, governmental utilities, and cooperatives. NERC, *Reliability Assessment*, 1997, p. 3, http://www.nerc.com/~filez/rasreports.html.

39. NERC, *Reliability Assessment*, 1998, p. 38.

40. Ibid., p. 7.

41. The current TLR procedures have been in place since 1997. There are five different levels of emergency. The figures in the text refer to the three most serious ones, whose growth rates have all been high. A graph and source data are available at ftp://www.nerc.com/pub/sys/all_updl/oc/scs/logs/trends.htm.

42. NERC, *Reliability Assessment*, 2001, p. 25, http://www.nerc.com/~filez/rasreports.html.

43. Diana Moss, "Competition or Reliability in Electricity? What the Coming Policy Shift Means for Restructuring," *Electricity Journal* 17 (March 2004): 25. A small number of transmission-owning utilities have been responsible for a large percentage of TLR incidents. This, however, can reflect either the weakness of their grids or their abundant opportunities to exercise market power.

44. Ibid., p. 17.

45. NERC, *Reliability Assessment*, 2001, p. 25.

46. Participant funding is also embodied in recently issued rules for generator interconnections. See Standardization of Generator Interconnection Procedures and Agreements, 106 FERC & 61,220, 2004.

47. Cleco Power LLC et al., Order Granting Petition for Declaratory Order, Docket No. EL02-101-000, October 10, 2002. SEtrans withdrew its application in 2003 because of conflicting demands of state regulators and FERC.

48. Bruce Edelston, director of policy and planning, Southern Company, quoted in Bruce Radford, "The Laws of Physics," *Public Utilities Fortnightly*, April 4, 2003, pp. 22–23.

49. William Hogan, "Transmission Market Design," Presentation graphics, April 4, 2003, http://ksghome.harvard.edu/~whogan/trans_mkt_design_040403.pdf.

50. A recent unpublished paper proposes use of a demand-revealing mechanism to circumvent free-rider problems. Robert Michaels, "The Economics of Participant-Funded Electrical Transmission," Paper presented at Rutgers University 14th Annual Advanced Workshop on Regulation, San Diego, June 2004, http://www.business.fullerton.edu/economics/rmichaels/workingPapers/040920%20pf.pdf.

51. California Public Utilities Commission (CPUC), "Order Instituting Rulemaking on the Commission's Proposed Policies Governing Restructuring California's Electric Services Industry and Reforming Regulation," R.94-04-031, April 20, 1994 (unavailable on Internet). This document came to be known as the "Blue Book," from the color of its cover.

52. In 2002 the CPUC decided to remove all of these testimonies and the Blue Book itself from its website for reasons that it has not made public. They are still accessible, however, at the commission's offices.

53. FERC ratified the California experiment by approving market-based rates in California through 1997 and beyond. FERC had to act to enable the California experiment to go forward because the agency has the statutory obligation to regulate "just and reasonable" rates in wholesale transactions. Prior to the coming of markets, this required comparisons of proposed prices and production costs. In the 1980s FERC began allowing rates to be set by market prices in areas where suppliers were unconcentrated enough (according to criteria set by the commission) that competitive conditions would neutralize any market power one of them might try to exert. In the months after the California filings, FERC began to process applications to form exchanges in other parts of the country, particularly the Northeast.

54. William Shepherd, "Reviving Regulation and Antitrust," *Electricity Journal* 7 (June 1994): 23. He did not cite any of the research discussed above but warned that existing utilities would claim that vertical separation "will cause large inefficiencies, even when those claims are false."

55. Richard Pierce, "The Advantages of De-integrating the Electricity Industry," *Electricity Journal* 7 (November 1994): 16–21. His earlier writings (Pierce, "A Proposal to Deregulate") did describe the possible benefits of vertical integration but asserted without evidence that deintegration would be worth this cost.

56. For instance, environmental economists David Moskovitz and Douglas Foy proposed to solve the stranded cost problem with a deintegration that included a sale of transmission at premium prices to pay off the stranded costs. David Moskovitz and Douglas Foy, "Looking for Peace in the Middle of a Nervous Breakdown," *Electricity Journal* 7 (November 1994): 22–33. Blank, Gilliam, and Wellinghoff likewise suggested vertical deintegration of corporate utilities and the founding of a nonprofit transmission company in order to pay the utilities' stranded costs and obtain tax advantages. Eric Blank, Rick Gilliam, and John Wellinghoff, "Breaking Up Is Not So Hard to Do: A Disaggregation Proposal," *Electricity Journal* 9 (May 1996): 46–55.

57. See Weiss.

58. Sant and Naill, p. 51. The probable source of the 15 percent figure is Naill and Dudley, whose itemization of savings yields a range of estimates between 5 and 15 percent. Roger Naill and William Dudley, "IPP Leveraged Financing: Unfair Advantage," *Public Utilities Fortnightly*, January 15, 1992, pp. 15–20.

59. Irwin Stelzer, "Vertically Integrated Utilities: The Regulators' Poisoned Chalice," *Electricity Journal* 10 (April 1997): 20–29.

60. Carl Blumstein and James Bushnell, "A Guide to the Blue Book: Issues in California's Electric Industry Restructuring and Reform," *Electricity Journal* 7 (September 1994): 19. At the time of their writing, the concept of an ISO had not yet been developed.

61. Marja Ilic et al., "A Framework for Operations in the Competitive Open Access Environment," *Electricity Journal* 9 (April 1996): 61–69. Problems like those she describes complicated operations in the early years of the ISO and PX.

62. Gegax and Nowotny; and Lawrence Hill, "Is Policy Leading Analysis in Electricity Restructuring?" *Electricity Journal* 10 (July 1997): 50–61. The integration studies are also mentioned in a report by the Consumer Federation of America, a political advocacy group usually sympathetic to regulation. Consumer Federation of America, *All Pain, No Gain: Restructuring and Deregulation in the Interstate Electricity Market*, 2002, http://www.consumerfed.org/allpain.pdf.

63. Hill, p. 53. I have encountered no subsequent citations to this article.

64. CPUC, Decision D.95-12-063, December 20, 1995, p. 98, http://www.cpuc.ca.gov/static/industry/electric/electric+markets/historical+information. The units in question were gas-fired generators and under normal conditions would set price in the new markets. Ultimately these two utilities chose to sell all of their in-state gas-fired capacity to independent power producers.

65. CPUC, Decision D.95-12-063, pp. 10, 90.

66. One economist from a utility, however, commented, "The record in the CPUC case provided no evidence of a market power problem that needs to be resolved through divestiture." "CPUC Power Exchange Tops List of Latest State Restructuring Plans," *Inside FERC*, December 25, 1995, p. 1. A Southern California Edison vice-president wrote that requiring the divestiture of generation "reduces competition" because it removes a competitor from the market. (It also adds new competitors who buy the units.) Vikram Budhraja, "Policy Choices on the Road to a Competitive Electricity Market," *Electricity Journal* 9 (May 1996): 60.

67. Currently in California Public Utilities Code. The law is still commonly known as Assembly Bill (AB) 1890.

68. FERC, Order Conditionally Authorizing Limited Operation of an Independent System Operator and Power Exchange, Docket Nos. EC96-19-001 (Oct. 30, 1997); and "California's Three Major IOUs Submit Market Power Mitigation Strategies," *Foster Electric Report*, April 16, 1997, p. 8

69. The law allowed utilities to recover their stranded costs in the difference between frozen retail rates and market-determined wholesale energy costs prior to 2002. Most market power studies submitted to FERC were concerned with monopolistically high prices, but the law's provisions made utilities more interested in low market prices. Some intervenors did express concerns about monopsony (market power of a buyer) and predatory pricing. The law also required utilities to apply any premia between the sales prices and book values of divested plants to stranded costs.

70. The third-largest utility, San Diego Gas &

Electric, also divested its gas-fired plants as a condition imposed on its later merger with Southern California Gas to form Sempra Energy.

71. FERC utilizes critical values of the Herfindahl-Hirschman Index of supplier concentration, a standard tool of antitrust analysis equal to the sum of squares of the market shares of all competitors. In some models of oligopoly it predicts that increased concentration will lead to higher prices, but in others it does not. See Robert Michaels, "Market Power in Electric Utility Mergers: Access, Energy, and the Guidelines," *Energy Law Journal* 17, no. 2 (1996): 401–24.

72. For an overview of the crisis, see Jerry Taylor and Peter Van Doren, "The California Electricity Crisis: What's Going On, Who's to Blame, and What to Do?" Cato Institute Policy Analysis no. 406, July 3, 2001.

73. Timothy P. Duane, "Regulation's Rationale: Learning from the California Energy Crisis," *Yale Journal on Regulation* 19 (Summer 2002): 508. The CPUC documents he cites are no longer available on the Internet.

74. Frank Wolak, "Measuring Unilateral Market Power in Wholesale Electricity Markets: The California Electricity Market 1998–2000," *American Economic Review* 93 (May 2003a): 425–31; and Frank Wolak, "Diagnosing the California Electricity Crisis," *Electricity Journal* 16 (August 2003b): 11–37.

75. Frank Wolak, "An Empirical Analysis of the Impact of Hedge Contracts on Bidding Behavior in a Competitive Electricity Market," *International Economic Journal* 14 (Summer 2000): 1–39; and James Bushnell and Celeste Saravia, "An Empirical Assessment of the Competitiveness of the New England Electricity Market," University of California Energy Institute Working Paper CSEM-WP101, 2002, http://www.ucei.berkeley.edu/PDF/csemwp101.pdf. This argument contains an unstated assumption that makes it empirically questionable. It assumes that forward contracts are for some reason usually priced below the spot prices that will actually prevail in the future.

76. See Paul Joskow and Edward Kahn, "A Quantitative Analysis of Pricing Behavior in California's Wholesale Electricity Market during Summer 2000," *Energy Journal* 23, no. 4 (2002): 1–35; Severin Borenstein, James Bushnell, and Frank Wolak, "Measuring Market Inefficiencies in California's Restructured Wholesale Electricity Market," *American Economic Review* 92, no. 5 (December 2002): 1376–1405; and Ramteen Sioshansi and Shmuel Oren, "How Good Are Supply Function Equilibrium Models? An Empirical Analysis of the ERCOT Balancing Market," Working Paper, University of California Energy Institute, April 2006, http://www.ucei.berkeley.edu/PDF/EPE_017.pdf. For dissenting views, see Scott Harvey, William Hogan, and Todd Schatzki, "A Hazard Rate Analysis of Mirant's Generating Plant Outages in California," LECG LLC, Cambridge, MA, January 2, 2004, http://ksghome.harvard.edu/~whogan/Harvey_Hogan_Schatzki_Toulouse_010204.pdf; and Tim Brennan, "Questioning the Conventional Wisdom," *Regulation* 24, no. 3 (Fall 2001): 63–69.

77. FERC, "Minutes of Technical Conference," p. 5.

78. Figures are from testimony by Jone-Lin Wang of Cambridge Energy Research Associates at a FERC technical conference. FERC, "Minutes of Technical Conference," pp. 5–7.

79. See testimonies of Peter Esposito and Diana Moss (antitrust concerns) and Christine Tezak (few antitrust concerns) in FERC, "Minutes of Technical Conference."

80. "California's Electric Utilities File 20-Year Plans with CPUC," *Foster Electric Report*, April 23, 2003, p. 10.

81. Richard Stavros, "Last Big Battle for State Regulators? California Again Is the Proving Ground," *Public Utilities Fortnightly*, October 15, 1999, p. 34.

82. James Bushnell and Catherine Wolfram, "Ownership Change, Incentives and Plant Efficiency," Center for Study of Energy Markets Working Paper 140, March 2005.

83. Magali Delmas and Yesim Tokat, "Deregulation Process, Governance Structures and Efficiency: The U.S. Electric Utility Sector," University of California Energy Institute, Energy Policy and Economics 004, March 2003.

84. Erin Mansur, "Vertical Integration in Restructured Electricity Markets: Measuring Market Efficiency and Firm Conduct," Yale School of Management, Working Paper Series ES, no. 32, 2003, p. 36. He also notes: "These results do not imply that divesting powerplants was a poor decision. However, it does caution regulators that, if they do require divestiture, then they also enable firms to sign contracts that will limit incentives to distort the market."

85. Newbery, p. 6. The British contracts ran for three years. He also makes the interesting point that although many electricity industries have been restructured successfully, they all started with substantial spare capacity (p. 10). California began with enough excess capacity that for its

first two years many generators could not cover their full costs at market prices. A rare constellation of events destroyed that excess more quickly than the state's utilities expected it would.

86. John Rowe, Janet Szczypinski, and Peter Thornton, "Competition without Chaos," AEI-Brookings Joint Center for Regulatory Studies Working Paper no. 01-07, June 2001, http://ssrn.com/abstract=286415. Rowe's Chicago utility divested its fossil and nuclear plants, while the Philadelphia company divested only nuclear. Along these lines, Green and Newbery supported deintegration for large British suppliers but not for small utilities in Scotland. Richard Green and David M. Newbery, "Competition in the Electricity Industry in England and Wales," *Oxford Review of Economic Policy* 13, no. 1 (1997): 27–46. As in California, retail rates in Pennsylvania were capped.

87. That utility, GPU, encountered financial problems when wholesale rates rose and customers in its area began abandoning direct access to return to its capped retail rates. State regulators refused to grant the company relief, saying that GPU should live with the consequences of divestiture and refusal to hedge. "To Avoid California Experience, GPU Wants to Collect over Rate Caps," *Electric Utility Week*, January 22, 2001, p. 16.

88. "New York Rebuts Idea of Bad Summer," *Power Markets Week*, January 29, 2001, p. 16.

89. Lynne Kiesling, "Getting Electricity Deregulation Right: How Other States and Nations Have Avoided California's Mistakes," Reason Public Policy Institute Study no. 281, May, 2001, p. 23, http://www.rppi.org/ps281.pdf.

90. Jamie Read, "Re-Verticalizing Electricity," Presentation graphics to Harvard Electricity Policy Group, June 4, 2004, http://www.ksg.harvard.edu/hepg/Papers/Read.Reverticalizing.Electricity.060404.pdf.

91. Read also suggests that a utility could auction the right to serve its residual load to an independent organization.

92. Experts initially viewed the breakup of American Telephone and Telegraph as valuable to only a handful of large businesses with extensive telecommunications requirements. Within two years, new service providers were selling to individual residences.

93. Richard Rosen, "Can Electric Utility Restructuring Meet the Challenges It Has Created?" Tellus Institute, Boston, 2000, p. 32, http://www.tellus.org/energy/publications/restructchallenge.pdf. He also notes some potentially harmful externalities that have not yet been realized. For example, he questions whether the choice of new generation investments should be in the hands of parties who do not bear the risks of excessive reliance on natural gas.

94. Ibid., p. 112.

95. Kiesling, p. 23.

96. Robert Michaels, "The Governance of Transmission Operators," *Energy Law Journal* 20, no. 2 (1999): 233–62.

97. FERC, Order No. 888, FERC Statutes and Regulations & 31,036, 1996.

98. "FERC Wrestles with Implementation of Independent System Operators," *Electric Utility Week*, January 29, 1996, p. 7. State regulators would not appear on boards, but many other interests would. The trade press (a transcript of the conference is unavailable) does not discuss the reasoning behind Joskow's choice of a nonprofit.

99. "Most Industry Participants Voice Strong Support for ISOs," *Foster Electric Report*, February 7, 1996, p. 12.

100. CPUC, Decision D.95-12-063, December 20, 1995, http://www.cpuc.ca.gov/static/industry/electric/electric+markets/historical+information/d9512063/index.htm.

101. Ibid., p. 60.

102. "California's Three Major IOUs Submit Market Power Mitigation Strategies," *Foster Electric Report*, April 16, 1997, p. 8. Above the PX and ISO would be a newly created Electricity Oversight Board, whose jurisdictional conflicts with FERC were generally resolved in the latter's favor and which ceased to have many meaningful functions as the market crisis grew.

103. Della Valle gives a fuller discussion of the legal and financial issues in divestiture, as well as a taxonomy of the forms it might take. Anna Della Valle, "Separating Transmission from Generation: What's Required and Why," *Electricity Journal* 10 (March 1997): 83–90.

104. Dennis W. Carlton, Prepared statement on behalf of the Sacramento Municipal Utility District, FERC Dockets ER96-1663-000 et al., filed September 13, 1996. See also "FERC: Calif. Must Run vs. Market Power," *Electricity Daily*, September 13, 1996; and "Most California Utility-Owned Thermal Plants Deemed 'Must-Run' by ISO Board," *Electric Utility Week*, July 21, 1997, p. 11. Must-run units would be a continuing prob-

lem for the ISO, even after the utilities agreed on contracts to set the price of their power. In 1997 the ISO governing board classified 14,500 MW (one-third of the state's power supply) as must-run, a figure which has since fallen.

105. "Various Parties Protest the California IOU's ISO and Power Exchange Proposals," *Foster Electric Report*, June 26, 1996, p. 1.

106. "California PUC's Conlon Urges Transmission Sales, Not ISOs, as Market Power Cure," *Electric Utility Week*, July 28, 1997, p. 10. Note that California's political reality became FERC's preferred institutional form. FERC, however, probably does not have the power to order divestitures.

107. Enron Capital and Trade Resources, a marketer, sponsored testimony at the CPUC by Richard Tabors proposing a transmission-only entity. The research underlying that testimony appears in Chitru Fernando et al., "Unbundling the U.S. Electric Power Industry: A Blueprint for Change," Risk Management and Decision Processes Center Working Paper 95-03-05, Wharton School, University of Pennsylvania, 1995, http://www.tca-us.com/Publications/RUEI.pdf.

108. They include American Transmission Company in the Midwest, http://www.atcllc.com, and Trans-Elect, which operates regional systems in Michigan and Canada and is prime contractor for the expansion of Path 15 between northern and southern California, http://www.trans-elect.com.

109. ICF Consulting, *Economic Assessment of RTO Policy*, Report to FERC, February 26, 2002, p. 7, http://www.ferc.gov/industries/electric/indus-act/rto/cost/02-26-02-report.pdf. The assumed discount rate was 6.97 percent. Several other scenarios were posited, all of which provided annual benefits ranging from 0 to 3 percent.

110. Thomas Lenard, "FERC's Flawed Assessment of the Benefits and Costs of Regional Transmission Organizations," *Electricity Journal* 15 (May 2002): 74–78.

111. ICF Consulting, p. 79.

112. Margot Lutzenheiser, "Comparative Analysis of ISO/RTO Costs," Presentation graphics from American Public Power Association National Conference, June 21, 2004, pp. 3–4, available from author at www.ppcpdx.org. The total percentages were calculated from figures on a graph. Data are given for the per mWh costs, but these also include maintenance while the others are only "operating costs." In unpublished correspondence, PJM has argued that Lutzenhiser's figures are too high since they include extraordinary expenses in connection with expansion of membership that should not be included in operating costs.

113. Vito Stagliano, "The Life and Death of Regional Transmission Organizations," *Electricity Journal* 14 (December 2001): 23.

114. Michael Maloney, Robert McCormick, and Raymond Sauer, "Consumer Choice, Consumer Value: An Analysis of Retail Competition in America's Electric Industry," Citizens for a Sound Economy Foundation, 1997, http://www.cse.org.

115. U.S. Energy Information Administration, *Electricity Prices in a Competitive Environment: Marginal Cost Pricing of Generation Services and Financial Status of Electric Utilities, A Preliminary Analysis through 2015*, DOE/EIA-0614, 1997, p. ix, http://tonto.eia.doe.gov/FTPROOT/electricity/0614.pdf. The report estimated that prices could fall by as much as 24 percent under conditions of "*intense* competition" with sellers aggressively cutting prices.

116. One recent study has shown largely negative consequences of an RTO. It was prepared by ICF Consulting for the three corporate utilities that would be operating under the proposed GridFlorida operator. See *Cost-Benefit Study of the Proposed GridFlorida RTO*, December 12, 2005, http://www.icfconsulting.com/Markets/Energy/doc_files/gridflorida-rto-report.pdf.

117. John Clapp and Margaret McGrath, "Comparing Apples and Oranges: RTO Cost-Benefit Studies Are Difficult to Reconcile," *Public Utilities Fortnightly*, September 15, 2002, pp. 32–37.

118. Ellen Wolfe, "RTO West Benefit/Cost Study, Final Report Presented to RTO West Filing Utilities," Tabors Caramanis & Associates, 2002, p. vii. This report is also the only one of its kind that estimates the spillover benefits to other regions that will result from the changeover in RTO West's territory.

119. A summary of research on for-profit and nonprofit institutions appears in Henry Hansmann, *The Ownership of Enterprise* (Cambridge, MA: Harvard University Press, 1996). In one of many similar articles, lawyers Angle and Cannon assert in their text that for-profit institutions will watch costs more closely and be more innovative than nonprofits. The only authorities they cite are two FERC commissioners, neither of whom was an economist. Stephen Angle and George Cannon Jr., "Independent Transmission Companies: The For-Profit Alternative in Competitive Electric Markets," *Energy Law Journal* 19, no. 2 (1998): 229–79.

120. Michaels, "The Governance of Transmission Operators."

121. James Buchanan and Gordon Tullock, *The Calculus of Consent* (Ann Arbor: University of Michigan Press, 1965); William Riker, *The Theory of Political Coalitions* (New Haven, CT: Yale University Press, 1962); and Donald Saari, *The Geometry of Voting* (New York and Berlin: Springer-Verlag, 1994).

122. Michaels, "The Governance of Transmission Operators."

123. *California Independent System Operator v. FERC*, 372 F.3d 395 (2004)

124. Robert Michaels, "Watching the Watchers: Can RTO Market Monitors Really Be Independent?" *Public Utilities Fortnightly*, July 15, 2003, pp. 35–38.

125. In one of their reports the California PX's monitors went so far as to explain how utilities could modify their bidding strategies to improve their chances of success in lowering market prices.

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128. Mark Roberts, "Economies of Density and Size in the Production and Delivery of Electric Power," *Land Economics* 62 (November 1986): 378–86.

129. Hossein Eftekhari, "Vertical Integration and Power Generation in the United States," *Journal of Economics* 15, no. 1 (1989): 25–31.

130. David Kaserman and John Mayo, "The Measurement of Vertical Economies and the Efficient Structure of the Electric Utility Industry," *Journal of Industrial Economics* 39 (September 1991): 483–502.

131. Keith Gilsdorf, "Testing for Subadditivity of Vertically Integrated Electric Utilities," *Southern Economic Journal* 62 (July 1995): 126–39.

132. Byung-Joo Lee, "Separability Test for the Electricity Supply Industry," *Journal of Applied Econometrics* 10 (January–March 1995): 49–60.

133. Paul Hayashi et al., "Vertical Economies: The Case of the U.S. Electric Industry, 1983–87," *Southern Economic Journal* 63 (January 1997): 710–25.

134. Herbert Thompson Jr., "Cost Efficiency in Power Procurement and Delivery Service in the Electric Utility Industry," *Land Economics* 73, no. 3 (1997): 287–301.

135. Mika Goto and Jiro Nemoto, "Analysis of Cost Structure by Multi-Product Symmetric Generalized McFadden Cost Function: Economies of Vertical Integration of Japanese Electric Power Companies," (in Japanese) *Denryoku Keizai Kenkyu (Electricity Economic Studies)* 42 (1999): 1–13.

136. John Kwoka, "Vertical Economies in Electric Power: Evidence on Integration and Its Alternatives," *International Journal of Industrial Organization* 20 (2002): 653–71.

137. Jiro Nemoto and Mika Goto, "Technological Externalities and Economies of Vertical Integration in the Electric Utility Industry," *International Journal of Industrial Organization* 22 (2004): 676–81.

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