Privatization and reform of the electricity industry: How Mexico can learn from the mistakes of others[1]

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Countries around the world have been reforming their electricity supply industries over the last two decades. The pervasiveness of the reforms suggests that they have resulted from fundamental changes that are affecting all countries alike. Technological change in the industry is a primary candidate.

Mexico has now also begun to respond to these new challenges and opportunities. The Mexican industry has more in common with the pre-reform industry in the UK or Australia than it does with the US. Most of the Mexican industry is under the control of the Comisión Federal de Electricidad (CFE), which is a vertically integrated firm controlling most of the generation, transmission and distribution of electricity in the country. The smaller Luz y Fuerza (LyF) is also government owned. It distributes electricity in the metropolitan Mexico City area, supplying less than 20% of total demand and producing a little over 1% of total electricity output. In addition, while the CFE has recently turned to private firms to provide needed investments in generating and transmission infrastructure, the CFE effectively retains control of these assets and continues to operate the supply system as a vertically integrated monopolist.

In other countries where the electricity industry was formerly a government owned, vertically integrated, monopoly the reforms have generally involved splitting the industry into separate generating, transmission and distribution sectors. The transmission system often remains a government-owned common carrier, or is kept under extensive regulatory control as a natural monopoly. Similarly, while many countries have privatized the distribution sector and introduced some competition between retailers, retail tariffs and other matters such as safety, reliability and customer service have remained under regulatory oversight specific to the electricity industry. By contrast, the generation sector has generally been restructured to increase competition and replace regulation and government ownership by market processes. The most successful of these reforms have maximized competition by establishing each generating station as a separate firm.[2] Competitive wholesale markets determine the spot price of electricity on an almost continuous basis, although firms can enter into long term forward contracts to

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[1] This is a companion paper to "Electricity Demand and Supply in Mexico," which is also included in this volume. That paper, jointly written with Eduardo Martinez-Chombo, presents a model of the Mexican electricity supply system. Readers are urged to consult that paper for further information about the Mexican industry and for detailed supporting arguments for some of the assertions made in this paper.

[2] See Green and Newberry (1992) for an early discussion of the problems created by establishing a market in the UK that was characterized by inadequate competition.

reduce risks. Formal futures and options markets have also developed in these environments as another way to share risks and to have some of them borne by speculators, energy trading companies, investment banks or other parties not formerly engaged in electricity trade.

The current government in Mexico has decided as a matter of policy to retain CFE and LyF under government ownership. The question we consider in this paper is whether the political constraint on privatization precludes the possibility of introducing any worthwhile reforms to the Mexican electricity supply industry.

New Zealand might provide a model for what could be done. In the early 1980s, a reformist Labor Party was in government in New Zealand. This government was committed to reform across a wide range of areas including reduced protectionism, reform of monetary and fiscal policy, increased competition in industry and changes to the structure and function of many government departments. Despite opposition from elements within the then governing Labor Party, some formerly government owned industries, including local electricity distributors, were privatized. However, the government retained ownership of the generation and transmission assets of the New Zealand electricity supply industry. A new type of enterprise, a "corporatized entity," was introduced in 1987 in an attempt to capture the benefits of reforming the electricity supply industry without relinquishing government ownership.

In order to assess whether corporatization can deliver the benefits of reform while preserving public ownership, we need to examine the goals of reform. We also need to understand why public ownership was so widespread in the electricity industry, and why the reforms have so often been accompanied by privatization.

Corporatization is not the only reform option available to Mexico. Many countries have retained public ownership of existing electricity generating firms while allowing private firms to invest in new assets under a number of different institutional arrangements.

The least radical option involves contracting out the construction of new projects to private firms. The newly completed plant is then turned over to the publicly owned firm to operate, perhaps immediately upon completion under a "turnkey" project or following a lease period under a "build, lease and transfer" (BLT) contract. This arrangement allows the publicly owned firm to reap benefits from more efficient plant construction, or new technologies that they might not otherwise know about. It does not offer, however, any benefits in terms of reducing operating costs or changing the method of determining prices.

Under some independent power producer (IPP) contracts, a private firm is allowed not only to build new plant but also to operate it for a period before the publicly owned firm takes control of plant operations. Such a new firm typically enters a market where a government owned generator is its major competitor for selling electricity. The distribution subsidiary of the incumbent firm is also often the major or sole buyer of the entrant's output. The transmission subsidiary of the incumbent firm is also often the

supplier of an essential facility, the transmission network, for delivering output from the entrant to its customers. Finally, the government owned incumbent also often obtains preferential treatment from the regulators even if it is not itself responsible for critical regulatory functions in the industry. Such a lopsided competitive framework usually means that a private firm is unwilling to enter the market unless it receives firm contractual guarantees for the purchase of its output from the government. These contractual arrangements often limit the gains from private entry into the industry.

We conclude that market reforms in the absence of extensive competition among many private firms could produce a worse outcome than current arrangements. Corporatization and IPP or BLT schemes are poor substitutes for a genuine market. Furthermore, the current arrangement for supplying electricity in Mexico is more amenable to through-going reform than would be an alternative structure with private firms operating under long-term contractual agreements with the government. Thus, introducing partial reform over the next few years may be a mistake if a genuine reform of the industry may become practical in five to ten years time. Weak reforms can also discredit the reform process, raising political barriers to the future reforms that will be required to clean up the mess.

What makes electricity supply different?

Almost from its beginnings, the electricity supply industry has been treated differently to many other industries. Around the world, government owned firms have dominated the industry. Even in the few countries where private firms have predominated, such as the US, the industry has been heavily regulated.

Electricity supply is often categorized along with telecommunications, water and sewerage services, natural gas pipelines and perhaps transportation services as a "utility industry." Together with some of these same industries, electricity supply is also often referred to as being part of the "infrastructure" of the economy. We need to understand in what ways the special treatment of electricity supply is related to its status as a utility or infrastructure industry.

In the closing decades of the twentieth century, the electricity industry underwent extensive reform. These reforms typically involved a move away from government ownership and regulatory control toward a greater reliance on market processes. Electricity supply began to be treated more symmetrically to many other industries. The pervasiveness of the reform process suggests that fundamental changes had taken place. In order to understand the objectives of reform, we need to understand the source of change in the industry.

Public ownership and monopoly

One of the justifications given for the special treatment of the electricity supply industry, and for many other utility industries, is that electricity supply is a "natural monopoly." The idea behind such a designation is that economies of scale are said to be so pervasive that the average costs of supply decline continuously as output increases. Such a situation

would have two important implications. First, the marginal cost of supply (the cost of production one more unit of output) would be below the average cost of producing all units of current output. If competition drives firms to price at marginal cost, the revenue raised would not be sufficient to cover the costs of production. Second, economies of scale imply that the largest firm in a market would have the lowest costs of production and thus could undercut all other firms and drive them out of business. The industry will tend to evolve toward a monopoly supplier.

A major problem with this argument in the case of electricity supply is that it does not appear to describe the actual shape of the cost curve for electricity generation.[3] As industry output expands, the marginal output comes from generating plant with higher, not lower costs of production. Peaking plant typically uses premium fuel, such as natural gas. Even hydroelectric plant, which is used to supply peak power demands and would appear to use very low cost "fuel", actually has high costs. The water stored in a dam can be used to generate electricity at any time. The implicit "shadow value" of the water is the benefit of using it to generate electricity when the cost of an alternative source of supply is at its greatest.

The high operating cost of peaking plant is compensated by its low capital cost. Conversely, base load plant typically has a high capital cost, but relatively low operating cost. Since it used for a long period of time, the saving in operating cost relative to peaking plant compensates for the higher up-front capital cost.

The fact that base load plant is added in large capacity increments suggests that there are some economies of scale in the investment process. If there were no economies of scale, new capacity would be added continuously as demand expanded or existing capacity depreciated. Yet the economies of scale are limited even for investment in base load plant. The capacity of new base load generating stations is not very different in large markets, such as the US, than it is in smaller markets, such as Mexico or Australia. Furthermore, the construction of electricity generating plant would not appear to be associated with any greater scale economies than the construction of other large industrial facilities such as oil refineries, chemical plants, steel mills, automobile plants and many others. These industries are not subjected to industry-specific regulation, and in most countries are dominated by competing private firms.

The critical factor differentiating electricity supply from other large manufacturing industries is that the high voltage grid that transports electricity from producers to consumers needs to be operated at all times as a single integrated system. The system operator needs to schedule generating plant to minimize the cost of supply while meeting constraints to keep voltage and frequency stabilized within acceptable bounds. Operation of the transmission network *is* a natural monopoly. On a longer time scale, a centralized process also is needed to vet additions to the network or expansions of

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[3] As the companion paper by Hartley and Martinez-Chombo (2002) shows, this is certainly the case for Mexico.

the capacity of existing links. Changes to one link in the network will affect flows throughout many of the remaining links and all of these changes may need to be considered when assessing the desirability of making any one change.

One could conceive of constructing an entirely new network that serves the same geographic area as an existing network but which is not inter-connected with that existing network. There would then be no need to co-ordinate planning or operation across the two networks. If the two networks serve the same general geographical area, however, duplication would be very expensive relative to the cost of simply expanding an existing network to supply additional customers.

Not only is a monopoly network desirable from the operational, planning and cost perspectives. As Figure 1 illustrates, the efficiency losses of having a profit-maximizing firm own the transmission network could be very high.

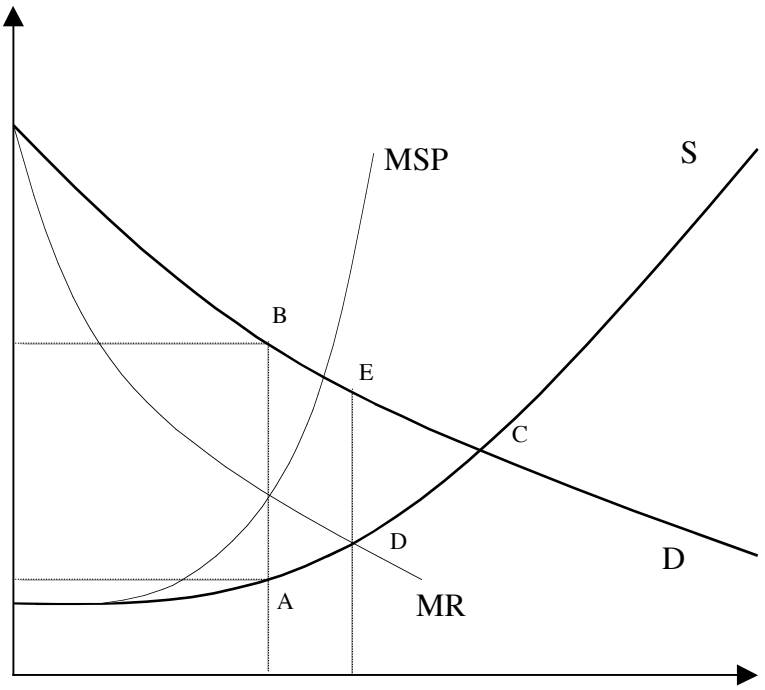

Figure 1: Efficiency cost of a profit-maximizing network owner

Suppose that a profit-maximizing network owner is a monopsonist buyer of electricity from the generating firms and a monopoly seller to the distributors or the final customers.[4] The network owner would take account of the fact that buying more electricity would raise the price that has to be paid to generators. This would provide an incentive to reduce the amount bought. In addition, when consumers are buying less, the

[4] The implicit assumption here is that there is only one link leaving the region with surplus power and one link delivering electricity to the region where demand exceeds supply. This is often the case in weakly connected networks such as the one in Mexico.

price they are willing to pay for the marginal supply will be higher. This provides an added incentive to restrict supply.

Specifically, the profit-maximizing network owner represented in Figure 1 would choose supply to equate marginal revenue from consumers (MR) to the marginal supply price from generators (MSP). The efficiency loss would be the triangular shaped area ABC. By contrast, if the network owner also owned the generating firms one of the inefficiencies would be eliminated. The combined firm would equate marginal revenue from consumers to the marginal cost of production. This would produce the smaller efficiency loss CDE. *Consumers* may prefer a vertically integrated monopoly supplier of electricity to a monopoly owner of the transmission grid alone *even though* the former would still result in efficiency losses.

The efficiency losses from private ownership of the transmission network create an *opportunity* for political action to yield net social benefits. They are not, however, sufficient to justify public ownership of the industry. One would need to show that public ownership can, in practice, realize the potential gains from eliminating private monopoly. As we shall argue later, publicly owned firms suffer from their own inefficiencies. In particular, while a profit-maximizing firm retains an incentive to minimize production costs, publicly owned firms typically incur costs far in excess of the minimum attainable. Nevertheless, the large potential efficiency losses associated with private ownership of a transmission network imply that the potential gains from alternative institutional arrangements are large.

Some countries, most notably the US, opted to supply electricity using regulated private monopolies that owned both the generation capacity and the regional transmission networks. Links between the regional networks were, until recent times, quite limited, which also limited the need for centralized coordination and control.[5] Integrating the generation and transmission functions eliminates the possible distortion from a network owner acting as a monopsonist buyer. The integrated firm retains an incentive, however, to act as a monopoly seller. A political process (such as the public utility commission hearings in the US) determines the price that the integrated firm can receive for its output, and hence also the amount of output that is demanded by consumers. The firm is then free to maximize profits within the constraints set by the political process. The method used to determine allowable price changes nevertheless can distort the firm's incentives. For example, the firm will have an incentive to over-invest if the regulated price depends positively on the capital investments made by the firm, It is arguable that a regulated private monopoly provided the best compromise between the abuses of monopoly and the inefficiencies of public ownership. It is, however, only feasible where industry participants can have confidence that the process that sets prices will be based on objective and predictable criteria and will be substantially independent of arbitrary political interference. Furthermore, advances in high voltage transmission technology

[5] The need to closely coordinate systems is also reduced when the major inter-regional links are, as in the US, direct as opposed to alternating current.

have expanded the potential gains from inter-regional trade in electricity. This has, in turn, created pressures on the older regionally-based regulatory system and led to a demand for deregulation and a greater reliance upon markets to coordinate electricity supply and demand.

We conclude that the potential abuses of monopoly are not sufficient to justify public ownership of electricity firms. In a context where political institutions are weak, however, effective regulation of private monopoly may be infeasible. Under those circumstances, public ownership may be less inefficient than an unregulated, or poorly regulated, private monopoly.

Other motives for public ownership

There are other reasons why less developed countries in particular may have favored public ownership of electricity supply firms. Some of these relate to the role of electricity supply as part of the infrastructure of the economy.

A modern, reliable electricity supply system is an important ingredient of economic growth. While electricity can be generated using small stand-alone plants, the cost is usually much higher than the marginal cost of grid power. The problem is that the up-front investment costs for an electricity grid are very large. The high marginal charges for electricity needed to recover these costs would discourage customers from using grid power. At a price that is high enough to pay for the capital investments, the demand for power may not be sufficient to justify those investments.

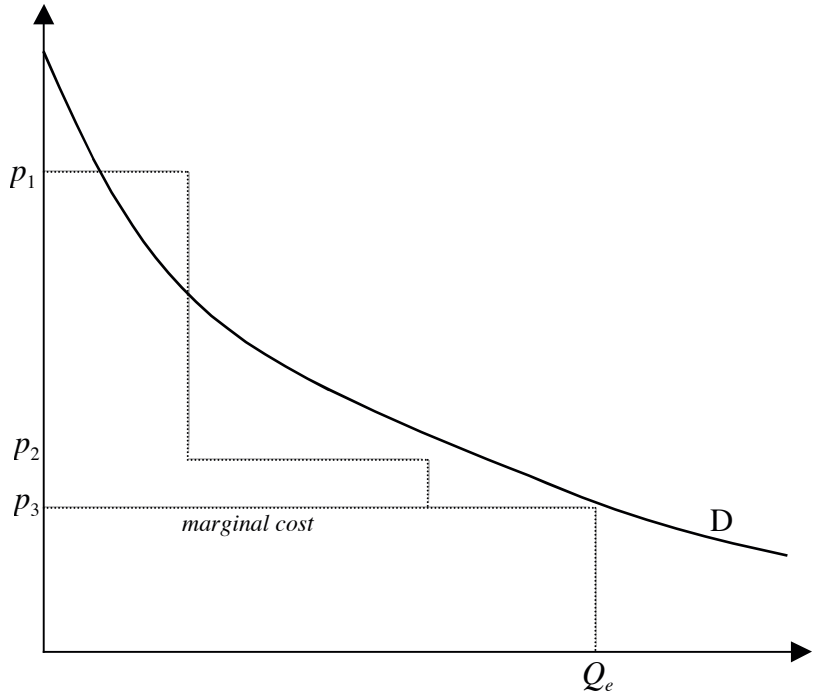

Figure 2: Efficient price discrimination

An alternative way of paying for investment in the system involves charging different prices to different categories of customers, or different prices for marginal and infra-marginal units of consumption.[6] As illustrated in Figure 2, customers who place a very high value on grid power may be willing to pay a high price for small amounts of electricity consumption. In the case illustrated in the Figure, the customer will continue to consumer grid power so long as the area under the demand curve from 0 to Q_e exceeds the total payment (the area under the step function). The chosen consumption level, Q_e will be efficient so long as the price p_3 for marginal units of consumption equals the marginal cost of supply.

The problem with this solution is that price discrimination is vulnerable to competition. New entrants can "cream skim" any customers being charged a price in excess of the costs of serving them. While customers who place a very high value on access to grid power might in principle be willing to pay more than others, they would prefer to pay as little as possible. It is possible, therefore, that the total value of grid electricity supply could exceed the costs of providing it, yet the revenue that could be raised in a competitive environment is insufficient to cover total costs. Limiting competition again raises the problem of incurring potential efficiency losses from monopoly, and public ownership may once again be the most practical solution in a developing country where regulatory oversight of a private monopoly may be ineffective.

Taxation may also be a reasonable solution to financing the large up-front investment costs for infrastructure. Basic economic infrastructure may have such a high value in a developing country that the benefits of financing it out of taxes could more than offset the efficiency costs of the taxes. Again, however, subsidizing investment in electricity infrastructure may be more acceptable politically if the firm undertaking the investment is publicly owned.

The immature political and economic institutions in developing countries may create other problems that favor public ownership of firms supplying grid power. Investments in transmission lines and power plants cannot be withdrawn once they are in place. Foreign enterprises may thus be reluctant to invest if they are at all uncertain about the reliability of domestic political institutions. More than outright nationalization is at stake. Governments can also change tax laws, regulations, or laws governing the repatriation of profits, after investments are in place. Even if foreign firms are willing to invest in the face of such sovereign risk, they are likely to demand very high rates of return for doing so.

Domestic firms may be less vulnerable than foreign firms to domestic political changes. The owners of such firms are likely to be able to exert more political pressure

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[6] Charging large prices for initial units also could be viewed as an implicit "connection charge" for using the system. Price discrimination may allow revenue to cover fixed investment costs while leaving consumers with the right incentives to choose a level of consumption that equates marginal benefits to the marginal cost of supply.

on domestic governments. The immature capital markets in developing countries may, however, make it very difficult to raise the large amounts of capital needed to develop electricity generating plants and transmission grids.

Motivations for reform

As we noted in the introduction, many countries have recently reformed their electricity supply industries. In countries where electricity was supplied by a publicly owned vertically integrated monopoly, such as the CEGB in the UK, privatization was one component of the reforms. Before being privatized, the firm was separated into generation, transmission and distribution subsidiaries. The motivation for this split was to separate the potentially competitive generation business from the natural monopoly transmission and scheduling functions. Government determination of the prices received by generators was replaced by a wholesale electricity market that served the dual function of determining the active firms supplying power to the grid at each moment of time and the current wholesale price of electricity.

Even countries, such as the US and Germany, with predominantly private electric utilities have been reforming their industries. The emphasis has again been on separating generation from transmission and distribution and introducing wholesale electricity markets in place of direct regulation.

The basic goal of reform has been to increase efficiency. Market prices are more responsive than regulated prices to changes in supply or demand conditions. Market prices can better signal to consumers the costs involved in meeting their demands and encourage consumers to adjust their demand to minimize the costs they impose on the system. For example, market prices will vary with the overall load on the system. Consumers able to interrupt demand for a short period, or at short notice, may save money by doing so when prices are high. Other consumers may be able to shift activity from peak to off-peak periods and will have an incentive to do so when prices more accurately reflect current costs.

Current and potential producers may also respond more flexibly in a market setting. Market prices signal to producers the marginal benefit of increasing supply. Any firm that believes it can cover its costs at current prices has an incentive to invest and enter the market. This can include, for example, firms producing steam as part of their industrial process and capable of using that steam to co-generate electricity if there is a market they can sell into.[7] Decision-making is decentralized and can exploit local and specialized information that may be harder to convey to decision-makers in a more bureaucratic system. In a regulated system, for example, the public utility commission or its equivalent must approve expansions in capacity. In a system characterized by a

[7] Mexico has recently begun to encourage co-generation projects. Co-generators are, however, allowed to sell only up to 25% of the capacity of their plants to the CFE, and only under very restrictive conditions.

publicly owned monopoly, the finance ministry or the government often have to approve investments.

Market prices are a clear and strong signal to consumers and producers to modify their behavior to maximize their benefits net of costs. Therein also lies a potential defect of relying more on markets and less on regulation. As we have already argued, a market characterized by a monopoly will yield an inefficient outcome. Market prices will be a clear and strong signal for consumers, but the signal will be a distorted one. For market prices to send signals that promote efficiency, the market structure needs to be competitive. Electricity market reforms that have produced unsatisfactory outcomes have all produced markets with inadequate competition. Conversely, as long as the resulting wholesale market is competitive, many other details of the reforms do not much matter.

Technological sources of reform

The electricity supply industry reforms instituted by many countries in recent years are a response, in large part, to technological developments. These technological changes have made wholesale electricity markets feasible and competition in such markets more likely. At the same time, new technologies have increased the risks in the electricity supply industry. Higher risks have in turn favored private firms over public enterprises. Capital markets are able to absorb risks at lower cost than either the taxpayers or electricity consumers who, under public ownership, typically bear the costs of changes to electricity costs or demand.

The most fundamental technological development affecting the electricity industry is the falling cost of computing. The system operator needs to schedule generating plant to supply the network on a continuous basis, taking account of the varying load on the system and unanticipated events such as outages of generating plant or transmission lines. Generators need to be called upon at short notice to maintain frequency, voltage and power flow. Continuous automatic monitoring of the system is required with computers repeatedly solving an optimal scheduling problem. For example, in the Australian wholesale electricity market generators can bid to supply either increased or decreased output on 6, 30 or 300 seconds notice.[8] Calculations are needed to determine when these so-called ancillary services should be called upon. The very short notice ancillary services are in practice scheduled automatically.

Computers are also needed to perform the accounting function in a wholesale market. Records need to be kept of which generating firms are supplying power or ancillary services at all times, and what the market prices were for electricity or ancillary services at those times. Similarly, records are needed of all power purchases from the pool and at what market prices. In the Australian market, all purchasers at any one time are also charged a share of the payments for ancillary services. Their share will normally

[8] Details of the Australian ancillary services market can be found at the National Electricity Market Management Company (NEMMCO) web site, http://www.nemmco.com.au.

depend on the amount of power they are drawing from the system and their load characteristics.

The falling cost of electronic equipment has also reduced the cost of sophisticated solid-state electricity meters that continuously track the amount of power consumed. Such meters are essential for obtaining maximum value from a wholesale electricity market. The major benefit of using a market to determine wholesale prices is that we can obtain a more accurate reading of the time profile of marginal costs. If consumers cannot respond to these prices, however, there is little benefit in revealing them. Sophisticated meters allow consumers to benefit by shifting their electricity demand from periods when prices are high to periods where they are lower. Smoothing out the demand load in turn saves resources by allowing the same demand for electricity to be met with lower total generating capacity and by allowing a bigger proportion of the total electricity to be produced with lower cost, large base load generating plant.

Effective competition in the distribution market may also require meters that continuously record electricity consumption. The distribution network, like the transmission network, is a natural monopoly. The network within a given geographical region needs to be operated as a system, and it would be very costly to duplicate the physical wires. Many countries have, however, instituted access regimes. Local distribution companies are required to provide access to their wires network at a regulated "wheeling" or access price. Third parties can purchase power from the wholesale market and sell it customers in a distributor's franchise area after paying the access charge to the distributor. Since the marginal cost of allowing access is likely to depend on the load on the network, access charges ought also to vary over time. In order to implement this scheme, however, records are required of the amount of power purchased at each moment of time by each of the customers of third party suppliers. Collecting and processing such records would be infeasible without sophisticated metering and computational technology.

Progress in developing and producing solid-state electronic devices has also lowered the cost of alternating–direct current converters (thyristors). The cost and limited capacity of thyristors was formerly a major impediment to the more widespread use of high voltage direct current (HVDC) transmission links.

For the same transmission capacity, a DC line has lower construction costs than an alternating current (AC) line. High voltage AC transmission lines are three-phase and therefore require at least three conductors. A typical DC line has two conductors (one for the return current flow), and thus requires smaller towers and a smaller right-of-way. The right of way for an AC line designed to carry 2,000MW is roughly 70% wider than the right of way for a DC line of equivalent capacity. Arrillaga (1998: 260) observes, furthermore, that an AC link needs a double three-phase line to attain the reliability of a two-pole DC transmission.

Operating costs, in the form of transmission losses, are also lower on optimized DC lines than on optimized AC lines of the same power capacity.[9] An offsetting factor is that the DC system has additional losses in the terminal stations that convert DC to or from AC. The trade-offs between losses and capital costs will depend on factors specific to each project, including the cost of a right-of-way. For typical systems designed to transfer 2,000 MW of power, however, the losses in the HVDC system will be lower for distances above about 200 km.

Another benefit of HVDC links is that they can improve the stability and controllability of the AC system. The conversion stations at either end of a HVDC link include frequency control functions, while the link itself is an asynchronous connection. A HVDC link therefore can assist with frequency control in the parallel AC system. A DC link also allows for a redistribution of the power flow in the AC network in response to swings in loads and generation inputs. Since a DC link is decoupled from the rest of the system, power transmission can be freely and rapidly adjusted up to the design limits of the DC converter stations. In addition, since HVDC links can be controlled to carry a specific maximum amount of power, outage of parallel AC lines cannot overload the DC line. This may make the overall system more fault-tolerant. An HVDC line can also assist with controlling reactive power in the AC system.

The falling cost of HVDC transmission has allowed large amounts of power to be transmitted over very long distances.[10] This has increased competition in electricity supply. The more frequent interchange of power between transmission systems has also helped create a demand for organized wholesale markets that continuously price electricity and allow it to be traded more easily. Greater ability to trade electricity may also encourage utilities to hold lower levels of excess capacity. This would in turn increase the amount traded during emergencies.

The falling cost of combined cycle gas turbines (CCGT) is another technological development that has favored the development of electricity markets. New CCGT plants have lower economies of scale than older coal-fired, oil-fired or nuclear plant. The relatively high thermal efficiency of combined cycle technology allows these plants to have operating costs much closer to the larger base load plants based on alternative fuels. Since natural gas is a much cleaner burning fuel than coal or oil, more stringent air pollution regulations have further reduced the difference in operating costs between CCGT and base load plants using cheaper fuels. Smaller economies of scale imply that more plants are required to supply the same load. At any one time, this allows more firms to operate base load plants and thus increase the competitiveness of the system. Over

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[9] The optimized lines in each case balance the capital costs of higher capacity links against the savings in transmission losses over the life of the facility.

[10] In the Mexican context, HVDC transmission may be particularly useful for allowing increased trade in electricity with the US. Hartley and Martinez-Chombo (2002) also demonstrate that the hydroelectric plants in the Grijalva river region of southern Mexico play a valuable role in the Mexican system. Their value might be enhanced by a HVDC link from this area to the central region of the country.

time, a given growth in demand, or loss of existing capacity through depreciation, requires more frequent investments and thus more opportunities for new firms to enter a market. With a lower investment at stake, more firms also may be willing to enter the industry. In particular, the availability of low cost efficient CCGT plants has encouraged many more industrial firms to co-generate electricity as a by-product of producing steam for other industrial processes.

More frequent and more pervasive technological changes have another effect. They increase the risk in the industry and tend to favor smaller and more dynamic firms, such as those started by venture capital. New developments also have linked electricity supply to other dynamic, higher risk, industries. In particular, growth in telecommunications and the use of optical fibers have increased the value of rights of way, including those owned by electric utilities. Deregulation of natural gas markets also has fostered the evolution of energy supply companies that cross traditional industry boundaries. Large bureaucratic enterprises are not well suited to exploiting opportunities created by rapid technological and institutional change. Regulations also tend to respond slowly to change, making them more of a burden for more dynamic industries.

Problems with public ownership

The other major motivation for reform of the electricity supply industry is that public ownership of industrial enterprises has generally proven to be quite inefficient. Research from academic economists, the World Bank, the OECD and others has documented the relative inefficiency of public as opposed to private firms.[11] Even an industry of privately owned firms that is far from perfectly competitive may be more efficient than a publicly owned monopoly.

One reason for favoring a publicly owned firm over a privately owned firm in a natural monopoly industry is that the public firm is thought to be less likely to exploit its monopoly power to artificially raise prices. The publicly owned firm has goals other than profit maximization. For the same reason, however, a publicly owned firm has much weaker incentives to provide good service to its customers or to reduce costs.

By definition, a publicly owned firm does not have ownership claims traded in the capital market. Trading ownership claims provides a number of benefits to private firms.[12]

The price of shares in a private firm reflects investor opinions about how well managers are performing. Furthermore, investors substantiate their opinions about current management by placing their own wealth at risk. They therefore have an incentive to ensure those opinions are well-founded. Poor managerial performance leads to share

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[11] See, for example, Bishop and Kay (1988), Boardman and Vining (1989), Shirley and Nellis (1991), Kikeri, Nellis and Shirley (1992), Galal, Jones, Tandon and Vogelsang (1994) and Megginson, Nash and van Randenborgh (1994) and a World Bank Report (1995).

[12] Hartley and Trengove (1986) have represented the following arguments in a more explicit formal model.

price declines, encouraging a takeover and the installation of new managers. Managers thus are under pressure to maintain profitability. If the managers of a private firm do send a private firm bankrupt, its assets can be sold to other firms that can use them more efficiently. It is much harder to discipline public sector managers. By definition, ownership of the firm's assets cannot change hands. The commitment to public ownership means that the firm can always count on being "bailed out" if it gets into financial difficulties. In addition, it is much more difficult to obtain information about how well current managers are performing when there is no share price information. Finally, unlike the investors in a private firm, the politicians or bureaucrats monitoring the performance of a publicly owned firm do not have a personal stake in the accuracy of their assessments. This is, at best, just one element in determining their success in their careers.

Another benefit of traded ownership shares is that the rate of return on shares reflects the compensation investors require in order to bear the risk inherent in that firm's investments. The rate of return thus signals to management the opportunity cost of investing in their enterprise rather than competing alternatives. New investments will raise share prices, and thus investor wealth, only if investors expect them to yield a positive net present value when discounted at the firm's cost of capital. By contrast, managers of publicly owned enterprises lack information about the rate of return required to compensate for the risks inherent in their investments. In particular, although publicly owned firms with debt guaranteed by the government can borrow at the government bond rate, this rate does not reflect the risk of capital investments made by publicly owned firms. Investors in government bonds are concerned about default risk if there is a chance that the government will not use its power to tax to redeem government debt. They may also be concerned about the risk of changes in future interest rates if the bonds are long-term, or they may be concerned about inflation risk if the bonds have a fixed nominal face value. The profitability of the investments that government firms make, however, will be at best a minor factor in investor calculations. Even if the government used all proceeds from bond sales to finance income transfers, for example, the rate of return on the bonds would not change so long as investors perceived the default or inflation risks to be unchanged.

The rate of return on shares also signals to investors the future consumption they can obtain by forgoing consumption today. Since the decision to save in a private capital market is voluntary, investors will only save if they believe they are making themselves better off. By contrast, by altering tax and transfer policies over time, the government can force individuals to alter their intertemporal pattern of consumption. Under some circumstances, individuals may be able to offset these compulsory intertemporal transfers,[13] but they also may not.

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[13] For example, current taxpayers who are actively transferring income to future taxpayers can alter transfers to offset changes in the intertemporal pattern of taxation.

A related issue is that public ownership does not eliminate risks. The risk that is voluntarily borne (at a price) by investors in a private firm is involuntarily borne by other parties in the case of publicly owned firms. If investments by a publicly owned firm turn out to be less worthwhile than anticipated, consumers may face higher prices or taxpayers will be called upon to finance the resulting deficits of the firm. Whereas private capital markets allocate risks to those investors who are most willing to bear them, the consumers or taxpayers who are forced to bear the risks of public sector investments are less able to do so. Higher taxes or charges will be very costly for consumers or taxpayers who are simultaneously suffering a temporary decline in income or increase in required expenditures.

The returns to private investors in a firm (bond holders as well as shareholders) also represent a return to capital as a factor of production. Publicly owned firms usually are not required to pay a market return on tax revenues used to finance investments. What would be a return to capital in a private firm is instead dissipated in transfers to politically powerful groups. For example, particular groups of consumers may benefit from paying less than the costs of serving them, or the firm may employ more workers, pay higher wages, or offer better working conditions, than needed to get the labor services it requires. These implicit or explicit subsidies, however, all impose efficiency losses. On occasion, the dependence on taxpayers for funds to finance investments may also mean that necessary and justified investments by the enterprise are delayed for budgetary reasons unrelated to the conditions in the industry.

Managers of publicly owned firms may also be less entrepreneurial than are their private sector counterparts. Management can make two types of mistakes. They can make decisions that turn out to unprofitable or they can fail to make decisions that would have been profitable. Managers of private firms have an incentive to avoid both types of mistakes since either of them will lower share prices below what they otherwise would have been and raise the probability of bankruptcy or a takeover. In the public sector, however, rewards and punishments appear to be more asymmetric. When mistakes are made, resources are expended to discover and punish those judged as responsible. On the other hand, many claim credit for successes and it is difficult for those truly responsible to obtain their just rewards. The result is that managers of public sector firms tend to be more risk averse than are their private sector counterparts and much more concerned to avoid mistakes than to seek success.

In summary, political oversight is a poor substitute for traded ownership claims as a method of encouraging management to operate a firm efficiently. Political objectives are much more diffuse and more difficult to measure than are share values. The information available to political monitors of public sector firms is also inferior to the information revealed by stock prices.

Public ownership and pricing

One of the particular problems resulting from political oversight of an industry is that prices often reflect cross-subsidies to politically favored groups. Sometimes, as with

government mail services, these take the form of a uniform price for a service that is far from equally costly to provide to all customers. In other cases, the cross subsidies are more obvious, since prices for a similar service differ by an amount than is far greater than any conceivable cost difference. Whenever prices do not correspond to marginal costs, however, customers who are under-charged will have an incentive to over-use the service, while those who are over-charged will restrain their demand when the cost of allowing them to consume more would be less than the benefits they would obtain from additional consumption. In the electricity industry in particular, costs vary by geographical location and the total load on the system. By contrast, tariffs in a government controlled or regulated system typically vary by customer type and what the electricity is used for.[14]

One of the major benefits of reforming the electricity supply industry is that wholesale prices can then more closely reflect marginal costs. In fact, one of the criticisms of such markets is that competition drives prices down to equal the short-run operating costs and firms cannot hope to recover sufficient funds to pay for investments in new capacity. Base load plant earns rents, however, during peak or intermediate load periods when higher operating cost plant sets the price of electricity. Indeed, to justify the base load plant on efficiency grounds, the present value of the saving in operating costs relative to higher cost plant has to at least cover the higher up-front capital cost of the base load plant. Payments for ancillary services also would allow peaking plant to recover capital costs. These are payments made to peaking plant to ensure that it is readily available to supply power even though it is not actually generating any electricity.[15]

A firm investing in base load plant with relatively low operating costs and reasonably assured levels of output can reduce the risk implicit in relying on short-term energy payments in excess of its operating costs by selling power on long term contract. So-called "contracts for differences" can achieve this even when all physical electricity trades have to be made through a centralized wholesale spot market and parties cannot enter into bilateral contracts to directly trade power. Under a contract for differences, a party selling electricity for a long-term contract price p agrees to pay the counter-party $s–p$ when the spot price s exceeds p in return for receiving from the counter-party $p–s$ when the spot price s is below p. Buyers can also trade price risks to other parties by buying contracts for differences. Formal electricity futures and options markets, which allow flexible risk sharing, have also often accompanied or followed the development of wholesale electricity markets.

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[14] The companion paper by Hartley and Martinez-Chombo (2002) discusses the relationship between prices and costs in Mexico.

[15] The companion paper shows that marginal cost pricing in Mexico is likely to raise revenue substantially in excess of generating costs.

Corporatization: A solution?

The most successful reforms of the electricity supply industry have promoted maximum competition among as many privately owned generating firms as possible. Simply introducing a wholesale spot market with accompanying financial contract markets could make matters worse if the market is uncompetitive. Market prices will provide strong signals to participants, but those signals will be distorted and encourage inefficient responses if the market is uncompetitive.

In the Mexican situation, reform has to respect another constraint. The current government has declared that the CFE and the LyF must remain publicly owned firms. One strategy may be to delay reform in the hope that a future government may consent to privatization. At least some of the current Congressional opposition, however, is even more opposed to privatization of "key public sector firms" than is the current government. Corporatization represents another possible strategy.

Corporatization is motivated by a desire to duplicate as closely as possible the managerial and incentive structure of a private firm while retaining public ownership. Any regulatory functions currently performed by the firm, such as setting safety or operational standards, are allocated to a new agency. The legal status of the remaining production unit is changed to remove any exemptions form general laws such as those pertaining to product or workplace safety, deceptive advertising, warranty violations or anti-competitive behavior.

The production unit is also given narrow, more commercial objectives. Since the firm does not have traded ownership shares, it is impossible to duplicate a goal such as maximizing market value. The firm can be required, however, to keep audited accounts using generally accepted accounting conventions, to present the same reports required of private firms, and to meet various accounting objectives. Possible objectives could include a required rate of return on the book value of assets, rates of increase in earnings, or targets for various ratios such as earnings relative to revenue, or expenses relative to revenue. Such objectives are relatively easy to monitor once the firm is using standard accounting practices.

The government appoints a board of directors and makes them responsible for achieving the specified objectives. The board is free to decide how best to achieve the specified objectives. The board hires the mangers and can compensate managers based, for example, upon the success of the firm in meeting its objectives.

The government, or the responsible minister, can replace the board if the firm fails to achieve the specified objectives, but does not normally have direct control over detailed policies such as those relating to employment practices, pricing or service levels. If the government wishes to over-ride a policy of the board, or change the objectives of the firm, it must do so through an open and public directive published, for example, in the government gazette.

The experience with corporatization in New Zealand and Australia has shown that it can eliminate some of the inefficiencies associated with public ownership. In particular,

corporatized firms in both countries have reduced over-manning, introduced more competitive sourcing of supplies and equipment, and achieved other significant cost reductions. The firms have also eliminated many cross-subsidies, have financed more of their investments from retained earnings, and have generally paid higher dividends to their government owners than did the former non-corporatized utilities.

Problems with corporatization

While corporatization can secure some of the benefits of private ownership, it also brings some of the potential problems. In particular, giving the publicly owned firm more commercial objectives also gives it more of an incentive to exploit monopoly market power. One cannot assume that, because the firm remains in government ownership, management will not respond to the new incentive structure.

Although a monopoly retains a strong incentive to minimize production costs, it also has an incentive to reduce its output below the efficient level. In particular, a corporatized publicly owned monopoly can restrict output and raise prices to achieve a higher return on capital, or a higher growth rate of earnings. Consumers will receive a distorted price signal just as they would with a private monopoly and resources will not be used efficiently.

Monopoly power can also lead to other abuses. It has been alleged, for example, that Electricorp of New Zealand (ECNZ) attempted to set its prices at the highest level it could while still making entry to the New Zealand electricity market unprofitable. ECNZ was corporatized in 1987, but generation was monopolized until Contact Energy was formed from less than 30% of ECNZ in 1996. Hydro-electricity provides most of the power in New Zealand, but thermal generation is the most likely source of significant new capacity. In particular, a number of private firms have examined the option of using cheap steaming coal from Australia to generate electricity on the north island of New Zealand. By pricing electricity just below the level that would allow a coal-fired plant to be profitable, ECNZ could exclude a new entrant. Although the threat of entry placed some constraints on ECNZ, the outcome probably was inefficient. In 2000–01, for example, New Zealand suffered significant power shortages following a prolonged drought. The drought would have had much less severe consequences if significant thermal capacity had been in place. In effect, the stored water had been under-priced relative to its true opportunity cost.

In order to place potential entrants on a more equal footing with ECNZ, Transpower was established in 1994 to own and manage the high voltage transmission network. After Contract Energy was formed from about 30% of the former ECNZ capacity, New Zealand established a wholesale electricity market in 1996. The market was not very effective, however, with ECNZ having such a dominant market share. The government subsequently privatized some additional small generating stations (about 13% of capacity) and split the remainder of ECNZ into three corporatized entities holding market shares of about 30%, 17% and 10% respectively.

The important lesson from this example is that corporatization, like privatization, is unlikely to achieve an efficient outcome unless the market structure is competitive. As we noted above, the transmission network is the core monopoly element in electricity supply. Once the transmission network is separated form the rest of the supply system and run as a regulated common carrier, generation can be organized into a very competitive wholesale market. There is no convincing evidence that economies of scale or scope extend beyond the individual power generating plant. In the state of Victoria in Australia, the generating stations were all privatized as separate firms and the resultant gains in efficiency from cost reductions and cost-reflective wholesale electricity prices have been stunning.

The Australian experience also demonstrates another important lesson. While the state of Victoria privatized all its generating stations into separate firms, the neighboring state of New South Wales (NSW) separated the state-owned Pacific Power into three corporatized entities each owning about one-third of generating capacity. The NSW firms reduced costs relative to the former state-owned monopoly, but did not achieve efficiency gains as large as the Victorian plants.[16]

Although a corporatized firm has stronger incentives to reduce costs than does a non-corporatized firm, its commercial orientation nevertheless is not as great as that of a private firm. Part of the problem is that the government rarely restricts itself to specifying only commercial objectives for the firm. The government also instructs the firm to pay attention to social goals that are often vague, not easily monitored, and allow the firm to excuse inadequate performance in dimensions that can be measured more objectively. In addition, the corporatized firm can often manipulate accounts to achieve objective targets other than through reducing costs or improving service to customers.[17]

Other important dimensions of performance, such as the quality of customer service, may not be very amenable to objective measurement. Indeed, it is possible to spend too many resources on customer service. If a private firm spends more on customer service than it gains in revenue, its share price will fall. Outside parties do not have to apportion costs or revenues to particular actions of the firm. An inadequate return to investors can trigger a takeover whatever its source. Knowing that, management has an incentive to monitor activities within the firm to ensure that the benefits justify the costs incurred. It is much harder for outsiders to judge efficient levels of service using accounting measures alone. Effectively, they need to attribute costs and revenues to different actions within the firm.

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[16] The NSW firms have also recently been accused of using their dominant market positions to artificially raise electricity prices.

[17] Private firms can also manipulate accounts, of course, but such manipulation is ineffective unless it deceives investors. Furthermore, while the recent Enron fiasco in the US demonstrates that a private firm can deceive investors for some time by manipulating its accounts, the episode also shows that even a very large private firm can be forced into bankruptcy when its credibility with investors, customers and employees is destroyed.

The fact that a corporatized firm must remain under government ownership creates other problems. Management knows that the assets cannot be sold to another party if the firm fails, so they can expect to be "bailed out" if the firm gets into difficulties. This is likely to reduce their incentive to minimize costs. Management might also be emboldened to engage in unprofitable activities, such as predatory pricing against new entrants, if they believe the government will insure them against losses.

Since government retains a stake in the commercial success of the corporatized firm, regulators or legislators may favor the corporatized firm relative to private entrants. Legislators may also face political pressure to protect the corporatized firm from competition in return for requiring it to maintain inefficient levels of employment or politically popular but economically inefficient cross-subsidies.

Knowing that competition with a corporatized firm is unlikely to be "free and fair" private firms will be reluctant to enter the market. The threat of entry can be as strong a force as actual competition in encouraging firms to control costs and limit excess prices. Reducing the threat of entry therefore also tends to compromise efficiency.

Finally, we noted above that the share market provides other services that are absent for a corporatized firm. In particular, the cost of capital for the firm provides a simple test for deciding whether a proposed investment is efficient. It is much harder to determine the opportunity cost of investment funds for the corporatized firm. On the other side of the capital market, the return on investments allows consumers to choose how much income to save and how much to consume. By contrast, the intertemporal resource reallocations and risk bearing that occur when corporatized firms make investments are involuntary. It is therefore much harder to judge whether the amount or type of investment is likely to increase efficiency.

The BLT (Build-Lease-Transfer) and IPP (Independent Power Producer) options

In a BLT or IPP project, a foreign firm builds new generating plant on behalf of the publicly owned utility. Using a private firm to build new capacity generally enables the public utility to exploit some of the cost-minimizing advantages of a private firm to obtain new capacity at a lower cost.

Under a BLT project, the public utility leases and operates the new plant for a fixed period. At the end of that period, ownership of the plant transfers to the domestic electric supply utility. In an IPP project, the private firm also operates the new plant for a specified period and under a long-term contract to supply electricity to the publicly owned firm.

The major shortcoming of a BLT project is that it does little to encourage more efficient operation of the plants. There may be some cost savings if the new plants incorporate technologies that would otherwise not be available to the public utility. There is little pressure, however, to implement the changes to labor market practices, for example, that allow private firms to achieve major cost reductions relative to their publicly owned counterparts.

In a typical IPP project, the long-term agreement between the public utility and the firm includes a take-or-pay contract for the interim period when the foreign firm owns the plant. Under this arrangement, the domestic utility agrees to pay for a minimal amount of electricity each year at a contracted price whether or not it actually takes delivery of the contracted amount. Foreign investors demand such agreements to limit their risk. Since the generating plant is immobile capital and the domestic utility is a monopsony buyer from the foreign-owned firm, the foreign firm is vulnerable to ex-post unilateral price reductions by the domestic utility. Since the long-term contract usually contains provisions for adjusting the price of power for changes in costs, the IPP owner has reduced incentives to control costs relative to a private firm selling into a competitive market.

In many developing countries, a shortage of government revenue is a major motivation for considering private involvement in electricity supply. Tax systems are often ineffective in such countries, and there are many potential uses for revenue. Population growth rates are high and education and public health services often are inadequate. Many elements of the physical infrastructure apart from electricity supply are in need of investment funds. Some of these, such as roads, ports and airports are much less amenable to private participation than is electricity generation. The governments in many developing countries also have high levels of debt so that interest payments consume a substantial fraction of tax revenues. If privatization is unacceptable, BLT or IPP projects may be the only feasible way of expanding electricity supply to cope with increased demand.

A BLT project in particular might be seen as simply another way for the domestic government to borrow funds. Ultimately, the domestic electric utility owns the investment just as it would if the government borrowed the funds on its own account and invested them in the new plant. If the domestic utility had borrowed abroad to make the investment, it would have used payments from consumers to cover the interest payments on the foreign debt. As it is, consumers will need to cover the lease payments to the foreign investor. The operation of the new plant is essentially the same whether the investment funds are raised before the project is built or covered by lease payments after construction has ended.

By contrast, an IPP project can amount to much more than an indirect method of borrowing abroad. Under an IPP scheme, the foreign firm directly uses payments for electricity to earn a return on its investment. While the foreign firm is managing the enterprise, it may be able to use different employment or other practices than the domestic firm and hence produce electricity at lower cost. The foreign investing firm also may have access to new technologies or management practices that may not be available to the domestic firm. In the case of Mexico, if the foreign firm is a US utility from one of the border states, there also may be some advantages from exploiting a greater ability to trade with the US subsidiary of the same firm.

The contracts under an IPP project nevertheless are likely to weaken the incentive of the foreign firm to control costs. In addition, a take-or-pay contract leaves the domestic

utility bearing the risk that the forecast demand growth justifying the new plant may not in fact eventuate. This again is similar to the situation that would apply if the domestic utility had borrowed directly to finance the investment on its own account. Finally, the foreign firm depends on the domestic government maintaining its contractual commitments just as foreign lenders depend on the government not defaulting on its debt.

BLT and IPP schemes are a poor substitute for privatization, competition and market reform. Since the domestic public utility continues to assume the risks, such schemes do not take advantage of the risk sharing benefits of private capital markets. They also do not take advantage of the ability of markets to reveal information about the costs and benefits of electricity supply or the appropriate rate of return for investments. The franchise operator will also have very poor incentives toward the end of the franchise period. The firm will have an incentive to take actions that can raise current profits even if they lower the value of the physical plant transferred to the domestic utility by a higher amount in present value terms.

IPP schemes might appear to facilitate market reforms by introducing private producers into the domestic industry. In reality, however, they may hinder future progress toward reform. For example, Mission Energy operated a power station in the Australian state of Victoria at the time of the reform of that state's electricity supply industry. Before the government could place the Mission plant on an equal footing with the other government-owned plants, it had to engage in quite complicated negotiations to buy Mission out of its take-or-pay contract and assume ownership of the plant. The plant formerly operated by Mission was the last major generating station privatized in Victoria.

The Mexican electricity market

The companion paper (Hartley and Martinez-Chombo, 2002) presents a model of the Mexcian electricity supply system. As part of the analysis, we examine recent growth in the overall level of demand for electricity in Mexico as well as its geographical distribution. Given the relatively high population growth rates in Mexico, and its increasing per capita income, the anticipated growth in electricity demand in the coming decade is substantial. In addition, the regions of greatest growth in demand do not correspond to the regions where most of the demand currently is concentrated. The following table, based on the models of demand growth estimated in the companion paper, illustrates these points.

The demand forecasts in Table 1 imply that Mexico is going to need substantial investment in electricity supply infrastructure in the next decade. A relatively high population growth rate also implies, however, that Mexico also needs to make substantial investments in schools and health care. High economic growth rates and growing trade with the US and Canada also imply a substantial need to upgrade the transport infrastructure. Among all these competing investments, and given the right institutional framework, electricity generation is well suited to being undertaken by the private sector.

It is expensive to raise tax revenues. The efficiency losses from taxation imply that it costs perhaps $1.30 to raise every dollar of revenue.[18] Government ought to use these valuable tax revenues for activities that the private sector could not undertake very efficiently and for which the coercive power of the state is uniquely suited. Investing in electricity generating plant is not a very productive use of scarce tax revenue.

The companion paper shows that, even within the electricity sector, it may be more important to invest public funds in the transmission network than in generating plant. Indeed, as the map in Figure 3 shows, Mexico is planning substantial expansion of its transmission grid over the next five years.

Table 1: Power demand (principal sectors) by region and regional demand growth

	Region	1999 GWh	2010 GWh	Annual compound growth rate
1	Baja California	8,165	20,031	8.50%
2	Noroeste	10,331	19,335	5.86%
3	Norte	11,458	22,153	6.18%
4	Golfo Norte	21,908	50,743	7.94%
5	Golfo Centro	6,589	12,170	5.74%
6	Bajío	12,849	24,247	5.94%
7	Jalisco	8,454	15,506	5.67%
8	Centro Occidente	7,785	16,466	7.05%
9	Centro Oriente	6,429	12,601	6.31%
10	Centro Sur	5,398	9,737	5.51%
11	Oriente	9,128	13,684	3.75%
12	Sureste	4,206	8,127	6.17%
13	Peninsular	4,144	8,337	6.56%
14	Luz y Fuerza	27,445	37,868	2.97%
Total		144,285	271,005	5.90%

As we argued above, the transmission network, together with its associated scheduling and control functions, is the essential monopoly facility in the electricity supply system and an appropriate focus for government intervention. If the government does not

[18] Many studies have produced losses of 30% for each $1 of revenue raised for developed economies. It is hard to believe the figures are any lower for countries such as Mexico.

continue to own and operate the transmission network, it needs at the least to place the network under strong regulatory control. More than protection of consumers against monopoly abuse is at stake. Private investors will be unwilling to invest in new generating capacity, or will require very high rates of return to compensate for the high risks, if they do not perceive the wholesale market to be free and openly competitive.

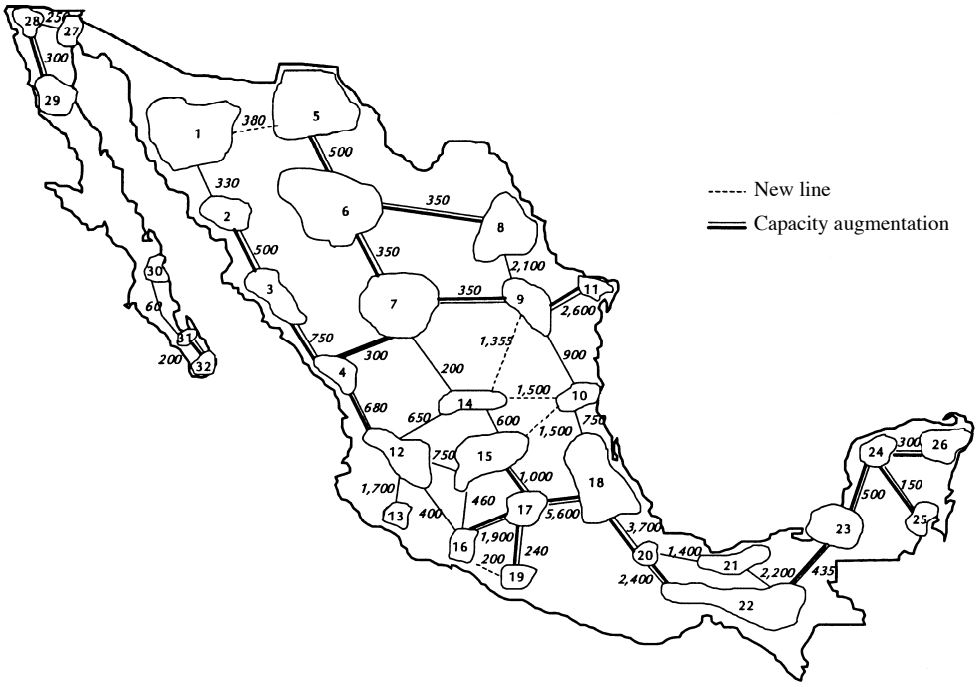

Figure 3: Planned transmission network for 2004

A problem that some countries have encountered when reforming their electricity industry is that even though they ensure the market as a whole has many producers, weak transmission links isolate some parts of the network from the rest of the system. Within these areas, local generators can exercise monopoly power, particularly when demand is high and the transmission links are operating at their full capacities.

The companion paper demonstrates that some regions in Mexico do become isolated from the rest of the system at times of high demand. The increased linkages between regions that will result from the planned expansion of the high voltage network would greatly reduce this problem. For example, the proposed links between regions 9 and 10 and regions 14 and 15 would greatly expand the competitive possibilities in the critical central areas of the country. The augmentation of the link between regions 17 and 18 would also greatly increase the potential degree of competition in the same general area. For this reason, if for no other, a reform of the Mexican electricity supply system might be more effective if it were delayed until the strengthening of the transmission network assures potential participants that the resulting market will be competitive.

It is better to take time to design an effective reform process than to proceed in haste and make potentially serious mistakes. For example, it would be a serious mistake to introduce a wholesale market in Mexico while leaving CFE in tact as a virtual monopoly owner of current generating capacity. It is essential to ensure generation is competitive before introducing market determination of prices.

Hartley and Martinez-Chombo and (2002) also examine the relationship between electricity prices and the marginal costs of electricity supply in Mexico. The paper shows how costs vary substantially by geographical location and the total load on the system. Current prices for electricity in Mexico do not correspond very closely to these costs.

Mexico has separate tariff schedules for residential, industrial, agricultural and public service customers even though costs do not directly depend on the purpose for which electricity is used. The costs of supplying electricity do vary by the voltage level at which electricity is supplied, and large industrial customers often connect directly to the high voltage transmission grid. The benefit of signaling this cost difference to industrial customers is one reason for having a separate industrial tariff. If other customers can alter the voltage level at which they take supply, however, it would be more appropriate to relate tariffs directly to the voltage level rather than the category to which the customer belongs.

Since the load on the system varies over time, marginal costs also vary over time. Efficient prices would reflect these cost differences. Residential tariffs vary seasonally and by the volume of consumption, but do not reflect costs very closely. Commercial tariffs have no seasonal or temporal variation at all. The industrial tariff is the most variable, with differing rates depending on voltage and service continuity. There is also some regional and temporal variation in the industrial tariff, but it again does not closely reflect costs.

Since the load pattern of different types of customers varies, some variation by customer type might be justified in the absence of prices varying by time of day. Unless the variation by customer type explicitly relates to the costs the customer imposes on the system, however, it would not give individual customers an incentive to modify their demand. At best, modifying tariffs by customer type would alter the mix of customers, and hence the load pattern, at different locations. This could reduce costs by producing a more uniform load curve over time or across locations. More commonly, however, the different tariffs for different categories of customers relate more closely to the inelasticity of demand. The evidence is thus more consistent with the hypothesis that price differentiation by customer type results from the exercise of monopoly power than an attempt by CFE, or the Mexican government, to increase efficiency of resource use.

Conclusion

New technology has created a unique opportunity in the electricity industry. For most of its existence, the industry has created somewhat of a dilemma for public policy. The industry was organized either as a government owned monopoly or as a heavily regulated

private monopoly. Both situations involved considerable compromise with the ideal outcome. Under both models, the monopoly supplier was vertically integrated.

In the new paradigm, separate firms supply generation, transmission and distribution services. Generation can be run as a competitive private industry not unlike many other manufacturing industries. The new technology, particularly in the area of data processing, allows a wholesale electricity market to be established, yielding the usual benefits of markets including better revelation of information about costs and benefits and better incentives to use resources efficiently.

Countries such as Mexico that had previously used publicly owned firms to supply electricity are in a better situation to exploit the new opportunity than are countries with regulated private monopolies. In the former case, the government can split the existing firms into the separate generation, transmission and distribution operations and privatize the generating assets so as to maximize the degree of competition in the new wholesale electricity market. By contrast, countries that already have vertically integrated private monopolies have fewer degrees of freedom. The government has to coax the existing private firms into selling off their transmission and distribution assets and most of their generation capacity before the new wholesale market can work efficiently. One of the costs of the "quick fix" BLT and IPP schemes is that they move the existing arrangement away from the publicly owned monopoly that is relatively easy to reform and toward the more complicated situation where the government has to buy private parties out of existing contractual arrangements.

In countries that have privatized their electricity supply industry to produce a competitive wholesale market, large cost reductions have produced some of the largest gains from reform. The elimination of excess employment has in turn constituted the major component of the cost reductions. Therein lies a political problem. Unions representing employees in the publicly owned firm are among the strongest opponents of privatization of electricity generation. If privatization is impossible because it is unacceptable to the unions, however, then the inescapable conclusion is that the major potential gains of reform are unobtainable.

Some countries have introduced a wholesale electricity market without first producing a competitive generation industry. Markets send very clear signals about costs and benefits and provide strong incentives to modify behavior. An uncompetitive market structure, however, produces distorted signals that provide strong incentives to do the wrong thing. Privatization and strong competition among generators are essential to reaping the maximum gains from reform. IPP schemes and corporatization are poor substitutes for a genuine market with maximum competition among privately owned generating firms.

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