



Governance of electricity transmission systems

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Abstract

This paper examines three different governance mechanisms for electricity transmission systems. A regulated transmission company (“Transco”) solution suffers from the usual problems of regulatory slack in a natural monopoly. A not-for-profit independent system operator (“NISO”) solution solves the regulatory slack problem by being involved in the day-to-day operations; however, the NISO solution suffers from the problem that the NISO directors can become “captured” by industry, leading to inefficient outcomes. In contrast, a for-profit independent system operator (“PISO”) solves the regulatory slack problem and is not subject to political pressure from industry. © 2005 Elsevier B.V. All rights reserved.

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1. Introduction

This paper investigates control mechanisms for the transmission system in deregulated electricity markets. Deregulation in the United States, Canada, New Zealand, the United Kingdom, and elsewhere has prompted much debate about how best to operate transmission systems. While it appears at least theoretically possible to obtain competition in the generation sector, transmission remains, for the most part, a natural monopoly. This monopoly bottleneck creates a critical requirement: equal access to transmission for all generators and consumers so that market power derived from transmission is not

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transferred into generation. The two established means of creating equal access are the “Transco” solution and the “Independent System Operator” (ISO) solution. Under the Transco model, the transmission assets are owned and managed by a regulated, for-profit monopolist; whereas under the ISO model, transmission assets are managed (but not owned) by a non-profit supervisory body. In the United States, the Federal Energy Regulatory Commission (FERC) has included both Transcos and ISOs as possible institutional forms for its mandated “Regional Transmission Organizations” (RTOs) under Order 2000. We argue that neither of these options is satisfactory, and analyze some of the trade-offs between them, as well as suggesting a different approach.

In the Transco solution, there is a corporate severance of transmission from generation.¹ The transmission company, commonly called the “Transco,” owns, operates, and manages the transmission system as a natural monopolist. To prevent monopolistic exploitation of both consumers and suppliers, the Transco is regulated. This is the approach taken in the UK, following the model that was found to work effectively in natural gas supply and distribution. The Transco model allows for competition and a level playing field in generation, but entrenches the transmission monopoly, since competing transmission providers would have to interconnect with the dominant (and presumably resistant) Transco and depend on it to dispatch electricity over their lines. In addition, the Transco model may lead to inefficiencies in decisions involving a trade-off between transmission and generation (as in [Leautier, 2001](#)). For example, expansion of transmission capacity to a “load pocket” is a substitute for new generating plants in an area. As recognized by the [Federal Trade Commission \(1999, p. 3\)](#), “the Transco may have incentives to favor its own transmission assets relative to any generation source, thereby discouraging new generation sources in the load pocket” in order to ensure more intensive use of its transmission capacity. Thus, even if the transmission assets are entirely separate from generation companies, the Transco model creates significant problems.

The alternative solution, commonly used in the US, is the ISO, a non-profit body which manages—but does not own—the transmission assets. The ISO framework has two principal advantages over the Transco model: it extends the level playing field, since the ISO will not discriminate between generators or between transmission and generation; and it creates the possibility of competitive supply in some parts of the transmission business. However, ISOs have been widely criticized in that the non-profit model employed appears open to lobbying and inefficiencies ([Michaels, 1999, 2000](#)). Indeed, on this basis the state of California recently restructured the boards of directors of its ISO to remove representatives from the electric generating business in lieu of a set of directors who have no connection with “stakeholders.”² Non-profit ISOs may also have relatively weak decision-making and cost-control capabilities. Our analysis of the ISO structure focuses on the potential for lobbying, and we apply the common agency model to analyze explicitly how industry influence is likely to be exerted on the ISO. A major contribution of this paper is that it

¹ FERC Order 888 concluded that “functional unbundling”—as opposed to outright divestiture—would be sufficient to ensure independence of the transmission assets of an integrated utility (at 21,552), but it appears that nothing short of corporate divestiture of generation assets will really be satisfactory.

² California had a sector-based Board of Directors until March 2001, at which time the constitution of the ISO was changed to accord with law AB-58.

embeds this common agency analysis within a model to highlight the trade-offs between the ISO and Transco solutions.

Not surprisingly, observers are divided over which is worse—the inefficient, poorly controlled, non-profit ISO, or the high cost, monopolistic Transco. There is, however, a third approach, which we present here: the for-profit ISO. This model has been tried in Alberta, Canada, where a private company, ESBI Ltd. has been acting successfully as the ISO since 1998. A similar approach is now being implemented in the “Alliance RTO” in the US, where the British National Grid Group Plc. is the new manager of the assets of 10 transmission companies. National Grid will receive a management fee and receive incentive-based earnings by delivering customer savings. The for-profit ISO, as we show below, attenuates the market power associated with the Transco model, and at the same time alleviates the problems of inefficiencies and lobbying associated with the non-profit ISO.

Our analysis builds on a variety of literature. Kleindorfer (1998) provides a useful overview of many of the issues in the ISO/Transco debate. Michaels (1999, 2000) argues that the governance of non-profit ISOs is unlikely to lead to consistent outcomes, will be difficult to regulate and will probably be dominated by organized interests. We extend some of these insights using the common agency model of Bernheim and Whinston (1986) and Grossman and Helpman (1994), and also explicitly compare ISO inefficiencies to the problems created by Transcos. Other critics of the ISO model include Hebert (1998) and Angle and Cannon (1998). Despite the persistent criticisms leveled at ISOs, they are the dominant form of control of the transmission system in the United States, and appear to be favored by FERC, as noted by Lambert (2000).³

We proceed by developing a simple model of the electricity industry in the following section. We then examine, in turn, the Transco model, the non-profit ISO model, and the for-profit ISO model, addressing particularly the problem of industry influence on transmission tariffs. We address some additional issues regarding the efficiency in for-profit and non-profit organization in Section 5, and conclude in Section 6.

2. A model of electricity transmission

In order to provide a reasonable model of the electricity industry, we consider the three layers in the industry—distribution, transmission and generation. We abstract from the network issues (e.g., Chao and Peck, 1996) in order to focus on the governance of the transmission assets. Assume that the distribution company (the “Disco”) is a natural monopoly with profits

$$\pi_d = pQ_d - c_d(Q_d), \quad (1)$$

where p is the price received by a distributor per unit of output Q_d , and $c_d(Q_d)$ is the cost of distribution. We assume that $c'_d > 0$ and that the Disco has declining average costs $d(c_d/Q_d)/dQ_d < 0$. The common practice, which we assume to hold here, is that the distribution

³ See also Koch (2000) and Kelly and Bogorad (1999) for criticisms of the Transco model. For a more general view of some of the issues, see Barker et al. (1997).

sector is regulated according to its cost of service, so that the price p the distribution sector earns for its services is

$$p = c_d(Q_d)/Q_d.$$

Since the average cost in the distribution sector is declining in output, the price the Disco receives is decreasing in the quantity produced: $dp/dQ_d < 0$.

For simplicity, we shall assume that the generation sector is a single firm, the “Genco.” The model is written as if consumers purchase directly from generators, who then buy transmission and distribution services.⁴ The Genco thus has profits given by

$$\pi_g = P(Q_g)Q_g - c_g(Q_g) - pQ_g - tQ_g, \quad (2)$$

where $P(Q_g)$ is the final demand ($P' < 0$); c_g is the cost of generation ($c'_g > 0$ and $c''_g > 0$); and t is the per unit transmission charge. We assume that there is no “line-loss” anywhere in the system, that is

$$Q_d = Q_g = Q. \quad (3)$$

Given the Disco’s price p and the transmission charge t , each of which the Genco takes as given, the Genco maximizes Eq. (2) with its choice of Q . Therefore, the Genco is a price searcher in the consumer demand market, but acts as a price taker in the distribution and transmission markets. The first-order condition for the Genco, for a given p and t , is

$$P(Q) + \lambda P'(Q)Q - c'_g(Q) - c_d(Q)/Q - t = 0, \quad (4)$$

where $\lambda \in [0, 1]$ is a parametric measure of the market power held by the Genco. Thus, for $\lambda = 0$, the generation sector behaves as if perfectly competitive, and for $\lambda = 1$, the generation sector behaves as if monopolistic.

The effect of an increase in t on p and Q can be seen by totally differentiating Eq. (4):

$$\frac{dQ}{dt} = \left((1 + \lambda)P'(Q) + \lambda P''(Q)Q - c''_g(Q) \frac{p - c'_d(Q)}{Q} \right)^{-1} < 0. \quad (5)$$

This derivative has a negative sign since the term on the right-hand side is the second-order condition for the imperfectly competitive generation sector, which must be negative. From Eq. (5) and the assumption that c_d/Q is decreasing in Q , it follows that $dp/dt > 0$. Thus, an increase in the transmission charge t decreases the total quantity traded but increases the price received by the Disco. The effect on p occurs because as the quantity sold decreases, the Disco’s average cost rises.

In the following sections, we examine the effect of allowing different organizations to manage the transmission sector, and compare prices and welfare under the competing institutional structures.

⁴ This is equivalent to a model in which consumers buy directly from regulated discos, who buy from generation companies. We have written the model in this way to minimize notational complication.

3. The “Transco” solution

The Transco solution allows for a separate for-profit transmission company (the “Transco”) to own, operate, and manage the transmission lines. “Managing” gives the Transco the right to determine the per unit price t for its services. The Transco faces costs $c_T(Q)$, where $c'_T > 0$ and c_T/Q is decreasing in Q , then its profits are given by

$$\pi_T = tQ - c_T(Q).$$

An unregulated Transco chooses t to satisfy

$$t - c'_T(Q) = -Q \left(\frac{dQ}{dt} \right)^{-1}. \tag{6}$$

Since, from Eq. (5), $dQ/dt < 0$, Eq. (6) implies that the Transco sets its transmission fee t to be greater than marginal costs, i.e., $t - c'_T > 0$. Thus, the Transco exercises its monopoly power as the sole transmission service provider.

In order to prevent this monopoly-induced distortion in the transmission sector, the Transco could be regulated. We assume that the regulator imposes an incentive contract to induce the optimal choice of t , and we derive the properties of this contract. Given the Genco’s choice of output $Q(t)$ for a given transmission fee t , the gross welfare to a benevolent regulator is:

$$U_R(t) = \int_0^{Q(t)} P(q) dq - c_d(Q(t)) - c_g(Q(t)) - tQ(t).$$

This expression is the gross benefits net of costs of electricity, where the marginal transmission costs are measured as the transmission fee t . Suppose the regulator offers the Transco an incentive contract $B_R(t)$. Let the *net* utility of the regulator be given by

$$V_R(t) = U_R(t) - (1 + \psi)B_R(t),$$

where $\psi \geq 0$ reflects the net social cost to the regulator of raising the payment $B_R(t)$. If the payment to the Transco is raised using distortionary taxes, then $\psi > 0$. The optimal incentive contract satisfies

$$(1 + \psi)B'_R(t) = \left[P(Q) - c'_g(Q) - c'_d(Q) - t \right] \left(\frac{dQ}{dt} \right) - Q, \tag{7}$$

implying that the payment to the Transco decreases as t rises.

In general, the Transco possesses private information about the costs of providing services and its own effort. Thus, the Transco may make (socially) inefficient choices about its business in order to benefit the Transco privately. For example, it may deter alternative competitors in the provision of transmission or ancillary services; use excessive capital (as in *Averch and Johnson, 1962*); or undertake too little cost-reducing effort (as in *Laffont and Tirole, 1986*). In each of these cases, the result is higher costs of service. We therefore assume that the regulated Transco’s costs are $\hat{c}_T(Q)$, where $\hat{c}_T(Q) \geq c_T(Q)$ and $\hat{c}'_T(Q) \geq c'_T(Q)$ for all $Q > 0$, because of some regulatory slack. We have chosen not to model this inefficiency as an endogenous process because it is not at

the heart of the paper: but the core idea is that the inefficiency of the Transco will increase the less information the regulator has, in a framework where the regulator sets prices to meet the Transco's costs.⁵ We also assume that $\hat{c}_T(Q)$ is the cost observed by the regulator.

Thus, the Transco maximizes the sum of profits from the incentive contract $B_R(t)$ and the transmission fee t taking into account that the regulator faces the agency problem, so that costs are $\hat{c}_T(Q)$:

$$U_T(t) = B_R(t) + tQ - \hat{c}_T(Q).$$

The first-order condition for the Transco's choice of t is thus:

$$\frac{\partial U_T}{\partial t} = B'_R(t) + Q + [t - \hat{c}'_T(Q)] \left(\frac{dQ}{dt} \right) = 0. \quad (8)$$

Upon substitution from Eq. (7), Eq. (8) can be rewritten as

$$\left(\frac{P(Q) - c'_d(Q) - c'_g(Q) - t}{1 + \psi} \right) \left(\frac{dQ}{dt} \right) + \left(\frac{\psi}{1 + \psi} \right) Q + [t - \hat{c}'_T(Q)] \left(\frac{dQ}{dt} \right) = 0. \quad (9)$$

In the event that $\psi=0$, so that there is no distortion associated with raising the contract B_R , the first-order condition (Eq. (9)) collapses to

$$P(Q) - c'_d(Q) - c'_g(Q) - \hat{c}'_T(Q) = 0.$$

This is simply the first-order necessary condition for maximizing social welfare, subject to the caveat that $\hat{c}'_T(Q) \geq c'_T(Q)$. Substituting into Eq. (9) for c'_g from Eq. (4), we obtain an expression for the markup of the transmission fee over the agency problem induced marginal cost $\hat{c}'_T(Q)$:

$$t - \hat{c}'_T(Q) = \frac{\lambda P'(Q)Q - (p - c'_d)}{1 + \psi} - \left(\frac{\psi}{1 + \psi} \right) Q \left(\frac{dQ}{dt} \right)^{-1}. \quad (10)$$

The first expression on the right-hand side of Eq. (10) is negative: the $\lambda P'Q$ term offsets the distortion due to generator market power and the $-(p - c'_d)$ term counteracts the distortion due to average cost pricing in the distribution market. The second expression, which is positive in sign, reflects the cost of raising the incentive payment to the Transco. Thus, in general, the regulator faces a trade-off between the distortions in the generation and distribution markets and the distortion in financing the incentive contract.

⁵ The property that as the regulator's information becomes less complete, the power of incentives schemes must also decline, resulting in less cost-reducing effort by the regulated firm, is well known from Laffont and Tirole (1986), and our model is already complex enough. Kleindorfer (1998: 70) similarly notes that the Transco solution "would give rise to the problem of providing regulatory incentives through performance-based regulation to assure that the TransCo, a regulated monopolist, undertook its responsibilities in a manner which promoted system-wide efficiency."

In the event that there is no distortion associated with raising the incentive payment to the Transco (i.e., $\psi=0$), the incentive contract results in the Transco setting the transmission fee less than its reported marginal cost \hat{c}'_T so as to offset the market power in the distribution and generation markets. However, even without a distortion from funding the contract, the difference between the transmission fee t and the true marginal cost, c'_T , is

$$t - c'_T(Q) = \lambda P'(Q)Q - (p - c'_d) + (\hat{c}'_T(Q) - c'_T(Q)). \tag{11}$$

Again, the first two terms on the right-hand side of Eq. (11) are negative in total. However, the last term is positive. Thus, the difference $t - c'_T$ is (at least) a smaller negative number than is socially optimal, and may even be positive, implying that the Transco does not even begin to offset the distortions in the generation and distribution sectors.

While Eq. (7) gives the *marginal* properties of the incentive contract, the contract must also satisfy the participation constraint:

$$B_R(t) + tQ - \hat{c}_T(Q) \geq 0, \tag{12}$$

Thus Eqs. (7) and (12), taken together, fully characterize the incentive contract $B_R(t)$.

To summarize, the Transco solution suffers from two problems that may potentially prevent social welfare from being maximized: (i) regulatory slack may cause costs to be higher than necessary ($\hat{c}'_T > c'_T$), and (ii) the cost of financing the incentive contract can be distortionary ($\Psi \geq 0$).

4. The not-for-profit ISO solution

An alternative to the Transco model is the not-for-profit independent system operator (NISO). We assume that the NISO buys the transmission services at cost $c_T(Q(t))$. A NISO manages the assets of the transmission company on a day-to-day basis. This gives the NISO two important advantages over the regulator in the Transco case. First, because it manages the daily operations of the transmission system, it has much better information than an arm's length regulator. This improved information, and hence lower regulatory slack, helps to limit the scope for productive inefficiency on the part of the transmission owner. Second, also because the NISO manages the system, it can request competitive bids on the provision of transmission services, again reducing costs. For example, suppose a city far from its generation sources has increasing demand. A NISO could (a) direct the incumbent Transco to build and operate new transmission capacity; (b) take *competitive* bids to build and operate new transmission capacity; or (c) offer incentives for new local generation. Since the NISO has good information on the system and can manage it to ensure a level playing field, its preference over these solutions should only be determined by cost-effectiveness. In contrast, under the Transco model, the increasing demand is likely to be met by the incumbent Transco building new transmission capacity, since it earns a return on its new capital.

An important potential inefficiency of the NISO solution is that, being a public entity, the NISO may be subject to pressure from the various interest groups with a stake in the policies chosen by the NISO, a point we consider in Section 4.2.⁶ However, before turning to that discussion, we first examine how an “ideal” NISO would operate.

4.1. An ideal NISO

An ideal NISO is one that attempts to maximize social welfare. As will become clear in a moment, an ideal NISO will provide the transmission asset owners a subsidy S in order to alter behavior in the generation and distribution markets. Thus, we assume that the NISO’s utility is given by

$$U_1(t) = \int_0^{Q(t)} P(s)ds - c_d(Q(t)) - c_g(Q(t)) - c_T(Q(t)) - S\psi, \quad (13)$$

where $S\psi$ denotes the *net social cost* of providing a subsidy of S to the Transco, where $\psi \geq 0$ again reflects the dead-weight-losses associated with raising the subsidy. The NISO faces a participation constraint that transmission services earn non-negative profits, i.e.,⁷

$$tQ - c_T(Q) + S \geq 0. \quad (14)$$

This constraint is binding in the “non-profit” equilibrium. The objective of an ideal NISO is to choose t and S to maximize Eq. (13) subject to the participation constraint (14). Let $\mu \geq 0$ denote the Kuhn–Tucker multiplier for the constraint (14).⁸ The necessary conditions for maximization of Eq. (13) subject to Eq. (14) are

$$\begin{aligned} \frac{\partial U_1}{\partial t} &= [P(Q) - c'_d(Q) - c'_g(Q) - c'_T(Q)] \left(\frac{dQ}{dt} \right) \\ &+ \mu \left(Q + [t - c'_T(Q)] \left(\frac{dQ}{dt} \right) \right) = 0, \end{aligned} \quad (15)$$

$$\frac{\partial U_1}{\partial S} = -\psi + \mu = 0. \quad (16)$$

⁶ In addition, the relationship between the ISO and the transmission providers may entail transactions costs that do not appear in the Transco solution.

⁷ In addition, there will also be a participation constraint for consumers of the form

$$\int_0^Q P(q)dq - P(Q)Q - S \geq 0.$$

We assume that this constraint is not binding. Obviously, in the event that the constraint is binding, there will be an additional social cost.

⁸ Thus, $\mu \geq 0$, $tQ - c_T(Q) + S \geq 0$, and $\mu[tQ - c_T(Q) + S] = 0$.

Using Eqs. (4) and (16), the first-order condition (Eq. (15)) can be rearranged to yield an expression for the markup of the transmission fee relative to marginal cost:

$$t - c'_T(Q) = \frac{\lambda P'(Q)Q - (p - c'_d)}{1 + \psi} - \left(\frac{\psi}{1 + \psi} \right) \left(\frac{dQ}{dt} \right)^{-1} Q. \tag{17}$$

This expression is identical to the regulated Transco markup in Eq. (10), except that this expression involves the true costs c'_T . From Eq. (16), we see that $\mu = \psi > 0$, implying the constraint (14) is binding, as long as there exists a dead-weight-loss associated with financing the subsidy S (i.e., $\psi > 0$). However, in the event that there is no dead-weight-loss associated with financing the subsidy ($\psi = 0$), the cost of the constraint (14) vanishes. If this is the case, then Eq. (17) reduces to

$$t - c'_T(Q) = \lambda P'(Q)Q - (p - c'_d), \tag{18}$$

which is the first-best solution. The only way for this solution to be obtained is if the social cost of raising the subsidy S is nil.

The advantage of the (unconstrained) ideal NISO over the regulated Transco solution is obvious from a comparison of the markup over marginal costs given in Eqs. (18) and (11), respectively.⁹ Because the NISO has outside means of verifying costs (i.e., by seeking bids from across the electricity sector), it does not suffer the agency costs $c'_T - c_T$ that a regulator faces with a regulated Transco.

If it is not possible to use a subsidy (i.e., $\psi \rightarrow \infty$), the ideal NISO will fail to maximize social welfare. Without a subsidy, the constraint (14) implies that $t = c_T(Q)/Q$. However, for a given t , $Q(t)$, the quantity chosen by the Genco, is given by Eq. (4). If the constraint (14) is binding, then there is only one value of t , say $t^\#$, that satisfies both Eq. (14) (with $S=0$) and Eq. (4). This is illustrated in Fig. 1, drawn under the assumption that $c'_T = c'_G = c'_d = c_d = 0$ for all Q . $MR(Q) = P + \lambda QP'$ is the marginal revenue curve, which gives the quantity $Q(t)$ chosen by the generation sector for a given t ; and the curve $t = c_T(Q)/Q$ gives the value of t such that the Transco's profits are zero. Given that the marginal cost of production is zero, the first-best solution is to choose Q^* such that $P(Q^*) = 0$. However, if quantity Q^* is produced, the average transmission cost is $t_0 = c_T(Q^*)/Q^*$. Given a transmission fee of t_0 , the Genco chooses quantity Q_0 . This implies that transmission profits are negative. Thus, (t_0, Q_0) cannot be an equilibrium. Indeed, the only equilibrium value of t for which the zero profit constraint is satisfied is $t^\#$, at which the Genco chooses to produce $Q^\#$, and average transmission costs equal $t^\#$. Thus, the distortion caused by the generation and distribution sectors can only be alleviated through the transmission sector if the transmission sector is subsidized. A subsidy of S^* drops the average cost curve enough such that at $t^* < c'_T = 0$, quantity Q^* is produced. However, in general, if there is a distortion in financing the subsidy ($0 < \psi < \infty$), the solution will involve a trade-off between the distortion due to market power and the distortion due to financing the subsidy.

⁹ Each of these equations assumes that $\psi = 0$. Alternatively, we could compare Eqs. (10) and (17).

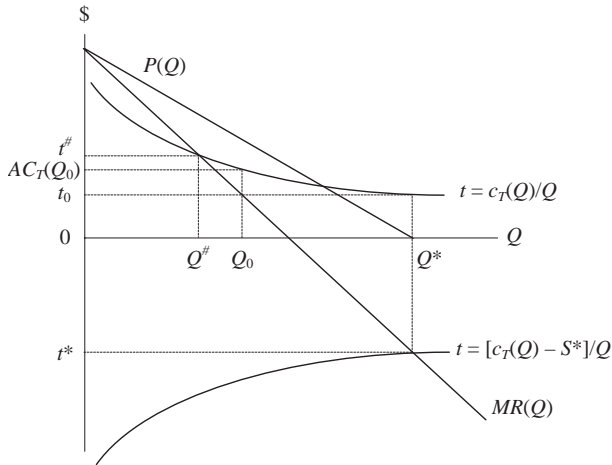


Fig. 1. Subsidies and the participation constraint for the transmission assets.

4.2. A political NISO

The NISO described above is ideal not just because its utility is synonymous with social welfare, but also because it does not face or respond to political pressure from the various interest groups. This is not realistic. To obtain some insight into the influence of industry players on non-profit ISOs, it is instructive to examine the governance of several major ISOs. Table 1 summarizes the sectoral composition of ISO managing committees in Pennsylvania–Jersey–Maryland (PJM), California (CAISO), New England (NEISO), New York (NYISO), and Ontario (IMO). In PJM, NEISO, and NYISO, there is a part-time, independent Board of Directors, but much of the practical authority devolves to a managing committee drawn from industry members. In Ontario, the IMO’s directors represent both the interests of the public and the companies involved in electricity generation, distribution, and transmission.

Table 1
Sector composition (%) of ISO managing committees

ISO committee	PJM	CAISO	NEISO	NYISO	IMO
Sector	Members committee**	Directors†	NEPOOL*	Management committee*	Directors
Unaffiliated		100			31
Generation/supply	77		53	43	19
Transmission	7		9	20	6
Distribution			18		19
Consumers	15		12	20	19
Other			8	17	6

* Manages operations only.

** Elects the Board of Directors and manages operations.

† CAISO initially had a sector-based board of directors; this was changed in March 2001. Details drawn from the website of each ISO in June 2001. Columns may not sum to 100 owing to rounding.

It might be thought that ISOs dominated by suppliers are likely to be run to maximize the benefits to existing suppliers, failing to meet the key requirement stipulated for RTOs by FERC Order 2000—independence. The [Federal Trade Commission \(1999\)](#) has similarly opined that the independence of ISOs is essential, but such independence hardly seems likely to arise if much of the managerial authority determining tariffs, rules, and development of the transmission grid remains in the hands of industry players. CAISO appears to be independent, but the directors are appointed by the Governor, and may therefore be prone to lobbying pressures. Furthermore, independence created by appointing directors with no industry affiliation comes with a cost: as Federal Energy Regulatory Commission Commissioner Curt [Hebert \(1998, p. 9\)](#) observed, “A totally disinterested management deprives the ISO of necessary expertise in fulfilling the goals of maintaining reliability and creating incentives for efficient management of the grid.”

We now consider a political NISO which cares about both the welfare of the various interest groups, although not necessarily equally. The justification for employing such an assumption is the substantial influence industry groups appear to possess in ISOs, as summarized in [Table 1](#).¹⁰ We use the common agency model of [Bernheim and Whinston \(1986\)](#) and [Grossman and Helpman \(1994\)](#) to characterize the equilibrium.

Let α_i denote the weight the political NISO places on the welfare $W_i(t)$ of each affected party, $i \in L \equiv \{g, d, c, T\}$, where a ‘c’ denotes the consumers. Let $B_i(t, S)$ denote the dollar value of transfers to the NISO from group $i \in I \equiv \{c, g\}$, contingent upon the transmission fee and subsidy.¹¹ We shall call these the “contribution” functions, with reference to the political campaigns run by the members of the NISO’s boards. We assume that both transmission operators and distributors earn zero net surplus, since there is no uncertainty and it is necessary for profits to vanish if the individual rationality constraints are satisfied. Thus, neither of these groups is able to influence the NISO via political contributions, i.e., $B_d(t, S) = B_T(t, S) = 0$.

We assume that the objective of the political NISO is to maximize a linear combination of contributions and welfare (e.g., [Grossman and Helpman, 1994](#), [Persson, 1998](#)):

$$U_N(t, S) = \sum_{i \in I} B_i(t) + \sum_{i \in L} \alpha_i W_i(t). \tag{19}$$

The weights α_i measure the value to the NISO of welfare of the different interested parties relative to the contributions $B_i(t, S)$. The gross welfare of the Disco, Genco, and transmission asset owners are given by Eqs. (1), (2), and (14), respectively. The gross welfare of consumers is simply their consumer’s surplus less the cost of the subsidy:

$$W_c(t) = \int_0^{Q(t)} P(s) ds - P(Q(t))Q(t) - S(1 + \psi). \tag{20}$$

¹⁰ At the extreme, it could be argued that the industry groups possess real authority, while the ISO Boards of Directors possess “formal authority” in the sense of [Aghion and Tirole \(1997\)](#).

¹¹ These could be in the form monetary payments such as bribes, campaign contributions or offers of future employment, or they could be in the form of non-monetary transfers such as political demonstrations, lawsuits, and other forms of political pressure. In the latter cases, $B_i(t, S)$ denotes the monetary value of this pressure to the NISO.

Each interest group faces a cost of influencing the NISO equal to $B_i(t, S)/\gamma_i$, where $0 \leq \gamma_i \leq 1$. As $\gamma_i \rightarrow 1$, the group faces vanishing transactions costs associated with raising and paying B_i dollars to the NISO. However, as $\gamma_i \rightarrow 0$, the transactions costs associated with raising and paying the contribution become prohibitive. Thus, γ_i measures the lobbying ability of group i , with an increase in γ_i corresponding to an increase in the group's ability to lobby, or, alternatively, a reduction in the group's transactions costs associated with lobbying.¹²

The net welfare of each lobby group is the gross welfare given by Eqs. (1), (2), (14), and (20), respectively, less the cost $B_i(t, S)/\gamma_i$ of making contributions $B_i(t, S)$. As shown by [Bernheim and Whinston \(1986\)](#), at the margin each contribution reflects the willingness-to-pay of each interest group.¹³ Thus the contribution from consumers satisfies

$$\frac{\partial B_c(t, S)}{\partial t} = -\gamma_c \lambda P'(Q) Q \left(\frac{dQ}{dt} \right), \text{ and } \frac{\partial B_c(t, S)}{\partial S} = -\gamma_c (1 + \psi), \tag{21}$$

and the contribution from generators satisfies

$$\frac{\partial B_g(t, S)}{\partial t} = -\gamma_g Q \left(1 + \frac{dp}{dt} \right), \text{ and } \frac{\partial B_g(t, S)}{\partial S} = 0. \tag{22}$$

The NISO takes as given the contribution functions $B_i(t, S)$ when it chooses t and S to maximize Eq. (19) subject to Eq. (14).¹⁴ Let v_T be the multiplier for the participation constraint (14). The first-order necessary condition for the political NISO is to choose t to satisfy:

$$\sum_{i \in I} \frac{\partial B_i(t, S)}{\partial t} + \sum_{i \in L} \alpha_i \left(\frac{\partial W_i(t, S)}{\partial t} \right) + v_T \left([t - c'_T(Q)] \left(\frac{dQ}{dt} \right) + Q \right) = 0, \tag{23}$$

and

$$\sum_{i \in I} \frac{\partial B_i(t, S)}{\partial S} + \sum_{i \in L} \alpha_i \left(\frac{\partial W_i(t, S)}{\partial S} \right) + v_T = 0. \tag{24}$$

From Eqs. (21), (22), and (24), the value of the multiplier for the constraint (14) satisfies

$$v_T = \omega_c (1 + \psi) - \omega_T \geq 0. \tag{25}$$

In Eq. (25), $\omega_i \equiv \alpha_i + \gamma_i$, $i \in I$, and $\omega_i \equiv \alpha_i$ for $i \in L$ and $i \notin I$, are the 'effective' lobbying weights for each constituency group. Substituting in the derivatives of W_i and B_i from Eqs. (21) and (22), and rearranging Eq. (23) using Eq. (25) yields an expression for the

¹² Alternatively, one could specify the lobbying costs as $B_i(t, S)(1 + \phi_i)$, where $\phi_i \geq 0$ (e.g., [Laffont and Tirole, 1986](#)). In this case, as $\phi_i \rightarrow 0$, transactions costs vanish.

¹³ More formally, the policy (t, S) is chosen to maximize $W_i - B_i + U_N$, for all $i \in I$, which is the sum of the net welfare of the NISO and contributing group i . Thus, the policy (t, S) is Pareto optimal, given the parameters α_i and γ_i . In addition, the policy also maximizes U_N , taking as given the contributions B_i . Combining these two implies $\partial B_i / \partial t = \partial W_i / \partial t$ and $\partial B_i / \partial S = \partial W_i / \partial S$. See [Bernheim and Whinston \(1986, Lemma 2\)](#) or [Grossman and Helpman \(1994, Proposition 1\)](#).

¹⁴ As before, there are also participation constraints for consumers and for the generators. We assume each is not binding.

difference between the transmission fee and marginal transmission costs under the assumption that the participation constraint for the transmission asset owners is binding:

$$\begin{aligned}
 t - c'_T(Q) &= \left(\frac{1}{1 + \psi} \right) \lambda Q P' - \left(\frac{\omega_d}{\omega_c(1 + \psi)} \right) (p - c'_d) - \left(\frac{\omega_d - \omega_g}{\omega_c(1 + \psi)} \right) \\
 &\times Q \left(\frac{dp}{dt} \right) \left(\frac{dQ}{dt} \right)^{-1} + \left(\frac{\omega_g - \omega_c(1 + \psi)}{\omega_c(1 + \psi)} \right) Q \left(\frac{dQ}{dt} \right)^{-1}. \quad (26)
 \end{aligned}$$

An increase in either the group’s direct importance through the welfare weights α_i , or the group’s indirect importance through the lobbying abilities γ_i , has the effect of increasing the group’s effective weight, ω_i .

Two impediments may prevent the political NISO from maximizing social welfare. One is the same problem that occurred with the regulated Transco and the ideal NISO, that the participation constraint combined with the cost of raising the subsidy imposes costs of correcting the market failure in the generation and distribution sectors. To see this, suppose there is no distortion through the effective weights, i.e., $\omega_i \equiv \omega > 0$, for all $i \in L$, so that the political NISO weights the welfare of each group equally, but the constraint (14) is binding and $\psi > 0$. Then Eq. (26) reduces to

$$t - c'_T(Q) = \left(\frac{1}{1 + \psi} \right) [\lambda Q P' - (p - c'_d)] - \left(\frac{\psi Q}{1 + \psi} \right) \left(\frac{dQ}{dt} \right)^{-1} < 0.$$

This expression is similar to Eq. (18), the first-best solution, but contains a weight less than or equal to one in value on the corrections for market power in the upstream and downstream markets (the first expression on the right-hand side), and contains an extra non-negative term (the second expression on the right-hand side). For $\psi > 0$, the second expression does not vanish. Thus, the benevolent political NISO uses the transmission lines as a means of alleviating the market failures upstream and downstream, but fails to fully alleviate the market power distortions due to the constraint (14) and the cost of raising the subsidy. As before, this problem goes away only when there is no social cost of raising the subsidy (i.e., when $\psi = 0$).

The second problem has to do with the relative political powers of the different interest groups. To see how the equilibrium changes as the political powers change, we examine the comparative statics effects of changes in the weights ω_i on the difference in $t - c'_T(Q)$.

From Eqs. (25) and (26), an increase in the weight on generators has the effect that

$$\frac{\partial [t - c'_T(Q)]}{\partial \omega_g} = \left(\frac{Q}{\omega_c(1 + \psi)} \right) \left(\frac{dp}{dt} + 1 \right) \left(\frac{dQ}{dt} \right)^{-1} < 0.$$

Thus, as the weight on generators increases, $t - c'_T(Q)$ gets smaller.¹⁵ Thus, ironically, lobbying by generators may be desirable because decreasing the transmission charge t

¹⁵ This also occurs when the participation constraint is not binding. In this event, $S^* = 0$, and $t^* Q^* - c'_T(Q^*) > 0$. Thus the change in the markup of an increase in the weight to generators is:

$$\frac{\partial [t - c'_T(Q)]}{\partial \omega_g} = \left(\frac{Q}{\omega_T} \right) \left(\frac{dp}{dt} + 1 \right) \left(\frac{dQ}{dt} \right)^{-1} < 0.$$

helps to solve double marginalization problem evident in Eq. (18). Of course, the reduction in t may be too large. For example, if $\omega_i = \omega > 0$ for all $i \in L$, the result is identical to the ideal NISO, with transmission fees reduced to adjust for the externalities. From this base, an increase in ω_g causes the transmission fees to fall too much.

An increase in distributor's weight has no effect on the choice of t , since distributors earn zero profits:

$$\frac{\partial [t - c'_d(Q)]}{\partial \omega_d} = - \left(\frac{1}{\omega_c(1 + \psi)} \right) \left(p - c'_d + Q \left(\frac{dp}{dt} \right) \left(\frac{dQ}{dt} \right)^{-1} \right) = 0,$$

where the second equality uses $dp/dt = [d(c_d/Q)/dQ] \times (dQ/dt)$, so that $Q(dp/dt)(dQ/dt)^{-1} = c'_d - p$.

Similarly, from Eq. (26), if the participation constraint is binding, an increase in the weight on transmission line owners has no effect on the choice of t . However, if the participation constraint is not binding, then

$$\frac{\partial [t - c'_T(Q)]}{\partial \omega_T} = - \left(\frac{1}{\omega_T} \right)^2 \left(\omega_c \lambda Q P' + \omega_d Q \left(\frac{dp}{dt} + 1 \right) \left(\frac{dQ}{dt} \right)^{-1} \right) > 0.$$

Thus, not surprisingly, transmission line owners will try to raise the transmission fee, which has the effect of increasing transmission profits.

Interestingly, when the participation constraint is binding, if the weight on consumers were to increase, the variable fee increases:¹⁶

$$\frac{\partial [t - c'_T(Q)]}{\partial \omega_c} = - \left(\frac{\omega_g Q}{\omega_c(1 + \psi)} \right) \left(\frac{dp}{dt} + 1 \right) \left(\frac{dQ}{dt} \right)^{-1} > 0, \text{ when } v_T > 0.$$

Consumers benefit from lower transmission fees because this increases the quantity supplied, lowering price and increasing consumer's surplus. However, they benefit from higher transmission fees because this lowers the subsidy they have to pay. As the transmission fee increases, the reduction in the subsidy consumers have to pay is larger than the reduction in consumer's surplus. Thus, consumers, prefer to have higher transmission fees, since they have to pay less in total with the higher marginal fee. Obviously, if the participation constraint were not binding, so that the optimal subsidy were zero, then consumers would prefer that t decrease, since then the only effect is the increase in consumer's surplus.

While in this model we have allowed only a single price for transmission, in reality transmission is typically location-based and has differential pricing based on various characteristics of the service: location, reliability, voltage, line losses, impact on the rest of the system, and so on. So a more sinister possibility exists in cases where the NISO is captured by generators beyond simply depressing transmission prices: Gencos may use the

¹⁶ Because consumers are such a diffuse interest group, it is difficult to imagine how their influence could be significant (e.g., Olson, 1965). Indeed, if one were to stack the board of directors with consumers it is probable that disinformation from generators and transmission asset owners would be sufficient to sway their decisions.

transmission system to *exclude* competitors.¹⁷ It is this fear that has motivated the unbundling of generation and transmission control. And as Leautier (2001) shows, generators have incentives to reduce transmission *capacity* to increase their own local market power. It is ironic that in so many ISOs, Genco representatives are dominant in the managing committees, making it unlikely that any non-profit ISO will remain unaffected by the lobbying efforts of the industry players.

In summary, our comparison of the Transco model and NISO model suggests the following. While NISOs are better able to control the Transco's costs because of their management of the system, they are also more subject to lobbying and influence activities by industry players. As we have shown, such lobbying may be efficient, but as a rule, it is likely to be undesirable. Thus, a decision about which system is preferred in a particular situation should revolve around the question of whether the distortion from lobbying the NISO is likely to be greater or less than the distortion from uninformed regulation of the Transco.

5. The for-profit ISO solution

The for-profit ISO, or PISO, solution we have in mind is similar to that used in Alberta, Canada, involves a regulator offering the PISO an incentive contract $B_R(t)$ of the form considered in the Transco solution. This contract has marginal properties as given by Eq. (7).¹⁸ The PISO will clearly share some properties with the NISO model and some with the Transco model, since we are both introducing an incentive contract and separating the management of transmission assets from their ownership.

5.1. The PISO solution

The PISO's objective function is to choose t to maximize

$$U_P(t) = B_R(t) + tQ - c_T(Q).$$

The most significant difference between the PISO solution and the Transco solution considered above is that the PISO, like the NISO, is involved in the day-to-day operation of the transmission lines. Thus, the PISO has much better information regarding costs than does the regulator overseeing the Transco. At the same time, the PISO is able to ensure equal third party access through its direct management of the transmission system. Therefore, the costs the PISO faces are likely to be closer to the true costs, $c_T(Q) < \hat{c}_T(Q)$.

The PISO chooses t such that

$$\frac{\partial U_P}{\partial t} = B'_R(t) + [t - c'_T(Q)] \left(\frac{dQ}{dt} \right) + Q = 0,$$

¹⁷ Harming competitors might come through charging high prices for new connections; limiting expansion of the transmission capacity so as to create pockets of market power; or providing preferential scheduling for some plants.

¹⁸ Since the PISO is a self-interested firm comparable to a regulator, this setup resembles in some ways the framework of Demski and Sappington (1987).

where $B_R^A(t)$ given by Eq. (7). The solution must satisfy

$$t - c'_T(Q) = \left(\frac{1}{1 + \psi} \right) (\lambda P'(Q)Q - (p - c'_d)) - \left(\frac{\psi Q}{1 + \psi} \right) \left(\frac{dQ}{dt} \right)^{-1},$$

which is the solution to the “ideal” NISO (Eq. (10)). Thus, the PISO solution maximizes social welfare, given the cost of financing the incentive contract.

What can go wrong? One possibility is that the transmission owners and the PISO collude. However, the PISO’s declared costs are the transmission owner’s declared revenues, and both the transmission fee and the quantity produced are public information. Under this arrangement, the only way for both parties to benefit would be for the PISO to pay a t higher than the solution above, and then to receive its share of the excess profits as a kickback from the transmission owners. Such a scheme would be obvious to even the dullest auditor.

In comparison to the NISO, a PISO is not susceptible to lobbying and influence activities, which can either enhance or diminish welfare (although there is a strong case to be made that they are in general harmful). In principle, the managers or directors of a PISO could be lobbied. However, such behavior is unlikely to be productive, since the principal reward to workers in the private sector comes from their remuneration, which depends upon their contribution to the profits of the firm.

5.2. Relative cost efficiency of for-profit and not-for-profit firms

Are there other reasons why one might prefer a NISO to a PISO? For example, is there any reason to think that a NISO would somehow be more efficient? In this section, we briefly examine recent evidence on the relative efficiencies of not-for-profit versus for-profit organizations. Although this summary of studies on the cost-efficiency of non-profits vs. for-profits is rather cursory, it does at least provide some support for the claim that a NISO is unlikely to be more efficient than a PISO.

For-profit firms have strong incentives to reduce cost, since their shareholders retain the increased profits. The implementation of a business plan by the executives may not be perfectly in line with what shareholders would prefer, since the executives may value spending more on wages, pleasant workplace surroundings, and so on. However, shareholders will exert pressure on executives to reduce costs, and in a competitive environment this effect can be very powerful. In contrast, non-profit firms do not have the same incentives to cut costs. The benefits to managers and board members of ensuring that system quality is high may overwhelm any perceived benefits to them personally of cost-cutting. Basically all of the benefit from cost-cutting in a NISO must flow through to consumers. But the unpleasantness of cost-cutting—firing staff, reorganizing operations, taking risks—are suffered by the NISO’s board and executives, so one would not expect much cost-cutting from a NISO.

The existing empirical studies of efficiency comparisons between non-profits and for-profits firms in markets where *both* exist tend to suggest that on balance the for-profits have an efficiency advantage. Almost all the studies find either that for-profits

Table 2
Empirical studies of cost efficiency

Author (year)	Industry	Efficiency advantage		
		For-profit	Non-profit	Neither
Ferrier and Valdmanis (1996)	Hospitals	×		
Fizel and Nunnikhoven (1992)	Nursing homes	×		
Frech (1984)	Nursing homes	×		
Knox et al. (1999)	Nursing homes	×		
Mark (1996)	Psychiatric hospitals			×
Mocan (1995)	Child care	×		
Mocan (1997)	Child care			×
Nyman and Bricker (1989)	Nursing homes	×		
Preston (1993)	Child care			×
Register and Bruning (1987)	Hospitals			×
Rosenman et al. (1997)	HMOs	×		
Van-Lear and Fowler (1997)	Group homes		×	
Vitaliano and Toren (1994)	Nursing homes			×

are more efficient or equally efficient. In only one empirical study of cost efficiency is it found that non-profits are more cost efficient. Table 2 summarizes some recent studies.

One of the problems with the studies noted in Table 2 is that such studies can, by definition, only be performed in industries in which both non-profits and for-profits exist. But this is a relatively small set of industries in our economy. In a large number of industries, there is simply no comparable set of non-profit firms. The implication is that for-profit firms are strictly dominant in those industries (e.g., Michaels, 1999, pp. 240–244). The set of industries where non-profits are common includes religious organizations, charities, universities, research organizations, nursing homes, hospitals, and day cares. Non-government-owned non-profits are a rarity outside this set of industries, so a non-profit ISO is really a very unusual institution.

In addition, there is evidence that non-profits pay about the same as for-profit firms, after controlling for industry and for individual characteristics such as education and experience (Ruhm and Borkoski, 2000; Leete, *in press*). Thus, the extra efficiency many studies claim to find in for-profit firms derives not from lower wages but from management that is more efficient.

6. Conclusions

This paper compares alternative institutional arrangements for the governance of electricity transmission systems. The two most common governance institutions observed are the regulated Transco solution, which is primarily observed in the UK, and the not-for-profit independent system operator, observed in the United States and Canada. A less common, but particularly interesting institution is the for-profit independent system operator system, recently employed in Alberta, Canada.

The regulated Transco solution has the problem that cost control by the regulator is impeded by asymmetries of information between the regulator and the Transco. The not-for-profit ISO solution has the advantage over the regulated Transco in this regard, since the NISO can utilize its position as the day-to-day manager of the system to learn about, and thus reduce, the costs of operating the system. However, the NISO has the disadvantage that it is susceptible to political manipulation. The evidence on this hypothesis is that the generation sector is prominently represented in most existing NISOs. The for-profit ISO has been shown to have advantages over each of these alternatives. Like the NISO, and unlike the regulated Transco, the PISO has the means to ensure that costs are held low, since it is involved in the day-to-day management of the system, and because it has the potential for calling for competitive bids in many aspects of the services it provides. In addition, the PISO solution, unlike the NISO, is not as likely to be susceptible to political pressure, since it is driven by a profit motive.

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