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IMPLEMENTING TRANSMISSION OPEN ACCESS: WITH SPECIAL EMPHASIS ON CHILE'S EXPERIENCE

PABLO SPILLER

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by

Pablo T. Spiller*
Haas School of Business
University of California, Berkeley

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Abstract

Chile's reforms of the electricity sector are pathbreaking: elimination of monopoly franchise, deregulation of generation and of new generation investments, introduction of direct access for large users, break-up of vertically integrated utilities, centralized dispatch undertaken by a private entity, and the introduction of an innovative regulatory system based on marginal cost pricing and on the role of a putative efficient firm. After 15 years of reforms, it is time to ask whether it is possible to improve upon a system that is, quite clearly, among the most efficient and sophisticated in the world. The current paper has two main purposes: first, to present the main shortcomings in Chile's transmission pricing policy and possible solutions; second, to show that this problem may not have a global optimal solution.

1. Introduction

When in the late 1970s the Government of Chile determined to reform the electricity sector it broke, albeit only silently at first, several tabus. Chile's reforms were path breaking: elimination of all monopoly franchises (including in transmission and distribution), deregulation of generation and of new generation investments (except for hydro), introduction of retail wheeling for large users, break up of vertically integrated utilities, centralized dispatch undertaken by a private entity, the introduction of an innovative regulatory system based on marginal cost pricing and on the role of a putative efficient firm. When these reforms were enshrined in the Law (DFL 2, 1982), Chile was a lone sailor at the forefront of the regulatory reform regatta.[1] Since then more and more regulators, academicians and even industry people have come to realize that electricity is not that different from any other commodity business, where private agents take risks and get rewarded for their actions.[2] Although there are peculiarities to the sector, which may call for government supervision, the lesson that the Chilean reformers have given is that light handed regulation may suffice. Since then a similar view has been taken by the governments of the Uk, New Zealand, Norway, Argentina, and Peru to name just those that have followed to some extent the Chilean route.

Although Chile's reforms were pathbreaking, bringing about a substantial amount of

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[1] For a discussion of the Chile's regulatory reforms, see Spiller (1993).

[2] It may be interesting to mention that the reforms undertaken by Chile in 1980 were neither funded nor supported by the World Bank or any other international organization.

private investment, increasing quality of service and reducing the real price of electricity, after fifteen years of successful performance it is fair to start questioning whether it is possible to improve upon a system that is, quite clearly, among the most efficient and sophisticated in the world. The current endeavor has two main purposes: first, to present the main shortcomings in Chile's transmission pricing policy and possible solutions; second, to show that the problem of transmission access has no global optimal solution.

II. Key Shortcomings of Chile's Transmission Pricing Policy

As has been mentioned by many before,[3] transmission is the only important part of the electricity system that may still be subject to large economies of scale. Economies of scale have important implications for transmission investment. Perhaps the most important is that at the optimal investment level, short run transmission pricing will not recover all investment costs [Schweppe et al.]. Thus, to achieve the optimal level of investment, other payments will be required.

By now it is well understood that what is called short run transmission pricing is nothing but the difference in spot prices at the ends of a transmission link. In Chile this is called the "transmission tariff." It may be better to call it a "transmission rent."[4] This transmission rent

[3] See Rudnick et al (1994).

[4] Indeed, there is no need for that transmission rent to accrue to the owners of the transmission link in question. It would be perfectly possible that such transmission rent would accrue to the pool and that owners of the transmission links will be paid a fixed payment based on

will be composed of the value of the excess of marginal over average losses and of the value of constraints.[5] If, however, node prices are distorted by regulatory measures,[6] so that they do not properly reflect marginal losses and transmission constraints, then the transmission rent will be reduced, and the need for supporting transmission investments through other mechanisms is exacerbated.

To understand the issues involved in providing for transmission investments, it may be worth discussing some of the basic problems in the design of transmission pricing in Chile which may be behind some of the perceived problems with access.

The first basic problem with transmission pricing in Chile is that since constraints are not included in node prices, there is a need for an excessive supplemental payment to cover transmission investment costs. A second problem is the mixing of what should be purely financial transactions with operational considerations. Finally, the third basic problem with transmission pricing is the mixing of sunk cost recovery with investment financing.

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some particular arrangement.

[5] Constraints give raise to what may be called "out of merit" dispatch. What that means is that generation marginal costs at both sides of a constraint will differ by more than marginal losses. The source of such a constraint is irrelevant, whether it is the result of thermal rating or security considerations.

[6] Regulatory distortions may arise from government imposed measures or from pool regulations.

a. Marginal Node Prices Do Not Reflect Constraints

Nodal prices in Chile are based on what has become known as "location factors." These are fixed factors that are applied to different nodes based on the expected marginal losses throughout the year, as they relate to the "center of gravity," or reference point, of the system. There are several problems with fixed location factors. First, since marginal losses are related to flows, marginal losses vary from moment to moment. In particular, truly marginal losses may be several times higher at the peak than at off peak times. Similarly, they may vary from day to day, and through the seasons. Thus, what is being used in Chile is the "average of marginal" rather than marginal losses. Elsewhere I have computed that moving from location factors to truly marginal node pricing can increase the transmission rent several times,[7] substantially reducing the need for a supplemental transmission charge. Thus, the fact that, as mentioned in Rudnick et al, marginal cost pricing recovers only 14% of total transmission investment costs may reflect the lack of truly "marginal pricing" of electricity in Chile.

Moving towards a truly marginal node pricing may require changing the way electricity is dispatched in Chile. For example, rather than the Central Dispatch Center (CDC) using declared marginal costs of the generators for its economic dispatch process, nodal wholesale markets may have to be developed where users and generators make bids, which are then reconciled by the

[7] See Spiller, Cox and Teece (1994).

CDC to assure that system constraints are taken into account.[8]

Thus, nodal wholesale spot markets will alleviate, although may not eliminate, some of the need for supplemental cost allocations in Chile, and elsewhere. A second advantage of developing a truly wholesale market is that it will allow for the separation of financial from operational considerations, which is the topic of the next subsection.

B. The Mixing of Financial and Operational Considerations

The regulations in Chile prohibit users and generators to undertake, in a conscious way, spot transactions. Indeed, all users of the grid have to have long term contracts for service. Generators have to sell all their available capacity through long term contracts, and users have to have long term contracts with particular generators to back up their consumption.[9]

While I have no quarrel with this regulation, the problem arises when operational considerations are mixed with what should be purely financial transactions. Indeed, if a truly spot wholesale market was operating in Chile, then we could perfectly decouple the operations of the system from financial transactions. These long term contracts would then simply be "contracts for differences," where the parties to a transaction agree on a particular price for a

[8] See Spiller, Cox and Teece (1994) and Outhread (1994) for discussions of the advantages of problems with nodal wholesale markets.

[9] Short term deviations of contracted amounts are satisfied in the "spot market."

particular amount of energy. In a system with nodal wholesale markets, these contracts for differences will have to be node specific. The parties then may have to enter into "transmission forward" contracts to insure themselves against movements in the transmission rent associated with the respective consumption and generation nodes. With those two set of contracts, the buyer's risK is only whether it will consume more or less than the quantity it actually transacted. Similarly, the risk of the generator is whether it will be called to generate and what its marginal generation costs would be (Spiller, Cox and Teece 1994).

These types of contracts truly decouple operational from financial considerations. These contracts are simply forward contracts with no particular delivery requirement. In Chile, however, long term contracts are assumed to have operational implications. The most important of all is the fact that although Chile's operations are based on a "pool" concept, where economic dispatch is the rule, its financial transactions are undertaken on a "wheeling" concept. Long term contracts are not simply insurance mechanisms, but they are believed to be physical transactions. Thus, the creation of the concept of zone of influence and of supplemental tariff allocations.

Chile's wheeling charges are divided in two categories: zero and positive (see Rudnick, et al). Zero wheeling charges apply to those contracts for which users are located in the "zone of influence" of the generator in question. Positive wheeling charges (i.e., supplemental transmission charges, or "toll") apply to those contracts for which the user is located outside the generator's "zone of influence." Zones of influence are determined based on load flow

simulations.[10] The rationale for the extra toll is that if a generator wants to provide service to a user that is far away, it has to pay some contribution to investment costs.

Unfortunately, while intuitive, this arrangement creates several inefficiencies, and it is the source of some of the problems mentioned in Rudnick, et al.[11] First, it distorts consumption below the optimal. Marginal consumption prices should be equal to the node price (accounting for instantaneous marginal losses and whatever constraints there are). Funding of sunk costs (the purpose of the extra toll) should not affect marginal consumption decisions. One can argue, however, that users that are far away from generation nodes should be charged the costs of transmission investments, and that this is one way of doing it. The problem, however, is that this way of doing it is inefficient as it distorts consumption.

Second, it provides local market power to generators over and beyond the value of marginal losses and constraints. To see this, consider a user located far away from the main generation center. Generators may be required to pay supplemental transmission tolls if they would enter into long term contracts with those users. Assume, now, that a generator locates close to those loads. It will be able to enter into a long term contract for a price that would include a premium over marginal losses. That premium would equal the toll that a marginal

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[10] Generators are requested to pay lump sum payments associated with the value of the assets, and their prorated use, in their zone of influence.

[11] For example, Rudnick et al mentions that some distributing companies in the north have been unable to obtain long term supply contracts, as the toll charges are too high.

generator would have to pay for any contracted amount with that customer. Observe, however, that such a premium reflects short term market power and not marginal transmission costs. Although such premium may be related to transmission investments, those are sunk, and sunk costs should not impact on marginal prices.

Third, it distorts location decisions by generators. In particular, as discussed above, supplemental toll charges provide a locational premium to generators that locate close to far away loads. This premium is independent of the status of the transmission links connecting those far away loads. While it may make economic sense in the future to invest in a close in generator rather than upgrading the transmission link, generators have no incentive to wait for a need to upgrade the transmission link. Even if the transmission link experiences no congestion, the locational premium may be enough to promote investment in far away generation, reducing the use of the transmission link. The reduction in the utilization of the transmission grid and the investment in generation represents an economic loss that increases the cost of delivered energy in the system .

If the toll would be eliminated, and instead all transmission asset costs would be divided according to some "area of influence computation,"[12] then those transmission charges would be of a lump sum payments, and long term contracts would not be influenced by their magnitude. Furthermore, consumption and investment decisions will not be influenced by sunk cost

[12] Like those proposed by Rudnick et al.

considerations.

c. The Mixing of Sunk Costs and Investment Financing

A final problem with the Chilean transmission pricing scheme is that it mixes recovery of sunk costs with funding of transmission expansions and investments. Chile's Law provides the investor in a transmission grid the ability to charge tolls and the right to receive payments according to "areas of influence." These collections should be in addition to the expected transmission rent. Overall revenue, however, should be sufficient to compensate for facilities that provide "adequate quality and security of service." (Rudnick, et al., p 2).

The law, then, provides essentially for a transmission owner to recover its investment costs. Furthermore, it will be extremely difficult for the regulator to determine that the costs associated with assets in place should not be recovered. Thus, the law provides for a peculiar incentive to over invest in transmission.

This overinvestment incentive, however, could be eliminated if, as in Argentina and in New Zealand, any transmission investment or expansion has to be fully pre-subscribed.[13] This approach would then fully decouple sunk cost recovery from investment financing. Indeed, after a period of years, sunk cost recovery will play a very minor role, as most transmission payments

[13] This approach was endorsed by the Western Regional Transmission Group's application to the Federal Energy Regulatory Commission. See WRTA's application.

would have been agreed among users and the builders of transmission capacity.

Although these three shortcomings main seem to be solvable, solutions often bring problems of their own. I discuss those problems in the next section.

III. The Impossibility of an Optimal Transmission Policy in a Decentralized Environment

An optimal transmission pricing policy should have two features: 1) provide for optimal short term electricity consumption; and 2) provide incentives for the optimal dimensionalization of the transmission grid. Feature 1) requires that consumers pay and generators receive short term marginal costs. Feature 2) requires that the transmission grid is optimally designed. The proper dimensionalization of the transmission grid also implies that investments in generation will not be distorted. In principle, a policy that grants investment decisions to a disinterested body and that recovers those investments in truly non-distortionary taxes, in an environment where investment decisions are privately made, achieving both policies is impossible. The reason is very simple. Investments have to be recovered. They are either recovered by subscription (in which case contracts can be made so that they do not distort marginal incentives), or they are recovered by ex-post payments. Either way has implications for the efficiency of consumption.

a. The Problems Associated with Subscription Methods

Consider first the problems associated with a subscription method. Assume that users recognize that their energy costs could be reduced by expanding the transmission capacity. Such investments require that users pay (either up-front or through fixed payments for a period of years) the appropriate investment costs of the expansion. Here the economies of scale in transmission raise an unavoidable complication. Under most conditions the efficient expansion exceeds that required by the current users of the grid (including generators) at this time. If the current users (and generators) fully subscribe such expansion, future users will free ride on the investment undertaken by the "old" users. This creates a "game of chicken" problem among current users. If you subscribe to the "optimal" expansion you pay a share of its cost. If you do not subscribe you pay nothing. Not subscribing, for example, may mean having to wait for your generating plant to be built *after* the transmission expansion was undertaken. Those that will benefit from the transmission expansion figure out that future users will not be paying, and thus unless future users are somehow excluded there will be an incentive for current beneficiaries of the expansion to delay it.[14]

One way of excluding future users is to dimensionalize the expansion to the needs of the current subscribers. This implies, then, that those that do not subscribe, including future users, may have to undertake their own expansion program. Thus, investment will be suboptimal.

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[14] For an application of this insight to investments in gas pipelines, see Spiller and Teece (1994).

To summarize, requiring all transmission investments to be recovered only through subscription distorts transmission incentives towards underinvestment, raising congestion costs and nodal prices. While short term prices are efficient, the size of the network is inefficient.

b. Problems Associated with Sunk Cost Recovery

So that sunk cost recovery does not distort short term consumption incentives, sunk costs should be recovered in a lump sum fashion. While such sunk cost recovery will have no implication for short term prices, it will have implications for investment in generation. There are two problems associated with generation. First, it distorts locational decision, and second, that it creates an entry barrier, limiting competition. Consider the locational decision of a generator.

Since sunk cost recovery will be based on some type of load flow or some other lump sum method, generators considering locations will only care about the node price that they will get in the different locations. Generators will not, however, take into consideration the fact that in one location they may force an investment in transmission capacity, while in another they will not. As a consequence, generators will not necessarily locate in unconstrained locations, increasing the need for transmission investments, and thus, increasing the overall costs of delivered energy.

A second implication of sunk cost recovery is that such lump sums may discourage a

marginal generator from investing even if there is ample excess transmission capacity.[15] Sunk cost recovery, then, restrains competition in the generation market, with its implications for the prices of delivered energy.

IV. Summary

There have been several proposals for allocating sunk costs based on benefits that transmission investments generate to users of the system (e.g., Rudnick et al). These schemes, however, only relate to sunk cost recovery, and they do not take into account the efficiency implications of such recovery. Furthermore, as applied to the Chilean case, they do not take into account the fact that sunk cost recovery has important efficiency implications. In this paper I have not tried to attempt to ascertain the respective benefits of alternative investment financing methods. It seems reasonable to believe that there will be some conditions under which one method will be more efficient than the other. For example, in a sector where growth will be mostly internal, a subscription approach will provide incentive to internalize the investment externalities. When growth comes from new users, though, such internalization will not take place and the subscription approach will fail to deliver an efficiently sized transmission grid. Similarly, in a sector with very little growth, so that no new entry is expected, sunk cost recovery through lump sum payments of incumbent generators may not have important inefficiencies. But such will also be the case with the "subscription" method. A full analysis of the respective

[15] This would be the case, for example, if for some reason prior investments were way above the necessary for the growth of the system.

methods advantages and disadvantages, though, is left for future research.

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