Conflicting Investment Incentives in Electricity Transmission

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Summary of Panel Presentation

In economics, it is usually assumed that the maximization of social welfare is the desired goal and that optimizing this objective is sufficient to achieve Pareto efficiency, considering "adequate and costless" transfers among market participants. However, this principle is not always true in deregulated electricity systems, where transfers are not always feasible and even when attempted are subject to many imperfections.

In the U.S. electric system, which was originally designed to serve a vertically integrated market, there are misalignments between payments for and rewards from transmission use and investments. In fact, while payments for transmission investments are made locally (at state level), the rewards from these transmission investments (based on rate-of-return regulation) are dictated by FERC (at the federal level) who has jurisdiction over the transmission network . This creates side payments, which do not allow "adequate and costless" transfers among market participants. Consequently, the maximization of social welfare can be incapable of achieving Pareto efficiency in the electricity system and other optimizing objectives should be considered. Unfortunately alternative objectives may produce conflicting results with regard to the desirability of transmission investments.

This work illustrates the potential existence of conflicting incentives concerning electricity transmission investment. Specifically, we show that even in simple radial networks, different desired optimizing objectives could result in divergent optimal expansions of the transmission network. Consequently, finding a unique network expansion policy could be a very difficult, if not impossible, task.

For any given transmission network, the respective system operator (or the corresponding regulatory authority) would ideally like to find and implement a network expansion that maximizes social welfare, minimizes local market power of the agents participating in the system, maximizes consumer surplus and maximizes producer surplus. Unfortunately, these objectives are not always compatible with each other.

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A key issue is that transmission investments have important distributional impacts. This means, for instance, that while society as a whole may benefit from the elimination of congestion, some parties may be harmed. As it is well known, transmission investments generally attain rent transfers away from load pocket generators and from generation pocket consumers to load pocket consumers and generation pocket generators. However, load pocket consumers and generation pocket generators cannot simply decide to build a line linking them. Their decision will be subject to scrutiny by not only a system operator, but also state and federal energy and environmental regulators. In this type of environment, the "losers" from transmission investment can be expected to expend up to the amount of rents that they stand to lose to block the transmission investment. This rent dissipation is wasteful. Moreover, it may block socially beneficial projects from being built.

The possible presence of an "incompatibility" among optimizing objectives is independent of the complexity of the transmission network structure. For example, a simple radial network captures all the information needed for the characterization of this incompatibility.

Consider a network composed of two nodes satisfying their electricity demand with local generators. Assume there exists only one (monopolist) generator in one of the nodes, say node 1, while there exist many small independent generators (forming a perfectly competitive market) at the other node. Furthermore, assume the generator located at node 1 has a production marginal cost lower than the marginal cost of production at node 2, but the price of electricity at node 1 is higher than at node 2. We are interested in evaluating the benefits of building a transmission line with adequate capacity linking both nodes.

In this case, we can distinguish two effects of the construction of the adequate-capacity transmission line. On one hand, competition among generators increases. This effect "forces" the generator at node 1 to decrease its retail price with respect to the self-sufficient-nodes scenario (SSNS). This price reduction will likely cause an increase in the node 1's consumer surplus and a reduction in the profit of the generator at node 1, with respect to the SSNS.

On the other hand, the transmission expansion causes a substitution (in production) of some low-cost power by more expensive power, as a result of the exercise of local market power by the generator located at node 1. Under the new scenario, the generator at node 1 can reduce its output level (although the quantity consumed at node 1 can increase with respect to the SSNS) and keep a retail price higher than the SSNS market-clearing price at node 2, to maximize its profit. If this happened, then the node 2's generators will produce more power (increasing both the generation marginal cost and the retail price at node 2 with respect to the SSNS equilibrium) to increase their surplus. The node 2's generators will increase their output levels up to the point in which the retail price at both nodes are equal and the total demand is met (assuming transmission constraint is not binding). At this new equilibrium, the producer surplus at node 2 will increase while the consumer surplus at node 2 will decrease with respect to the SSNS. In other words, because the power generation at node 1 is cheaper than that one at node 2 for the relevant output levels, the exercise of local market power by the node 1's generator causes a substitution of some of the low-cost power generated at node 1 by more expensive power produced at node 2 to meet demand. This out-of-merit generation, caused by the transmission expansion, reduces social welfare with respect to the SSNS.

While the substitution effect is social-welfare decreasing, the competition effect is social-welfare improving in the previous example. Which effect dominates depends on the particular cost structure of generators and the demand at each node. Therefore, for some particular cost and demand structures, the transmission expansion that minimizes the local market power of generators (building the adequate-capacity transmission line, in this case) can be different from the expansion that maximizes social welfare. Likewise, the maximization of social welfare, the minimization of local market power, the maximization of consumer surplus, and the maximization of producer surplus can all result in divergent optimal expansions of the transmission network.

Moreover, even when the optimizing objective is clearly determined, the optimal network expansion under that objective changes depending on the cost structure of generators. Given that the production costs of generators change depending on factors like generation capacity, the optimal network investment depends on these factors. That means, for instance, that, without modifying the network structure at all, the current optimal expansion under some optimizing objective could be sub optimal, under the same objective, when considering a generation expansion plan.

This interrelationship between generation and transmission investments must be incorporated when evaluating any transmission expansion. However, defining the optimal expansion of a network as a function of the strategic behavior of generators is a very complex task due to network externalities and the complementarities and substitutabilities of different generation and transmission expansion projects.