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Transmission Rights and Market Power

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1. Introduction

Historically, the primary barrier to greater competition in the electricity industry has been the vertical integration of most firms. Control of the transmission grid can advantage some competitors at the expense of others. In electricity markets around the world, policymakers have attempted to solve this problem through the creation of independent 'gridcos' or 'system operators' that operate their network in a non-discriminatory manner.[1] To date, most of the concern about market power has therefore focused on the horizontal market power of large generation companies. However, the introduction of transmission rights into this process adds a new set of market power concerns. To the extent that transmission rights provide their owners with an added level of influence or control over transmission markets, some of the original concerns over 'vertical' market power must again be considered.

Stakeholders throughout the United States are currently working to reach a consensus on the structure and protocols that will define tradable transmission rights in the context of the various wholesale electricity markets, and their associated Independent System Operators (ISOs), now forming in different regions of the U.S. Much of the discussion has focused on the relative merits of physical transmission rights in comparison with financial transmission rights. Proponents of physical transmission rights express a desire to reduce uncertainty in transmission service without having to submit to the vagaries of relatively untested transmission pricing schemes. However, this security comes at a potentially high cost.

Most of the concern about physical transmission rights relate to the ability to implicitly or explicitly remove that transmission capacity from the marketplace. Under a very strict form of physical right, owners could simply choose not to sell it if they don't want to use it. Modifications that require the 'release' of spare capacity back into an open market

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[1]These institutions in some cases also own and maintain the transmission that they operate. In other cases, such as California's ISO, ownership of the transmission assets remains with incumbent utilities.

could potentially alleviate this problem, but there is concern that such releases would not occur far enough in advance to be of much use to schedulers. Similarly, the transmission capacity that is made available for use by non-rights holders can also be manipulated by the owners of transmission rights.

The alternative form, financial transmission rights, provide to their owners congestion payments, but not physical control of transmission paths. In electricity markets such as California's, even financial transmission rights could potentially be utilized to effectively withhold transmission capacity from the market place. However, methods for withholding transmission capacity are somewhat more convoluted, and probably more difficult, for owners of financial rights than for owners of physical rights. In this paper, I discuss some of the potential concerns over transmission rights and their use for the exercise of various forms of market power.

2. The Value of a Transmission Right

Once regional electricity markets begin operating in a fashion consistent with their intended design, we will begin to see an electricity marketplace with a level of price volatility that accurately reflects the cost volatility inherent in operating an electricity system characterized by limited storage and widely fluctuating demand. The electricity industry is also characterized by high capital costs driven by the periodic need for very expensive and lumpy additions to the generation and transmission stock. It has long been argued that this combination of widely fluctuating prices and relatively risky investment decisions makes necessary the creation of long-term instruments to mitigate the risks involved in participating in this industry. While both forward and futures markets for electrical energy have already been developed and are expected to expand, there remains the problem of mitigating the risks associated with the physical delivery requirements of these energy contracts.

The role envisioned for transmission rights is to fill this need for insuring against the delivery, or basis, risk imposed by location specific energy contracts. For example, consider a firm wrote a contract to sell power to someone at point B, and its generation were at point A. In order to hedge its locational price risk, the firm would want to be sure that it could either ship its power from A to B or that it could close its position at point B for its equivalent production cost at A. It is also hoped that the codification of transmission property rights would help to provide economic incentives for efficient investment in additional transmission and generation resources.[2] Furthermore, it has been argued that the creation of a liquid secondary market in transmission rights can help reduce the potential for the exercise of market power in the generation of electricity.[3]

[2] It appears that there are many issues yet to be resolved if this hope for efficient investment signals is to be fully realized, see Oren, et al., (1997), Bushnell and Stoft (1996) and (1997).
[3] See Stoft (1998)

The problem at hand, therefore, is to create a fungible form of transmission property that can, for a price, provide the equivalent of guaranteed access to an electricity market in a given location, regardless of the congestion levels experienced in the network surrounding that market. The metaphor for a physical transmission right is a 'right-of-way' on the network for the electrons belonging to a given generator. The metaphor for a financial transmission right is an option contract that guarantees its owner the right to sell power at the spot price at a given location in the network, regardless of where that power is injected into the network. Unfortunately, the complexities of power flows and the requirements of maintaining the integrity of the transmission grid make both these metaphors somewhat misleading.

Financial transmission rights are often paired with markets that employ pool-based, nodal pricing while physical rights are usually discussed in the context of a decentralized market of bilateral trades. However, it is important to remember that these linkages are not absolute. A financial form of transmission right can easily be developed for California's decentralized transmission market, while some kind of physical, albeit complex, property could probably be developed for a nodal market.[4] The form of market does not necessarily have to reduce the options for the form of transmission rights.

3. Financial Transmission Rights

Financial transmission rights, as their name implies, provide no direct influence on the dispatch decisions of an ISO. Such a right would entitle its owner to be paid the transmission price on a given path (multiplied by the number of rights the owner has), or, in a nodal market, the price difference between two nodes. This payment would net out any price risk associated with using that transmission path. Importantly, such payments would be made to each owner of such rights, *regardless* of that owner's actual usage of the transmission system. The payments under this right are therefore independent of the owner's physical use of the grid.

While financial transmission rights, more commonly known as transmission congestion contracts were originally conceived as a complement to a pool-based nodal pricing regime,[5] the concept is certainly transferable to zonal markets such as California's. In California, the price discovery process focuses on the cost of transmission across a congested path between market zones.[6] Through the use of adjustment bids, the California Independent System Operator (ISO) modifies the proposed dispatches of market participants in a way that results in a single transmission price, to be paid by all

[4] Such rights should be approached with caution, due to the potential for adverse incentives for the investment and maintenance of transmission facilities. See Wu, et. al (1996) and also Bushnell and Stoft (1996).
[5] See Hogan (1992) and Harvey, Hogan, and Pope (1997)
[6] See Bushnell and Oren (1997).

participants who create the flows that are responsible for the congestion.[7] An agent can guarantee its access to flows across a congested path by not participating in this transmission market, but by doing so, this agent exposes itself to considerable price risk since it is committing to pay the transmission price, no matter how high it is.[8] A financial transmission right could eliminate this price risk.

3.1. Modifications to Financial Rights

The above definition of a financial transmission right is, by necessity, a stylized one. Various modifications of this basic template have been proposed to suit the needs of different wholesale markets. One prominent proposal is the inclusion of a 'tie-breaker' clause that would provide dispatch preference for the rights holders in the event that the ISOs congestion management protocols are insufficient for relieving congestion. In the context of the California market, this problem may arise if there are insufficient 'adjustment bids' to relieve congestion.

Unfortunately, financial rights, with or without the tie-breaker preference, could also potentially be used to withhold transmission capacity from the market. This problem is discussed further in section 5.

4. **Physical Transmission Rights in the California Marketplace**

A similar but alternative form of transmission right would not fully disconnect rights payments from physical usage. An owner of a physical transmission right would be guaranteed free usage of a congested path between zones A and B (up to a level commiserate with the number of rights the owner has). The owner would have the option of using the rights or of putting them up for sale in a secondary market that would (possibly temporarily) transfer this right-of-way to another agent. Under the conditions of the right, the owner would guarantee itself access to the market that it wishes to transact in. The right therefore effectively eliminates the locational price risks associated with energy transactions in a given area.

The definition of a physical transmission right is somewhat elastic, and indeed the effectiveness of such a form of property will depend upon the details of its implementation. The question remains as to what substantive differences, if any, exist between these two forms of transmission rights. In general terms, the difference seems to fall under the expression 'with a physical right, I can do what I want with it.' Control of a system of physical rights is perceived to be less centralized than one organized around financial rights.

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[7] Those agents that create 'counter flows' that relieve congestion also earn this transmission price for each unit of congestion that they relieve.

[8] In a case where there are not enough adjustment bids to relieve congestion, the ISO will administratively impose a feasible dispatch through pro-rata rationing and an 'administrated' transmission price.

What is it that an owner of a physical transmission right would want to do with such a right that it would not be allowed to do with a financial right? Advocates of physical rights express the desire to guarantee their grid usage without having to submit to the vagaries of untested transmission pricing schemes. There are also potentially serious costs associated with such a guarantee, however. These costs relate to the ability to withhold transmission capacity from the marketplace.

5. **Transmission Rights and Market Power**

In this paper, I focus mainly on the use of transmission rights to exercise market power. Transmission rights can also play a significant role in influencing the incentives of firms to exercise market power with their generation resources, as is demonstrated in a more general model by Joskow and Tirole (1998 and 1999). Of particular concern here is the extent to which transmission rights, be they physical or financial, can be used to create the appearance of congestion that does not in fact exist. In other words, the extent to which transmission rights can be used to withhold transmission capacity from the market. In the short-run,[9] such withholding could prove profitable for firms in three ways.

- The withholding of transmission rights into a given zone can increase the value of local generation resources.

- The withholding of transmission rights into a given zone can increase the value of the transmission rights themselves.

- The withholding of generation output can capture the congestion revenue that would otherwise accrue to the owner of a transmission right.

The potential for and the severity of any of these market distortions will depend on many factors, including the concentration of ownership of generation resources and of transmission rights. The ability to withhold transmission rights, even physical rights, is also limited by requirements that spare capacity be released back into the marketplace. What is not clear is the extent to which large amounts of transmission capacity could be incorporated into decentralized generation schedules at the last minute (or hour, in the case of California). The transaction costs involved in these markets for released transmission capacity is a key concern in the implementation of physical transmission rights. Since there is no control of transmission capacity under a paradigm of financial rights, there can be no direct withholding of transmission capacity with financial rights. However, firms with financial rights may find it profitable to indirectly withhold transmission capacity by falsely reserving more transmission capacity than they truly need. The possibilities of such a strategy are discussed in section 6.

[9] Once again, investment issues are not addressed here.

It is important to note the potential use of transmission rights as an instrument for exercising market power will increase their value to those firms that can use them to that end. Any open market or auction process that is used to distribute these rights can therefore result in more rights flowing to the firms that can abuse them the most.[10] An initial allocation of rights amongst many firms therefore will not guarantee that those rights will not end up being concentrated among a few dominant firms through secondary markets. Joskow and Tirole (1998 and 1999) demonstrate that the protocols used for the initial allocation of rights can significantly impact the resulting efficiency of the market as well as the revenues generated from the allocation.

In this section I will develop a simple example based upon a two node network to demonstrate each of these potential market distortions. Consider a two node network where there is unlimited supply at $20/MWh at one node and a demand function of the form $q = 200 - p$ at the other. Connecting these two nodes is a transmission line with thermal capacity of 200 MW.

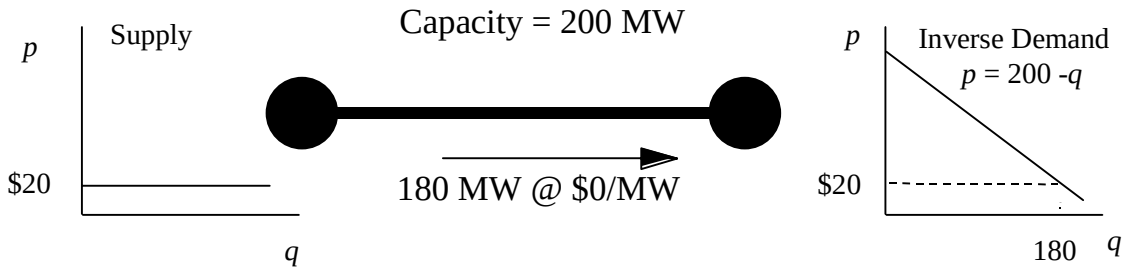

Figure 1: Efficient Dispatch

5.1. *Utilizing Transmission Rights to the Advantage of Local Generation*

Under the first scenario of transmission rights abuse, there is also a generation source located at the demand node with unlimited capacity and a cost of $20/MWh. One firm owns all of this 'local' generation, as well as all the transmission rights on the connecting transmission line. If the transmission rights were allocated efficiently, 180 MW would go to producers at the low cost node, who would sell their power at their marginal cost of $20/MWh to the demand node. The line would be uncongested and the cost of the transmission rights would therefore be zero. If the transmission rights were of the physical form, however, the local firm could withdraw them from the market and choose to generate the monopoly quantity of 90 MW with its local generation.[11] The price at the demand node would therefore be 200 - 90 = $110/MWh (see figure 2).

[10] Borenstein (1988) demonstrates this result in the context of several markets for such 'operating licenses,' including the distribution of landing slots at airports.

[11] The monopoly production quantity can be derived by taking the marginal revenue of the local firm, $200 - 2q$ and setting it equal to the marginal cost of production, 20. This yields $180 = 2q$, for a price $p = 110$.

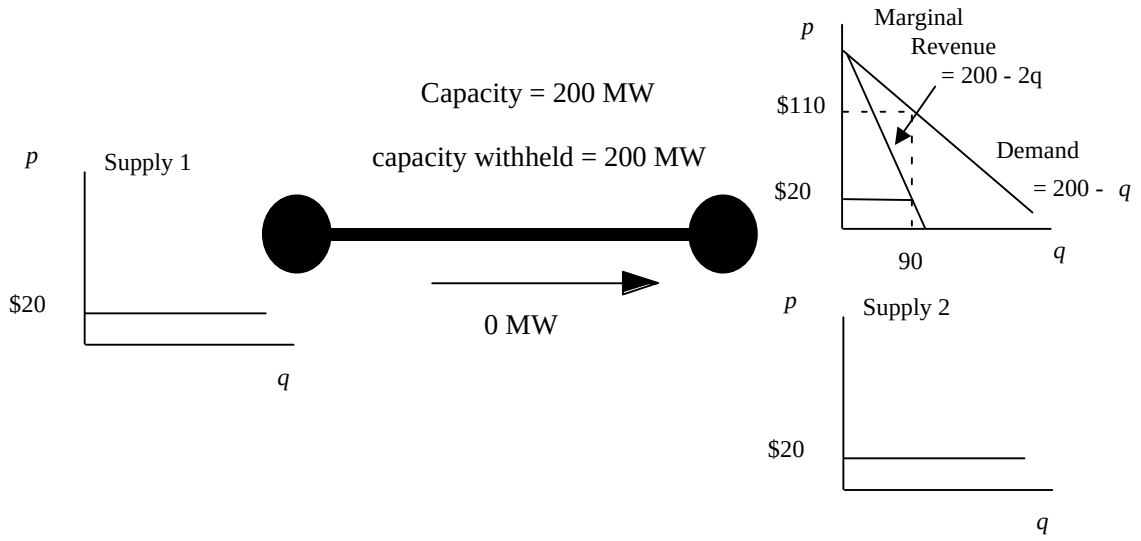

Figure 2: Blocking Competition to Local Generation

This is an extreme example where one firm controls both 100% of the transmission capacity and of the local generation. The same logic would apply to somewhat smaller fractions, however, where the dominant firm would simply perform the calculation on the 'residual' demand that was left over after the other firms have used up their capacities. It is also important to note that the local firm can sometimes utilize transmission constraints to strategic advantage *even when it has no control over the transmission rights*.[12] A Limited transmission capacity can make it profitable for a generator to withhold output, thereby forcing the transmission constraint to bind. Such a firm would concede some market share to increased imports, but could more than make up for the lost sales by raising prices on the remaining demand. Here, I am restricting the discussion to the strategic use of the transmission rights themselves. It is worth noting that the transmission rights, which held no value in the competitive case, would be quite valuable to either generators at the competitive node, or consumers in the local market. This prospect is examined in more detail below.

5.2. *Utilizing Transmission Rights to Maximize Transmission Revenues*

The divestiture of generation resources from firms that own transmission rights does not eliminate the potential for using those rights strategically, as our next example demonstrates. Consider the above 2 node market without the presence of the local generation at the demand node, as depicted in figure 3. The transmission rights are again held by one firm, but that firm has no other financial or commercial interests in this market. Once again, if this firm can utilize its transmission rights to withhold

[12] See Borenstein and Bushnell (1997) for an empirical example of the potential benefits of such behavior in the context of the northern California market and Borenstein, Bushnell, and Stoft (1997) for a theoretical analysis of this problem. Joskow and Tirole (1998) analyze the impact of financial transmission rights that cannot be withheld from the market on the output decisions of strategic firms.

transmission capacity from the market, it can find it profitable to do so, even though it owns no generation resources. Remember that in the efficient outcome, we have 180 MW of transmission being utilized by generators at the supply node for shipment to the demand node. If the transmission rights holder instead 'reserves' 110 MW of transmission capacity for its own use and effectively takes that capacity off the market, then we once again have the monopoly quantity of 90 being sold at the demand node, with a price of $110/MWh. Assuming that the supply node is very competitive, the price there would be $20/MWh and the transmission owner would collect a price of $90 for each of the 90 MW of transmission capacity that it releases for actual use. Once again a dominant transmission rights holder has effectively induced the monopoly outcome, *even though it owns no generation*.

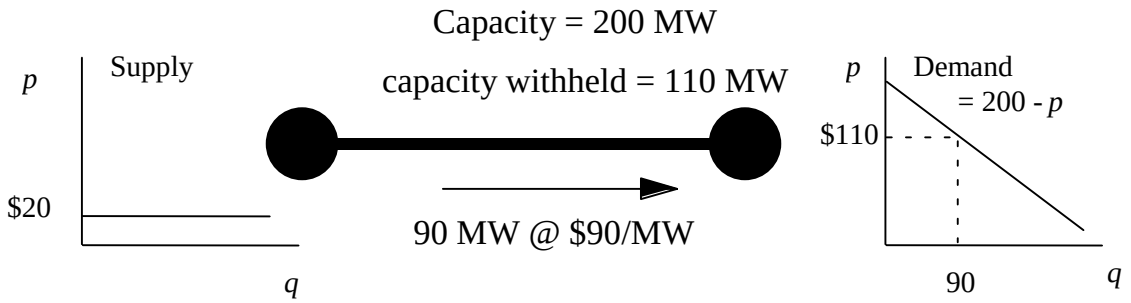

Figure 3: Transmission Monopoly

Once again, we would expect that the dilution of ownership of transmission rights would reduce the problem, perhaps significantly. It does not guarantee the elimination of this problem, however. In particular, note that in the perfectly competitive these transmission rights have no short-run value. There is no economic downside to attempting to withhold transmission capacity when the value of that capacity is zero. Even a firm with an apparently modest share of the transmission rights may in such a situation feel that it has little to lose from withhold some of that transmission capacity from the market.

5.3. *'Capturing' Transmission Rents*

The third strategic manipulation of transmission rights does not directly utilize the transmission rights at all, but rather involves the withholding of generation capacity in order to capture the congestion revenue that would otherwise flow to the transmission owner. Consider once again the same two-node network, with the modification that the transmission capacity is only 90 MW, rather than 200 MW. This network is illustrated in figure 4. The efficient outcome would result in full utilization of the 90 MW to provide power to the demand node. The price at the demand node would be $110/MWh, while the price at the supply node, assuming price-taking behavior, would be $20/MWh. The transmission rights holders would earn $90 for each MW of transmission capacity they sold or utilized. Thus, we once again have the 'monopoly' outcome from the previous

two examples, except that here it is the best we can do given the transmission limits on the system.[13]

Now consider that a single firm owns all the generation. That firm would prefer to adjust its output to 89.99 MW, thereby decongesting the line and allowing the price at the supply node to skyrocket to $110.01/MWh from $20/Mwh. The corresponding transmission price drops to zero, since there is no congestion. The generation firm has therefore 'captured' the congestion revenues that had been flowing to the owners of the transmission lines. There is some disagreement over how viable such a strategy is when there are multiple generation firms.[14]

More relevant to the focus of this paper, however, is the question of whether the form of transmission rights impacts the ability of such a strategy to be implemented. The answer is unclear. A monopoly generator could achieve its goals by either setting its output or by taking advantage of an artificial surplus of physical rights to get the owners of such rights to undercut each other until the price is driven down their marginal cost, which is zero. However, the same market power over transmission capacity that was abused in the previous two examples could counterbalance the market power of the generation firm here, reducing the problem to a bargaining game between a dominant generation firm and a dominant transmission firm. Although transmission rights holders may stand a better chance at recovering some transmission revenues in such an environment, consumers are unlikely to benefit. This is because output remains at the monopoly level. Only the distribution of the monopoly rents has changed.

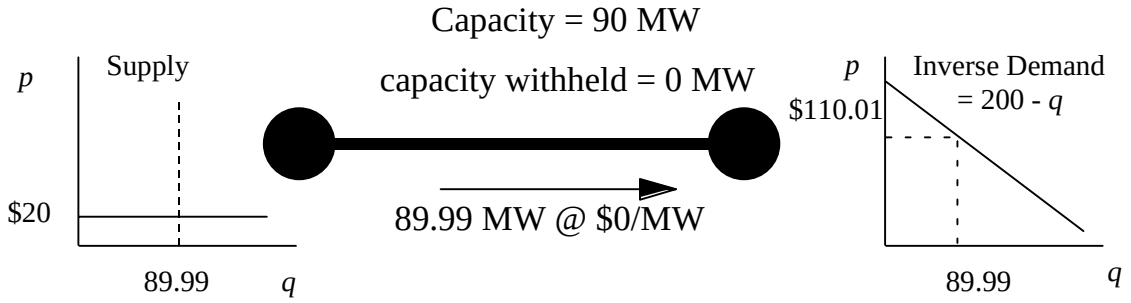

Figure 4: Capturing Transmission Revenues

The most relevant observation here may be the one made by Stoft (1998). The best way to ensure that rents are not captured, and transmission rights are not rendered valueless, is to have a thriving secondary market for those transmission rights. Transmission rights aid entry into generation markets, and any firm that has some generation at the supply node could pick up a right at no cost, increase production, congest the line, and start

[13] This example does illustrate some of the investment incentive problems inherent in transmission markets, since the owners of the transmission clearly prefer to 'reduce' the capacity of the line to the monopoly capacity. On the other hand, consumers would clearly benefit from expanding the capacity and would be willing to pay to do so.

[14] See Backerman, et al. (1996), Oren (1997a) and (1997b), Stoft (1998), and Weiss (1997a) and (1997b).

collecting revenues from the suddenly valuable transmission rights. Thus, in the absence of a dominant firm in the generation market, active secondary markets in transmission rights can help prevent the capturing of transmission rents by generation companies.

6. **Withholding Transmission Capacity with Financial Transmission Rights**

In the above examples, we have implicitly assumed that a transmission rights owner can simply withhold its rights whenever it wants to. These examples serve the purpose of demonstrating *why* a rights holder might want to do so. In this section, we discuss *how* an owner of financial transmission rights might, in the context of the California transmission protocols, achieve the equivalent of the physical withholding of transmission capacity.

In the California market, 'schedule coordinators' submit their proposed schedules to the ISO. The ISO determines whether these schedules are feasible, given the physical limitations of the network. Schedule coordinators are also allowed to submit 'adjustment' bids along with their schedules. These are essentially a statement of how much that SC would be willing to pay to utilize the transmission paths associated with its schedule. When there is congestion, the ISO will reduce schedules according to which SC has the lowest willingness-to-pay for using the transmission path. The transmission price for all users is set at the price determined according to the implied value of the last 'adjustment' made to a schedule.

A key feature of the California market is that transmission prices, like energy prices, are based upon advance schedules, as well as real-time power flows. This allows rights holders to collect revenues for scheduled use of transmission lines, even if that usage does not become a reality. A scheduling coordinator that owns a significant number of financial transmission rights can potentially force a de-facto withholding of that transmission capacity through use of the scheduling process and extreme adjustment bids. This withholding could raise the congestion price on the line and possibly result in additional profits for the owner of the rights.

Consider the following example, which is illustrated in figure 5. Scheduling Coordinator 1 has arranged an actual transaction between the supplier at the left node and demand at the right node. SC1 would prefer a dispatch of 180 MW from node 1 to node 2. A truthful adjustment bid from SC1 would include a $20/MW decremental bid at node 1 and a continuous decremental bid of $(20+Q)/MW for the demand node, where Q is the MW *reduction* from the desired level of 180 MW. In other words, if demand were reduced by 10 MW, the marginal decremental bid of demand would be $30/MWh. At the efficient dispatch, there would be no congestion and no transmission congestion charge.

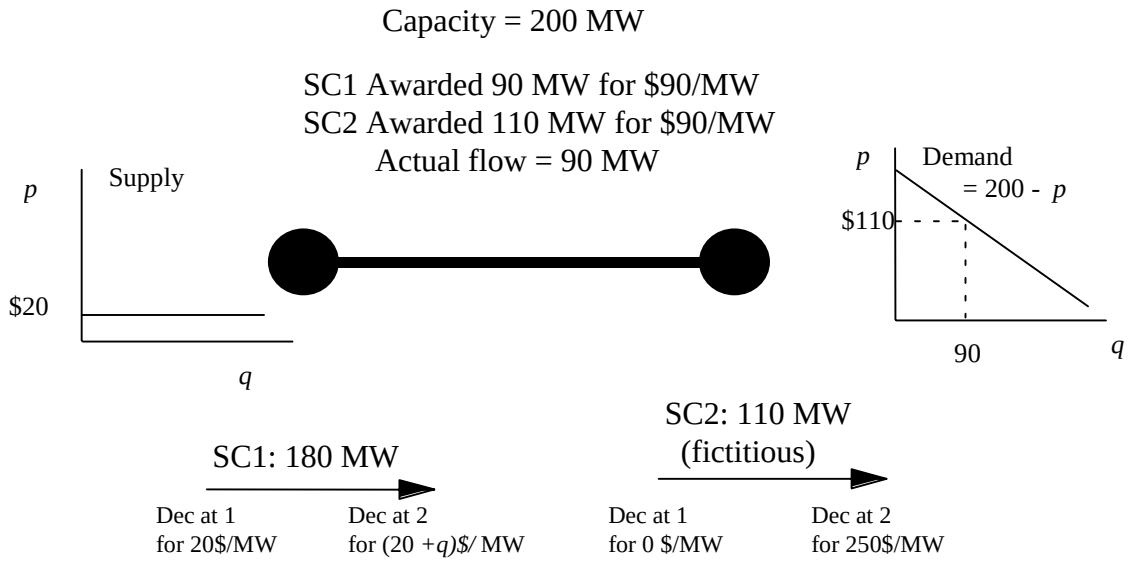

Figure 5: Withholding Transmission Capacity with Financial Rights

Now consider Schedule Coordinator 2, who owns the full 200 MW of financial transmission rights to this line. SC2 has access to plausible supply and demand at the two nodes, but does not intend to actually transact with them at this time. Nevertheless, SC2 chooses to schedule 110 MW of power in at node 1 and 110 MW of power out at node 2. SC2 decides to submit a very extreme set of adjustment bids for this schedule, say a decremental bid of $0/MW at node 1 and $250/MW node 2.

The congestion management process would allocate transmission in the following manner. SC2, with the largest adjustment bid spread, is deemed to have the most value for the first 110 MW of capacity. SC1, with a smaller adjustment bid spread, is allocated the remaining 90 MW of capacity. The adjustment bid spread of SC1 when it is allocated 90 MW is (20+90) - 20 = $90/MWh. As the marginal adjustment bidder, SC1 sets the congestion price at $90/MWh. SC1 therefore pays 90 x 90 = $8100 for the transmission path. SC2 pays 110 x 90 for the capacity that it has scheduled, but as the owner of the transmission rights, SC2 also earns 200 x 90 = $18000. This produces a net profit of $8100 that arises from submitting the false schedule.

It is important to note that, under the above scenario, the owner of the financial transmission rights earns revenues for those rights even though there is no congestion in real time. If they suspect that 'false' scheduling will increase transmission costs, schedule coordinators that do not own transmission rights could therefore avoid these transmission payments by not scheduling their transactions ahead of time and instead trading fully in the real time imbalance market. Such an increased burden on the real-time market would add extra stress to the system with potentially harmful implications for system reliability. A firm such as SC2 could therefore not profitably execute the above strategy consistently without other firms adjusting their behavior to avoid false congestion payments. On the other hand, this strategy would work at least once, and

could be potentially profitable if employed only periodically in a random manner that would be difficult for other firms to anticipate.[15]

7. **Conclusions**

While the issues surrounding market power and transmission rights are not wholly separable from those involving horizontal market power in generation, some new concerns do arise. There is some risk that transmission rights may allow their owners to effectively reduce the transmission capacity made available to the competitive market. This could result from either a simple refusal to sell unused 'physical' transmission rights or from more subtle manipulations of rules requiring the 'release' of such capacity into secondary markets. Depending on the dispatch protocols of the market, such manipulations may be possible with either physical or financial rights. While such manipulations may be quite involved, and may not be profitable on a continuous basis, it is important to note that, in hours in which there would otherwise be no congestion, a transmission rights owner has little to lose from trying to withhold some capacity.

Under the California congestion management process, owners of transmission rights may be able to effectively withhold transmission capacity through the submission of extreme price bids. There are several factors that may mitigate the impact of such strategies, including the ancillary service costs associated with fictitious schedules and the ability of the spot market to react to the real-time absence of congestion that arose in the day-ahead market. However, there is considerable uncertainty about just how such markets may operate. Given these concerns and the inherent uncertainties, the initial offering of transmission rights in California was to be limited to a level below the full transmission capacity available to the California ISO. More recently, however, it has been decided that the 'full' amount of transmission capacity, where the amount available is somewhat subjective, should be auctioned at the initial offering. Such a large offering could bring to the fore concerns such as those articulated in this paper.

[15] Note that such a random strategy would be different from simple speculation on the relationship between day-ahead and real-time congestion prices. This is because the firm with the transmission rights has nothing to lose from false scheduling. If such a strategy is anticipated by other firms, there is no day-ahead congestion and therefore no cost to falsely reserving the transmission capacity.

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