The Problem with Capacity Markets: Evidence from the Reliability Payment Mechanism in Colombia

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Overview

Restructured electricity markets around the world have developed a variety of mechanisms to resolve the so-called "missing money" problem. With perfectly inelastic demand and a price cap that is set lower than the assumed value of lost load, the revenue for infrequently-used high-marginal-cost generation plants may be less than their fixed and variable costs. This loss would lead to the shutdown of these plants and a potential shortfall in generation capacity. Capacity payment mechanisms provide a fixed payment stream to generation plants for making their generation available, even if they do not produce any electricity.

The reliability payment mechanism used in the hydro-dominated Colombian wholesale electricity market provides one possible capacity market design. Under a reliability payment mechanism, generation owners receive a fixed payment per kWh of "firm energy" that they make available. The firm energy should correspond to the minimum amount of electricity that a generation plant can produce in low water conditions, determined based on historical water inflows. A second essential parameter is the scarcity price. This price is updated based on an administrative formula that incorporates changes in the variable cost of the most expensive thermal generation. During hours and days in which the wholesale market price for electricity exceeds the administrative scarcity price, all plants must have scheduled production equal to or exceeding their firm energy. In these periods, generators receive (and purchasers pay) the scarcity price, not the wholesale price, for their firm energy. If generators are unable to produce their firm energy quantity, they pay the penalty for their shortfall equal to the difference between the market price and the scarcity price.

We document two shortcomings of the reliability payment mechanism as used in the Colombian wholesale electricity market. First, it creates perverse incentives for both generators and consumers. Major generation firms have the unilateral ability to determine, through their generation offer prices, whether or not a scarcity condition exists. Forward contracts between generators and retailers no longer reduce the incentive for generators to increase wholesale prices because the scarcity price caps the contract settlement price. Furthermore, during scarcity conditions, electricity consumers have no incentive to conserve electricity, because the scarcity price caps the price they pay.

Second, the reliability payment mechanism does not lead to the lowest-cost combination of generation required to meet electricity demand. The essential parameters are all determined by a regulatory process, not by a competitive market. These include the firm energy quantities assigned to each generator, the scarcity price, the total firm energy requirement, and the price paid per kWh for firm energy.

Methods

We use hourly and daily data from the first ten years of operation of the reliability payment mechanism in Colombia, from 2006 to 2016. This data includes the generator price and quantity offers, generation quantities, electricity demand, firm energy quantities and payments, wholesale prices, hydrological conditions, and generator cost information.

Using this data, we calculate measures of the unilateral ability and incentive for generators to raise (or lower) wholesale prices, based on an extension of the methodology in McRae and Wolak (2014) to account for the reliability payment mechanism. Whether a generator wishes to raise or lower the wholesale market price depends on

the ordering of their firm energy quantity, the forward contract quantity, and the generation quantity. For example, if the forward contract quantity exceeds the firm energy quantity, with an intermediate value of the realized generation quantity, then the generator will want to push the wholesale price as high as possible under scarcity conditions, but push the wholesale price as low as possible under non-scarcity conditions. Similar perverse incentives exist for other combinations of the forward contract and firm energy quantities.

Separately, we provide a decomposition of the revenues and profits of each generation plant in the Colombian market over the ten-year period. This shows the contribution of the firm energy payments to the overall profitability of each plant.

Results

We show the generation firms in the Colombian wholesale electricity market respond to the perverse incentives created by the reliability payment mechanism. In the months before an adverse hydrological event, hydro generators offer too much generation at a price that is below the scarcity price (and likely below the unobserved water value). Offer prices exhibit considerable bunching right below the scarcity price. This behavior kept the scarcity condition from being triggered but at the expense of running too little thermal generation and too much hydro in the crucial months leading up to the hydro shortage. Once the scarcity conditions occurred, there was a discontinuous jump in offer prices to a much higher level, far more than the scarcity price. The response of generators to the reliability payment mechanism worked against the provision of a reliable supply of electricity at a reasonable price during a period of low hydro inflows.

For independent thermal generation firms, we show that a high proportion of total revenues (in some cases exceeding 50 percent) come from the fixed firm energy payments. These payments likely exceeded the minimum required to keep the plants in operation. An unfortunate aspect of the reliability payment mechanism is that generation owners can collect this revenue for many years, then later walk away from their obligation to produce the firm energy quantity at the scarcity prices. This happened in late 2015 in Colombia and contributed to a generation shortfall during the low-water period.

Conclusions

The results demonstrate that the reliability payment mechanism in Colombia not only fails to minimize the cost of meeting electricity demand but also creates perverse incentives for electricity generators that potentially reduce the reliability of electricity supply. These results are of broad interest because the Colombian design is considered a "best-practice" design for a capacity market. In particular, it overcomes an issue in some other capacity markets of paying for generators to be available during periods when they are not required. It also caps the price that generation plants receive for their output when they are required to produce.

The paper highlights the need for capacity market designs based on market mechanisms, rather than arbitrary regulatory decision processes. Only market-based systems can ensure the reliable supply of electricity at the lowest cost to consumers.

References

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