MARKET POWER AND PRICE EXPOSURE: LEARNING FROM CHANGES IN RENEWABLES' REGULATION

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Section 1: Summary

Ambitious environmental targets, together with decreasing investment costs, have fostered the rapid deployment of renewable energy around the world. However, the goal to fully decarbonize the power sector will require further investments to replace conventional power plants with renewable energy resources. One simple solution is to set a target level of investment in renewable energy capacity and then allocate long-term energy contracts to the lowest bidders at the resulting auction-based prices.

In designing these auctions, regulators have to make several decisions, ranging from the auction format to the bidders' eligibility requirements, to name just two. However, one dimension of auction design stands out for its key impact on electricity markets: whether the auctioned contracts expose renewable investors to the volatility of short-run electricity prices, or not. To provide full price insurance, regulators have the option of auctioning off fixed prices per unit of output --these are the so-called Feed-in-Tariffs (FiT). Instead, to provide full price exposure, regulators have the option of allowing producers to sell their output at the short-run electricity market price, to which they add an auction-based fixed premium --these are the so-called Feed-in-Premia (FiP).

We aim to analyze how these choices regarding the degree of renewables' price exposure affect the performance of electricity markets once the investments have taken place. The importance of this question is compounded by the massive renewable investments that will have to take place in the future. Our results provide key insights to the ongoing debate about how to support the deployment of renewables at least cost. We focus on the largely unexplored issue of how renewables' pricing schemes affect firms' bidding incentives for given capacities, an important determinant of the performance of electricity markets. This is a required first step towards analyzing the endogenous choice of long-run variables such as entry, exit, or the capacity and location of the new investments.

Our contribution is to capture the effects of price exposure on market power, an issue that is relevant in electricity markets and beyond. We provide a tractable model and a structural analysis comparing firms' market behavior subject to different degrees of price exposure. This analysis could well apply to many other markets that are also organized sequentially (e.g., gas, oil, emission allowances, bonds, or stocks, among others) where firms face different degrees of price exposure depending on whether they are subject to short or long-term contracts. To our knowledge, this article is also the first to provide a causal impact of price exposure on market power, taking into account the countervailing incentives.

Section 2: Research approach and previous research

We leverage a quasi-experiment that took place in the Spanish electricity market, where the regulator first decided to pay existing wind producers at market-based prices (FiP), then moved them to fixed prices (FiT), and ultimately switched them back to market-based prices again (FiP). These regulatory changes provide a unique opportunity to identify the impacts of renewables' price exposure on market performance. It is important to point out that these changes were implemented by surprise, that wind already represented a significant share of total output, and that no other changes in market rules or market structure took place during that time. Access to very detailed wholesale market bid data thus allows us to conduct an empirical analysis of the causal effects of changes in the degree of renewables' price exposure on firms' bidding behavior in electricity markets and the resulting impacts on market power.

We contribute to the literature by characterizing and comparing the equilibria under fixed-prices and market-based prices using a simple and tractable model. We use a differences-in-differences approach to capture the magnitude of the effects while avoiding potential confounding factors. Moreover, to our knowledge, there are only a few papers that explore the effects of renewables' pricing schemes for given capacities. For instance, Dressler (2016) highlights that FiT acts like forward contracts; Bohland and Schwenen (2020) attempt to explore the market power impacts of a

voluntary change in the pricing scheme in the Spanish Electricity market during 2005, a period when renewables represented less than 10% in the energy mix.

Section 3: Results

We employ theoretical and empirical approaches in answering our research question. Our theory model shows that exposing renewables to electricity market prices encourages them to arbitrage the resulting price differences, which indirectly reduces the dominant firms' incentives to exercise market power in the day-ahead market (henceforth *arbitrage effect*). On the other hand, paying renewables based on fixed prices directly reduces the dominant producer's incentives to increase market prices as fixed prices act as a forward contract over the firm's renewable sales (henceforth *forward contract effect*). These two effects act in opposite directions, we show that their relative strengths depend on market structure. In particular, the higher the share of wind output in the hands of the dominant producers, the stronger the *forward contract effect* and the weaker the *arbitrage effect*. Hence, shielding renewable producers from market prices is relatively more effective for mitigating market power in highly concentrated markets, which are the ones where market power concerns are likely to be higher.

In our empirical results, we show the relevance of the *forward contract effect* under FiT and the *arbitrage effect* under FiP. Finally, to understand which of these two effects dominated in shaping market power, we leverage our structural estimates to compute markups in the day-ahead market. We find that markups were significantly lower while firms were subject to fixed prices as compared to market-based prices. The average markup during the fixed price regime was 6.3%, while it was 8.3% and 10.7% under the market-based price regimes. Our results are robust to alternative ways of comparing the markups. Based on these findings, we conclude that, given the market structure of the Spanish electricity market, the *forward contract effect* dominated over the *arbitrage effect*, which led to weaker market power when renewables were paid at fixed prices, relative to when they were exposed to market-based prices.

Section 4: Conclusions and future research

We analyze how the degree of firms' price exposure impacts market power, taking into account two countervailing incentives. On the one hand, reducing firms' price exposure mitigates firms' incentives to increase prices. On the other hand, if firms are insulated from price changes, they face weaker incentives to arbitrage price differences, which enhances the dominant producers' market power.

This trade-off is particularly relevant for a key policy debate in electricity markets; namely, how to pay for renewables. Since compliance with the environmental targets requires massive investments in renewables, it is paramount to understand how alternative pricing schemes for renewables impact market prices and efficiency. One of the key messages of the paper is that understanding the impact of renewable policy requires an analysis of the interaction between conventional and renewable suppliers, and not just of renewables alone. The interplay between the two types of suppliers drives much of the outcomes and efficiency results of the paper.

We have used the Spanish electricity market as a lab to explore the trade-off between the *forward contract* and the *arbitrage effects*. Our empirical analysis confirms that the dominant producers attempted to exercise market power by withholding output in the day-ahead market. When exposed to variable prices, independent wind producers made the withholding strategy more costly by overselling their idle capacity in the day-ahead market in order to arbitrage price differences across markets. Instead, paying renewables according to fixed tariffs reduced arbitrage, but it also mitigated the dominant producers' incentives to withhold output in the first place. The latter effect dominated, giving rise to relatively lower markups under fixed prices.

There are reasons to expect that market power concerns in electricity markets will diminish over time (as demand response and storage facilities become more widely spread). However, there are also compelling reasons to remain vigilant as the increase in renewables' penetration in the hands of the dominant producers will make it increasingly important to understand how renewables' pricing rules affect market performance. The long-run impacts of such differences on investment decisions are left for future research.

References

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