Renewable generation and network congestion: an empirical analysis of the Italian Power Market

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This article aims at disentangling the impact of renewable production on network congestion and zonal price differences in the Italian Power Market using a unique database with hourly observations spanning over a 5-year period (2010-2015). The recent economic literature has highlighted the likely reduction of wholesale market price and increased volatility driven by the increased electricity production from renewables. Nevertheless, when electricity markets are organized as two or more interconnected sub-markets with zonal prices, the integration of renewable energy sources (RES) raises additional research questions. The final effect of a larger renewable production becomes less obvious as it consistently depends on the localization of the supply and the demand as well as on the relative efficiency of pre-existing local production and the transmission network capacity. For its particular features, the Italian Power Exchange represents a natural case study to test the efficiency of renewable energy sources (RES) integration into the electricity markets. Italy has reached its quota of 17% renewables in final energy consumption in 2014, therefore implementing the 2009 Climate Package six years ahead of the 2020 horizon. The market is composed of six regional sub-zones with a specific generation mix determined by historical and geographic reasons; inter-zonal transmission capacities are not equally distributed either. If transmission constraints are not binding, the wholesale market clears with a unique price; if congestion arises, up to six zonal prices emerge. This particular design allows a detailed study on the relationship between renewables and other generation technologies together with congestion effects. Our empirical strategy consists in estimating two econometric models: a multinomial logit model, to assess whether renewables (solar, wind and hydro power) increase the occurrence of congestion, and a two stage least squares (2SLS) model to evaluate the impact of RES production on congestion costs, defined as the price difference of two contiguous zones. Our analysis shows that a larger solar and wind supply in importing regions decreases the probability of congestion compared to the no congestion case, while the reverse occurs when renewable production is located in an exporting region. Hydroelectric production has a similar effect, whereas the demand has exactly the opposite impact. The 2SLS estimations reveal that the

same mechanisms explain the level of congestion costs. Although this effect seems to be symmetric in importing and exporting regimes, its magnitude is more significant when a region is importing electricity. Therefore, in terms of policy recommendations, our results suggest that the installation of renewables should be primarily promoted in importing regions. Our results also highlight that the magnitude of the congestion effects, both in terms of probability and costs, is very sensitive to the location of the historical efficient production, mainly hydroelectric power, and to the geographical configuration of the transmission network.