ECONOMICS OF GRID INTERCONNECTIONS: A HETEROGENEOUS MARKET DESIGN CONTEXT

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Overview

The exchange of electricity across different countries or jurisdictions requires the existence of interconnections between the grids of the respective parties. These interconnections generally allow bidirectional trade, enabling arbitrage across markets, and their transmission capacity is always limited. This grants interconnection capacity its scarce resource aspect, and as such, the efficient allocation and utilisation of this resource falls within the realm of economics, and arises as a central issue in the economics of grid interconnections.

The design of the linked electricity markets directly affects how interconnections operate. From a market restructuring perspective, three possible combinations of market states arise, depending on whether or not the interconnected countries have deregulated their power industries: both countries' power markets are deregulated, neither of the power markets is deregulated, and one country's power market is deregulated while the other is not. In the literature, the third state, which we label heterogeneous interconnections, is rarely considered despite its increasing importance as several links of this type are set to be established in the near future (Tunisia - Italy, Egypt - Cyprus - Greece, Algeria - Italy...). Therefore, this investigation attempts to fill this gap by reviewing how existing interconnections of this type operate, identifying the mechanisms by which their capacity is allocated, and analysing the economics of heterogeneous interconnections.

Methods

We start by presenting an in-depth analysis of some existing heterogeneous interconnections and how they function, namely: the interconnection of Quebec with Ontario, The interconnection of Morocco with the Iberian Peninsual, and the interconnection of Turkey with Georgia . Then, based on this analysis, we identify and describe the currently prevailing capacity allocation mechanisms in this type of interconnections. Subsequently, we develop a conceptual framework on the economics of the utilisation of grid interconnections, highlighting the effects of cross-border exchange on aggregate social welfare, and on the markets' individual welfare, separately. Finally, based on the developed theoretical framework, we identify some inefficiencies that can plague the utilisation of grid interconnections, specifically when heterogeneous markets are involved, and we discuss some ways to limit these inefficiencies.

Results

Our results highlight that the capacity allocation mechanisms for heterogeneous interconnections often appear to be adaptations of those used in homogeneous interconnections which does not account for the unique challenges of heterogeneous contexts, and that the efficient utilisation of grid interconntions is unlikely to occur if any of the involved markets behaves strategically and cross-border dispatch is monopolised. Moreover, in this paper we show that the regulated market has an informational advantage over the liberalised market, as it can observe both actual and historical prices in the liberalised market. It can therefore leverage its informational advantage to manipulate outcomes by misrepresenting its marginal costs and their sensitivity to cross-border exchange. As a result, heterogeneous interconnections are likely to be less efficiently utilised compared to homogeneous ones, reducing

overall welfare but increasing the regulated market's individual welfare. This implies that mechanisms that decentralise exchange decisions and disregard congestion revenues (e.g., implicit auctions) are less effective in heterogeneous contexts where the regulated market can monopolise arbitrage.

Conclusions

The primary economic purpose of grid interconnections is to facilitate cross-border electricity trade. From a commercial perspective, as electricity is a homogeneous good, its trade is largely governed by arbitrage principles. Consequently, full arbitrage leading to price convergence emerges as the socially optimal outcome from our findings. Other rules governing the economics of grid interconnections and revealed by our results, such as the evolution of social welfare and arbitrageurs' profits as a function of exchange, or the way the autarky price gap and its rate of closure through exchange directly explain welfare gains from trading, are likewise reflective of arbitrage principals. A well-functioning interconnection must therefore guarantee the proper utilisation (in the dispatch timeframe) of its capacity up to its limits, or up to the price-gap closing volume, representing the socially optimal outcome. However, the efficient outcome will not prevail if arbitrage decisions are undertaken by the interconnection owner, collecting its subsequent rents, or if the individual markets behave strategically, and arbitrage is centralised, as is generally the case when regulated markets are involved. Indeed, The main inefficiencies that arise in heterogeneous interconnections are due to the vertical integration of the regulated market's utility, its ensuing monopoly of cross-border arbitrage, and information asymmetries, granting the regulated market a dominant position. Depending on how the regulated market is structured, specifically the degree of private sector participation within it, some allocation mechanisms prioritising independent access to the interconnection in the regulated market can in principle reduce the severity of these inefficiencies.

References