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ASSESSING ECONOMIC CONSEQUENCES OF THE EUROPEAN ELECTRICITY MARKET DESIGN CHOICES: THE CASE OF BALANCING MECHANISM

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Overview

The competitive electricity wholesale market is, in fact, a sequence of several markets. These notably include: a futures market, a “day ahead” forward market, a congestion management mechanism, a reserves market, a balancing market, and sometimes a market for generation capacity. The precise configuration of this sequence comprises the overall institutional arrangement of an electricity reform: its market design [Wilson (2002)].

Our paper shall focus on a single link in this chain, the last one: real-time energy balancing. In this module, direct control over all operations of injecting or withdrawing power, from several minutes or hours before real time until its actual implementation in real time, is placed under the direct and exclusive authority of the transmission grid manager (TSO in Europe). Although this “balancing” module is neither the best known of the electricity reforms, nor the one with the greatest volume of activity, it is of the greatest importance, both technically and economically, since electricity sector presents a special combination of unique characteristics, such as: the impossibility of storing significant quantities; the range of variation and uncertainty in consumption and generation; the short-term price inelasticity of demand; and the constraint of ongoing real-time balancing of consumption and generation. Given these properties, any economist would guess that the institutional arrangements that ensure real-time energy balancing must be much more than a technical feedback mechanism for the system, but rather a centrepiece in the competitive structure. Aside from their physical role in balancing global volumes of supply and demand, these arrangements also provide the sequence of electricity markets with the only real-time price formation mechanisms. Since this real-time energy is the only form of power that is physically tradable between wholesale market operators, its price provides the “real” basis for the entire chain of forward prices, from futures through day ahead, inclusively [Hirst (2001).].

In practice, competitive reforms apply two broad variants of balancing arrangements. These are easily distinguished, with one being a “real-time market” and the other a “balancing mechanism.” [Boucher, J. and Smeers, Y. (2002)]. The principal difference between these two arrangements is that the “real-time market” uses its market price to impute a value to electricity in real time, while the “balancing mechanism” imposes a penalty that creates a substantial gap between the purchase and sales price of power. This penalty, specific to balancing mechanisms, is incorporated into the prices of the observed gap between the forecasted magnitudes of forward contracts and the real magnitudes of consumption and generation. The main argument used in the European Union to rationalise imposing such a penalty is an engineering argument. The security of the electricity system, which is the top priority of the transmission system operator (TSO), would be imperilled if real-time energy market prices were used. In this paper we will not examine this engineering argument regarding security. We limit our labours to an economic evaluation of the institutional arrangements already in place for balancing energy in real time. We are essentially comparing two types of existing arrangements: the market arrangement using market prices, which will serve as a benchmark, and the penalty-based balancing mechanism. This comparison has real empirical relevance within the European Union, since France and Belgium implement balancing mechanisms that rely on penalties, while the real-time market solution remains possible in the Netherlands. These three bordering countries are currently engaged in discussions on coordinating their PXs and on provisions for allocating interconnections. The fact that the operation of these PXs and interconnections is linked to their balancing arrangements reinforces the interest in such an assessment.

Methods

In the framework of a two-stage equilibrium model [Bessembinder, H. and Lemmon, M. (2000)], a first stage, the forward market (day ahead and intraday) is followed by the real-time stage.

Each participant in these markets, whether buyer or seller, forward or real-time, must confront substantial uncertainties, being forced to make decisions on the first market (day ahead, etc.) before having all the relevant information. Indeed, during the second, real-time, phase, a positive or negative randomness in consumption kicks in and has repercussions on production under the authority of the TSO. Both the generators and retailers in this market are characterised by risk aversion. They seek to maximise their utility as of the closing of the first of the two markets, which thus serves as a market for hedging the risks inherent in the nature of the second market. Since each of these two markets (forward and real-time markets) has an equilibrium, we can compute the quantities traded and the equilibrium price of electricity on each (forward price and real-time price). Within this framework, we define penalties—which transform “real-time markets” into a “balancing mechanism”—in terms of a parameter modifying the price of positive and negative imbalances in the power measured in real time. The TSO compares the volumes committed on the day ahead (or intraday) market during the first stage with actual measurements of effective consumption and generation during the second stage. We also define the time of the “Gate Closure” as a parameter. This is when the TSO definitively cuts off trades on forward markets and opens the second period, during which real-time balancing occurs under its authority. The exact timing of this division between the two markets dictates the set of information available to market participants, and thus impacts on the level of uncertainty they must confront when making decisions.

Results

We have examined the economic consequences of using penalties in balancing arrangements. Running a few numerical simulations on the basis of a two-period equilibrium model, we have found four principal economic consequences: (1) a distortion of the forward price; (2) an asymmetric shift in the welfare of market participants; (3) an increase in the TSO's revenues; and (4) inefficiencies. The magnitude of these consequences increases as the temporal position of the gate closure moves away from real time. In their choice of the temporal position of gate closure, TSOs define the structure of information available to agents making decisions on forward markets, and by extension the level of uncertainty entering into their decisions. With the combination of gate closure positions and penalty levels, TSOs define the incentive system that applies to decisions made under uncertainty by other agents who are risk averse. Moreover, these rules of the game have asymmetric impacts on retailers and generators, on small, vertically disintegrated and large, vertically integrated generators, and on flexible and inflexible generators. These rules may also function as barriers to entry for small, disintegrated actors.

Conclusions

In light of these preliminary results, and given the current situation in which countries in the western European Union continue to seek to improve and harmonise their market designs, we wish to underline that economic consequences of this type cannot continue to be ignored by decision makers…whether TSOs or regulators. We do not deny that balancing provisions are extremely important for the security of the grid and the good functioning of the electricity reforms. However, it is clear now that these balancing arrangements are not only technical security mechanisms. Rather, they are institutional arrangements in which the TSO sets the rules of the game for other agents, with implications not only in real time, but also on forward markets (day ahead and intraday). In conclusion, the security mechanisms that are TSO's balancing arrangements are not neutral in terms of their impacts on wholesale markets or the competitive dynamics on these markets. Since there exist several alternative designs for balancing arrangements, it is not unreasonable to expect TSOs and regulators to account for the economic consequences of the various models when they establish the architecture of the wholesale market: either during the initial market design, or during a later review in light of the experience accumulated in other countries.

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