ONLINE APPENDIX

A.1 SENSITIVITY ANALYSIS

The sensitivity analysis has been designed as follows. Since we believe both the demand intercept IC and the demand slope DS to be the most important parameters and potential drivers of the results, those are the two parameters that we have varied independently. In particular, while keeping IC_{base} fixed at its original value, we have varied the difference between the demand intercept of the peak and the base load period, i.e., $\Delta IC = IC_{peak} - IC_{base}$, from 0% until 200% with a 5% step. This means that IC_{peak} varies from 1,400 [MW] until 2,600 [MW]. The same has been done for the demand slope. The base value has been kept at its original value and the peak value has been varied in a way to obtain a difference between 0% and 200% in 5% increments. In the sensitivity analysis we have solved both models, the cost- and the bid-based one, for all 1,681 combinations of different demand intercept and demand slope values. All of the equilibrium results have been computed using diagonalization, and have been validated using theoretical results of Wogrin et al. (2013). In the case of multiple equilibria, we have taken into account the one with the better total social welfare result.

Before analyzing the results, let us briefly discuss the type of equilibria that we expect to obtain. As demonstrated in Wogrin et al. (2013), there exists a closed-form expression for the capacity at equilibrium in both bid- and cost-based models. This value, however, does not only depend on the model parameters, but also on the number of load periods binding at equilibrium, which is not something that can be predicted easily a priori. In any case, in a two-load period example capacity is either binding in one load period (the peak) or in both load periods (peak and base). For the sake of clarity of the following results we therefore want to classify the type of equilibrium into four different types: a) both bid- and cost-based equilibria are binding only in

the peak; b) the bid-based model is binding only during the peak, and the cost-based is binding in both load periods; c) the opposite; d) both models are binding in both load periods.

Being able to differentiate among the different types of equilibria is important as it is those types that determine whether one market design is better than the other. First of all, in type d) equilibria both market designs yield the same total social welfare, since the binding capacity implies the same prices and quantities, and subsequently the same market efficiency. Out of the 1681 simulated cases only 5% were type d) equilibria.

Second, we discuss type a) equilibria in which the cost-based market always outperforms the bid-based one. There exists a formal proof, which is omitted here, of when this situation can occur. However, the rationale behind this is as follows: both models have the same capacity which is only binding in the peak period; therefore, profits and consumer surplus in this period is the same in both models. The model outcomes only differ in the base period, in which capacity is not binding, and which comes down to a comparison of a market equilibrium under perfect competition (cost-based model) and a Cournot market (bid-based market). In such case, a perfectly competitive market outperforms the Cournot market in terms of market efficiency (not that we are referring only to the base load period and the case when capacity is not binding). Out of the 1,681 cases 23% are type a) equilibria.

Third, in type b) equilibria capacity is binding in both load periods for the cost-based model, and only in the peak for the bid-based model. In those cases, the bid-based market results in higher social welfare than the cost-based one. A formal mathematical proof can be derived but is omitted here. In our simulations this happens 72% of the time. Finally, type c) equilibria never occur in our simulations.

Figure 1 shows the difference in market efficiency (i.e., welfare) between the bid-based market and the cost-based one for the 1,681 cases considered (i.e., positive numbers indicate that the bid-based design results in higher welfare than the cost-based one).

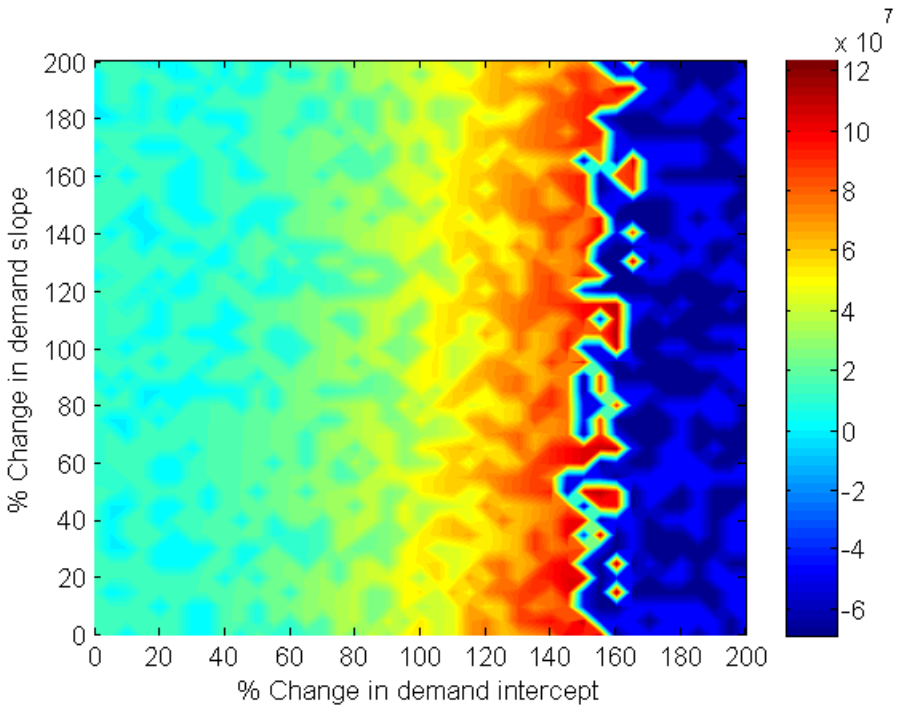

Figure 1: Difference of market efficiency of bid-based market minus cost-based market in $.

As shown in the figure above, in 72% of the experiments with different parameters a bid-based market outperforms the cost-based design. All of these cases correspond to type b) equilibria, which is when cost-based market capacity is binding in both periods whereas the bid-based capacity only binds in the peak. Let us try and provide some intuition on when and why this occurs. When comparing the market equilibrium results of bid- and cost-based models in only the base period we observe that, in general, the demand of the cost-based model (as it is a perfect competition) will be higher than in the bid-based model (Cournot model). Therefore, there can be cases when the base load market demand in the cost-based model exceeds the value for the equilibrium capacity that is binding in only one load period, whereas the bid-based base load demand

does not. If that is the case, then type b) equilibria can occur.

As the difference in the demand intercept becomes larger, there is a point when the base load cost-based demand also falls below the one load period capacity mark, and that is when type a) equilibria can happen. Consequently, the higher the difference in demand intercept the better the bid-based market performs due to type b) equilibria, up until a threshold of around 150% when the difference in demand intercept becomes large enough such that the equilibrium changes to type a), in which the cost-based market is better as indicated by the negative numbers in Figure 1.

We have also observed that up until a 5% difference in demand intercept type d) equilibria can occur. This means that when the demand intercept of peak and base are very similar, then neither a bid- nor a cost-based market can achieve an equilibrium where capacity is binding in only the peak period. However, this is not a general result.

In summary, the sensitivity analysis of the numerical example identifies the demand intercept as the main driver of the results. We find that the bid-based market outperforms the cost-based market in 72% of the cases analyzed. The higher the difference between peak and base demand intercept, the higher the difference in social welfare. However, when this difference becomes large enough, the ranking switches and the cost-based market achieves higher market efficiency, which happens 23% of the time. In the remaining 5% of the cases both market designs perform equally.