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The strategy robustness of mark-up equilibria

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This paper has been replaced by the updated version "The robustness of industrial commodity oligopoly pricing strategies" EPRG1522, which generalises and extends some of the theorems, and characterises it as a general contribution to Industrial Organization, rather than more narrowly targeted at models of electricity markets. The revised version also contains a separate appendix surveying the literature on learning models and their stability and convergence, with a section surveying their application to electricity market models.

This earlier paper is an extension of the paper "The Robustness of Agent-Based Models of Electricity Wholesale Markets" EPRG1213. That paper was motivated by the need to develop techniques for analysing market power that bedevils liberalised electricity markets, and started from the observation that agent-based models were increasingly used to study markets that would be otherwise hard to model, and where transmission constraints might change the market size and number of competitors from hour to hour. Such models usually assume that generators offer power at a mark-up on marginal (i.e. mainly fuel) costs, either choosing a fixed mark-up or choosing a mark-up that increases with the level of the marginal cost – in effect offering a steeper supply schedule than the marginal cost. The earlier paper asked whether these restricted assumptions were robust against different specifications of the actions available to more strategic generators, and found, apparently surprisingly, that these models appeared very robust against single firm deviations.

At the time this seemed an incomplete story and this paper shows why and extends the analysis to show when the standard agent-based model solutions may not be robust and hence may be less reliable as models of electricity markets. The original paper demonstrated that a single deviant firm choosing a quantity instead of a mark-up (or a slope instead of a fixed mark-up – in either case following an apparently more profitable strategy) would do no better than the other naïve firms. At the time, this seemed surprising. Now, the result is almost entirely self-evident and become clear in the figures provided in the paper. The reason is that in a simultaneous move Nash game in which each firm takes the actions of others as

given, any firm, including a deviant firm, will choose the optimal value for its choice variable, whether it be the mark-up or output, and the result will be the same level of output. This in itself may be of some interest, but we raise the important question of what information is available to agents making their choices - what if a firm can commit to her output to which other firms respond afterwards, as in the Stackelberg model. This is consistent with agent-based models in which other firms gradually learn of the change in the deviant's strategy and adapt their choices accordingly.

The paper shows that while these mark-up equilibria are robust against Nash deviations, they are not robust against more sophisticated deviations. We show that a sophisticated player acting as a Stackelberg leader can profitably commit to a different strategy than the followers, anticipating and taking account of the response of these naive followers, who mechanically choose actions from their limited strategy set but adapt to the leader's choices. Hence, the various mark-up models considered are not robust against such deviations. We also demonstrate that the symmetric mark-up equilibria are not robust to a subset of non-collusive firms following a different strategy.

These results suggest the need to test agent-based models against such deviant firms, to see whether, or in what circumstances, simple mark-up models may give misleading predictions of the exercise of market power.

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