



Does Strategic Ability Affect Efficiency?

Even within the same market, firms vary across a number of dimensions—structure, production capacity, market experience, and general core competency. If you go as far as to observe individual managers, you will find resumes with differing academic training and experience. It is easy to imagine how these differing backgrounds play a role in strategic decision making.

In PERC Working Paper 1703, PERC’s Professor of Free Enterprise, Steve Puller, Texas A&M University’s Fernando Luco, University of Chicago’s Ali Hortacsu, and Shanghai Lixin University of Accounting and Finance’s Dongni Zhu ask whether strategic ability affects efficiency. Even though the potential diversity in strategic behavior is obvious, models that are used to analyze these decisions leave heterogeneity out of consideration. In many empirical studies, firms are assumed to make fully strategic decisions, playing some form of a Nash Equilibrium.

In a strategic equilibrium, the assumption is that all firms are best responding to the beliefs of their ri-

vals and all of the firm beliefs are mutually consistent. Basically, each firm makes the best decision for themselves, based on what they think the other firms will do. And their beliefs about their rivals’ behavior are correct.

These models can miss economically significant market dynamics in settings where firms differ in strategic sophistication. Recent work has shown that deviations from the Nash Equilibrium play can be economically significant and affect the overall efficiency of the market. In earlier work, Hortacsu and Puller (2008) studied the Texas electricity market and identified firms that persistently deviate from Nash bidding. This deviation from Nash bidding has important effects on the overall operations of the market—low-cost power plants are not called to produce and consequently, production costs rise.

This suggests that models allowing for boundedly rational firm behavior can be valuable for explaining the outcomes of real-world markets. One such model is the Cognitive Hierarchy, which maintains the best-re-

sponse assumptions, but also allows room for firms to have beliefs about their rivals’ strategies that are not consistent with their rivals’ actual behavior. Thus, the Cognitive Hierarchy allows for multiple forms of strategic behavior, allowing different levels of sophistication by players in the market.

So, what if all firms engage in some level of strategic behavior, but some firms “fall short” of playing the Nash Equilibrium? Does heterogeneity in strategic sophistication affect the efficiency of the market? The authors examine the spot market to sell electricity to the power grid in Texas via auctions. Firms in this market vary in size, structure, personnel structure, and other characteristics. Using data on individual firms’ marginal cost of production and bids into power auctions, they assess the level of strategic sophistication across electricity generators.

They find the strongest determining factor of strategic sophistication to be the size of the firm. Larger firms are higher in the Cognitive Hierarchy, and are more strategically

sophisticated. Manager characteristics, such as academic training, play a smaller but still significant role. Notably, there is substantial heterogeneity in the level of strategic sophistication across the firms in the Texas electricity market, and this leads the grid operator to dispatch higher cost power plants when lower cost plants are available. Moreover, they do not find evidence of substantial learning in the early years of the market.

They also examine how increases in strategic sophistication affect efficiency. Using the model parameters, they calculate the outcomes under different scenarios in which the level of strategic sophistication of low-level firms is increased either exogenously or through mergers with high-level firms. The authors simulate unique predictions of market outcomes under various policy counterfactuals. Not only does the model allow for more realistic models of real-world bidding behavior, but it allows researchers to simulate outcomes under changes in the market structure.

For example, consider a merger between a large and small bidder in this market. This type of merger would be unlikely to lead to substantial cost synergies (the savings in costs after two companies that complement each other combine) because the costs of generating electricity is almost entirely driven by the model and vintage of the electric generator.

Because of this you might expect the increase in concentration brought about by the merger to enhance market power and reduce economic efficiency. However, in a merger between two boundedly rational firms, this merger could increase efficiency.

Suppose that the large firm is a high-level strategic thinker and the small firm is a low-level strategic thinker. If the merger causes the large firm to take over the bidding operations, then the power plants of the small firm will subsequently be controlled by a higher level strategic thinker. This can increase efficiency because the low-type firm would be less likely to bid prices so high that its efficient productive capacity is priced out of the market.

The authors simulate this type of merger in the Texas electric market, finding that strategic sophistication does improve efficiency, though at a decreasing rate. For instance, exogenously increasing the sophistication of low-level type firms to the level of median-type firms will increase market efficiency by 9-16%. However, in firms with median levels of sophistication, the increase is smaller. Finally, mergers can increase efficiency even when the merger increases market concentration with no cost synergies.

The results show that while small firms appear to behave as if they are boundedly rational in a Cognitive Hierarchy sense, large firms behave

Cognitive Hierarchy Model

Level-0 Players
Entirely Non-Strategic Bidding

Level-1 Players
Assume all other players are Level-1, and act in response

Level-2 Players
Assume that all other players are a combination of Level-0 or 1, and act in response

***In general all Level-K players will assume that all other players are distributed between Level-0 and Level-K-1 and act in response**

closely to what a Nash model would predict. If a small low-type firm were to merge with a large, high-type firm, then the efficiency would improve despite the increase in concentration. However, when the medium-sized firms merge with large firms, the market power effect dominates the sophistication effect and efficiency decreases.

Bottom line: increasing sophistication may increase efficiency significantly. Mergers that do not generate cost synergies but increase concentration may also increase efficiency as long as the higher level of sophistication of one of the firms is transferred to the rest involved in the merger.

Peer Quality and the Benefits to Attending Better Schools

A common feature of educational systems around the world is that students sort into high school and colleges on the basis of ability. In the United States, students are placed in high schools by neighborhoods

and attendance zones, and college is largely based on academic performance. Across all of these contexts, students and families reveal preferences for attending more selective high schools and

colleges with higher achieving peers. Despite strong evidence for attending high schools with better peers, there is mixed evidence on whether doing so actually improves academic outcomes. In PERC



Working Paper 1704, PERC's Rex Grey Professor, Mark Hoekstra, Texas A&M University's Yaojing Wang, and American University of Beirut's Pierre Mounghanie work to find a conclusion by examining high school quality across a range of schools that vary in selectivity. They also take into context other inputs, like class size and teacher quality.

This study looks at the educational system in China, where enrollment at selective high schools is highly competitive, and admissions is the most competitive at the highest-ranked high schools. University level admissions decisions are mostly based on performance on a college entrance exam, called the Gaokao or the CET. All students who wish to attend college must take this exam. The CET is the main reason for competitive admissions into high schools, as students try to set themselves up to do well on the exam and attend a selective university.

Using data from the CET, the authors estimate the cognitive returns to high school quality. To overcome selection bias, they use a regression discontinuity design that compares applicants that are barely above and below admissions cut offs. They compare the performance of these students to each other, which helps distinguish the effect of attending more selective high schools from other unobserved factors, like ability or motivation. By narrowing the selection area of the study to a single school district, rather than across cities or countries, many factors can be eliminated that could explain the variety of findings documented in previous literature—such as differences in institutions or behavioral response.

They measure “teacher quality”

by the concentration of “superior” teachers, which is the top rank of teachers in China. It is the only ranking that cannot be earned based on credentials such as advanced degrees. Instead, it is based on performance evaluations that include a component of student performance on college entrance exam.

Results across a full range of high schools indicate that while peer quality improves significantly across all sets of admission cut offs, the only increase in academic performance occurs from attending Tier I (most selective, highest quality) high schools. Further evidence suggests that the returns to high school quality are driven by teacher quality, rather than peer quality or class size.

Overall, they find few academic benefits to attending more selective high schools. Specifically, being barely admitted to a more selective school is associated with an average of a one-fifth standard deviation increase in peer quality. There are meaningful increases in peer quality across different admission thresholds throughout the range of high schools. However, they find no evidence that attending schools with higher-ability peers leads to improved college entrance exam performance, on average.

In contrast, attending the higher quality Tier I schools leads to a 0.16 standard deviation increase in exam performance. Given this exam is the primary factor in admission to universities in China, these gains lead to significant increases in students' ability to attend four-year colleges.

In the context of peer quality, this finding is puzzling. While the authors document that threshold-crossing is associated with significant increases in peer quality across all schools, even

outside the Tier I threshold, the only returns come from attending Tier I, rather than Tier II (second-best) schools. The results are consistent with the hypothesis that returns to high school quality are caused by teacher quality, rather than peer. This is the main difference between the Tier I and II schools. This finding is likely responsible for returns to attending more selective schools and is consistent with previous estimates on the value-added of superior teachers.

This study helps to explain the mixed findings in previous literature, documenting significant increases in peer quality, while only some report finding performance gains. The finding of substantial differences in returns to school quality but within the same educational context suggests a need for increased focus on understanding and measuring why school quality matters.

This is important because different mechanisms have different policy implications. For example, if gains from selective schooling were thanks to peer effects, there would be limited options for enabling more students to benefit from school quality. On the other hand, if the differences are driven by differences in teacher quality, then it may be possible to extend the benefits of attending better schools to more students, without reducing returns to others. Results in this study are more consistent with the latter interpretation, since the only positive returns to high school quality occur when there is also a significant increase in teacher quality.





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