November 10, 2015

Dear Search Committee:

      I am very happy to write this letter of recommendation for Zhe Yuan, who is applying for your position. I am on his dissertation committee (chaired by Prof. Victor Aguirregabiria), and I have known him for three years. He took my PhD class in Econometric Methods in Marketing, and did very well. After that, I hired him as my research assistant for one year. I mainly asked him to comment and summarize papers that I need for my research. He has always done a serious job, and been able to share his own views. I find Zhe to be very smart and very hard-working. When Zhe invited me to serve on his dissertation committee, I was very glad to accept it, and I have enjoyed my interactions with him and seeing him to become more mature over time.

      Zhe Yuan's job market paper is a very ambitious project which studies the competition in the airline industry. Because of the data availability, this industry has been an area that attracts attention from many empirical industrial organization economists. However, in my opinion, this is also one of the most difficult industries to analyze, because airlines compete not only via their services, but the extensiveness of the network that they offer. One research question that IO economists are interested in is how an airline decides whether to provide services to a particular route (i.e., whether to offer direct flight service that connects city A and city B. The availability of the data has made this market a platform for applying strategic discrete choice models, i.e., discrete entry and exit games. This area of research has grown rapidly in the past 15 years. When applying it to study airline competition, the literature has typically assumed that each route can be treated as an independent market. But such an approach has abstracted away an important rationale behind airlines' strategic incentive when making such decisions. Instead of being independent, every entry (or exit) would have an impact on the network size and its configuration. I believe it is fair to say that all airlines recognize this as a crucial aspect for the business, and hence hub-and-spoke system is adopted for almost all major airlines. Although the theoretical IO literature has made progress in explaining the hub-and-spoke network, the empirical IO literature has not modeled an airline's profits as a function of its own network and its rivals' networks. This is because developing an empirical strategic interaction model that explicitly incorporates airlines' networks is a formidable task. Each entry and exit decision in a particular route is no longer independent. Instead, the decisions to enter different routes are all inter-connected. For instance, by entering a route, the airline not only serves this route, but also expand its connecting flight services that involve this route. Hence, even we just consider a static game, the equilibrium of such a model is very hard to compute because of a large number of possible network configurations.

      Zhe's PhD thesis is ambitious in the sense that it attacks exactly this major shortcoming in the literature, namely abstracting away network competition. Obviously, this problem is very difficult, and some simplifications have to be made in order to keep things tractable. Zhe

constructs a three-stage decision model where an airline first decides the network, and then decides the capacity of services to provide in each city pair, and then sets prices in each city pair. Zhe abstracts away the dynamic aspect (i.e., how the configuration of a network tomorrow depends on the current network configuration), and assumes that in every period, a static game of this nature is being played. Abstracting away the dynamic problem is a limitation for his study. But it is hard to deny that his research has made a significant contribution to the literature by opening up the possibility of modeling network competition in the airline industry. In fact, even though Zhe only considers a static network competition game, it is very difficult to solve for an equilibrium because there are so many possible network configurations to consider. Hence, Zhe turns to the moment inequality approach, which does not require solving for an equilibrium, when estimating the structural parameters. After estimating the model, he then uses the model to conduct a counterfactual experiment which allows JetBlue to enter the Atlanta-New York segment, and see how other airlines respond to it. I believe this is the only model that allows us to see how airlines would react in city pairs other than the route being threatened directly by an entry (in this case, Atlanta-New York). There are also other simplifications such as the use of revenue functions instead of modeling the primitives behind the revenue. But such an approach is also commonly used in the discrete game literature. What I am trying to say is that when you read Zhe's job market paper, you should compare what he has done with the current frontier of the literature. When you view his work this way, I am confident that you will be impressed by his thesis research.

I also find Zhe Yuan to be very productive. In addition to his job market paper, he has some work-in-progress that look very promising to me (he is coauthoring those works with Prof. Victor Aguirregabiria and Prof. Yao Luo). I am sure Prof. Aguirregabiria and Prof. Luo will describe those works in their letters. In sum, I would strongly recommend Zhe to any departments looking to hire in the field of Industrial Organization. In particular, if your department is looking for a candidate who is well-adapted to the advanced econometric methods in Industrial Organization, you should find Zhe Yuan to be a very good fit for your position. I should mention that perhaps due to his cultural background, Zhe could give people the impression that he is reserved in an interview. But he is actually a good presenter, and his presentation is always very well-organized.

I hope you find my letter useful in assisting your search. If you have any questions, please feel free to contact me at 416-946-0728 or aching@rotman.utoronto.ca.

Sincerely,

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