



The University of Oklahoma[®]

DEPARTMENT OF ECONOMICS

November 10, 2015

Letter of Recommendation for Zexuan Liu

Dear Member of the Search Committee,

I am writing to endorse with great enthusiasm the application of **Zexuan Liu** for an appointment at the Assistant Professor level at your department. Zexuan is actively working on his dissertation and is strongly committed to completing his Ph.D. requirements by May 2016.

I have known Zexuan since he entered the Ph.D. program at Oklahoma in 2011. He took Mathematical Economics with me in Fall 2011 and later on took Industrial Organization with me in Fall 2013. I have been directly working with him for the past 2 years and I am chair of his dissertation committee. Zexuan is an excellent teacher and researcher. He has outstanding empirical skills and uses cutting edge techniques independently to isolate and identify the impact of various changes (endogenous changes such as merger or quasi-exogenous such as policy change). Zexuan's dissertation contains 3 chapters, all empirical studies of the U.S. airline industry. The first chapter looks at the impact of a policy change (tarmac delay rule). The second chapter studies the impact of merger on on-time performance and various other measures of product differentiation. The last chapter tests the relationship between quality uncertainty and equilibrium horizontal product differentiation.

When Zexuan began searching for his dissertation topic, he was very interested in the U.S. airline industry. Motivated by both personal experience and extensive media coverage on tarmac delays, he became interested in the tarmac delay rule first. This work later on led him to other airline delay measures. Let me say that at this point that my interest in airline delay is entirely due to him.

Zexuan, in the **first chapter** of his dissertation, studies the impact of the tarmac delay rule. Triggered by multiple highly publicized lengthy tarmac delays, U.S. Department of Transportation released a new tarmac delay rule in December 2009. The rule stipulates that airlines must provide opportunities for passengers to deplane after certain amount of time on the runway (3 hours for domestic flights and 4 hours for international flights), or face severe financial penalty. Initially the rule covered only large and medium airports and later on was extended to smaller airports. Zexuan was concerned with the tarmac delay and its impact on passengers. But he is also concerned with the potential unintended consequences of the tarmac delay rule. The rule only fines violation of extensive tarmac delay, without fixing the underlying problems which cause extensive tarmac delay in the first place. Zexuan is concerned that the underlying problems will simply surface in different forms. In particular, he (as some others before him) conjectures that flights which would experience extensive tarmac delay (in the absence of tarmac delay rule) are likely to be canceled, which would end up hurting the

passengers even more. This is indeed what Zexuan found: Flight cancellation rate increases around 5% due to the tarmac delay rule. Moreover, his results suggest that airlines use a selective cancellation strategy to minimize the disruption and the corresponding economic loss.

Analyzing tarmac delay led Zexuan to consider other types of delay measures (such as departure delay and arrival delay etc.). The U.S. airline industry has also experienced significant consolidation in recent years. One natural question is combine this two and analyze how merger between airlines affects on-time performance. In the **second chapter** of his dissertation (joint with Pallab Ghosh and me), Zexuan studies the impact of one particular merger - that between US Airways and America West.

There is an extensive literature on the impact of merger (e.g., Kim and Singal (2003).) which mostly focuses on how merger affects prices. Prince and Simon (2014) investigate the impact of merger on quality measured by on-time performance, while Mazzeo (2003) analyzes the relationship between market structure and on-time performance. Zexuan's work is closely related to this literature, especially to Prince and Simon (2014). However, Zexuan's work is unique in several aspects. First, Zexuan focuses on a specific merger (that between US Airways and America West) and carefully selects sample periods to avoid contamination of various demand and supply side confounding factors (e.g., terrorism, subsequent merger).

His second and most important contribution is to use cutting-edge econometric techniques to isolate and identify the impact of merger. Existing studies have used standard diff-in-diff method by comparing the treated group (merging carrier-routes) and "control group" (non-merging carrier-routes). In contrast, Zexuan uses genetic panel matching to select carrier-routes from the whole "control group" to construct an appropriate matched group, and then compare the treated group with this matched group (rather than whole control group). Zexuan first excludes all overlapping routes (served by merging carriers as well) from the control group, because merger likely will affect non-merging carriers on the overlapping routes. Next, Zexuan uses the same diff-in-diff method as in existing studies, but quickly finds that the treated group and the "control group" do not follow common time trend, so the estimates from the standard diff-in-diff would be biased. Zexuan then started actively looking for ways to construct a more proper "matched group" to compare with the treated group. He first tried with propensity score matching to identify non-merging carrier-routes which have similar predicted probability of merger (even though they do not experience merger) as carrier-routes in the treated group. This turns out not to work because the treatment (merger) takes place only once and for all merging carriers' routes, but using propensity score matching imposes the implicit assumption that merging carriers were making merger decisions at the carrier-route level. That is, US airways and America West can merge on some routes but not on other routes. This does not fit with reality and the corresponding implication can easily be discouraging as Zexuan has spent a long time to assemble data from various sources for the propensity score matching process and estimation. But Zexuan was not discouraged and he worked extremely hard and found an alternative way to construct the matched group. The idea is to identify those in the control group (non-merging carrier-routes) that "look like" those in the treated group (merging carrier-routes) in terms of various characteristics. In particular, for each carrier-route, data are available for a list of variables (e.g., financial variables, market structure variables such as market share and HHI, and other route-level characteristics such as distance, population etc.). Zexuan then

calculates the “distance” between any pair of carrier-route for each of these variables. Weights then can be assigned to these variables, and one can sum up the distance across the variables. This gives a distance between any pair of carrier-routes. For each carrier-route (say A) in the treated group, one can identify the carrier-route (say B) in the control group with the smallest aggregate distance to A. Zexuan found that this method has been used in previous studies. However, he could not directly apply their method. First, this method is ideal for cross-sectional data while Zeuxan has panel data. To take advantage of the time series dimension of his data, he needs to develop a panel matching method. Second, it is unclear how the weights should be assigned to different variables. The first question is easy to solve conceptually – one only needs to add up the distance at each point in time, so the distance is not only aggregated across variables, but across time as well. The challenge mostly lies in implementing this strategy, especially on minimizing the computational burden since he needs to calculate the distance along a vector of variables for each pair of carrier-routes. Each pair consists of one carrier-route in the treated group and the other in the control group, and there are thousands of such pairs. The second question is how the weights to variables should be assigned. Zexuan found inspiration from other literature and used a genetic matching method. He first assigns initial weights to the variables for each period in the data (pre-merger periods only). The genetic matching then evaluates the outcomes and adjusts the weights accordingly. Each iteration moves closer to the “optimal weights” which minimizes the distance between the treated group and the matched group.

Zexuan’s third contribution is to extend on-time performance to vertical differentiation, and consider other measures of vertical differentiation as well as horizontal differentiation. To my knowledge, this is the first time horizontal differentiation is analyzed in terms of merger impact in the U.S. airline industry. Zexuan is currently polishing the estimation for horizontal differentiation measures and is also looking at the raw data to provide more intuitions/mechanisms to help readers understand the results for vertical differentiation.

Zexuan’s contribution to this project was greater than the other two authors (a colleague and myself) combined, and this is why he is the lead author of this project. First and foremost, his input to discussions we regularly had about how to write and revise the manuscript and the direction that the paper should follow was immense and invaluable. Moreover, finding, modifying and implementing the econometric methods are mostly due to him. The main challenge in the paper is to construct a proper matched group which then can be compared with the treated group to isolate the impact of merger. Zexuan worked extremely hard and was quite successful in combining and modifying existing method for his needs. Impact of endogenous policy/structure change is a commonly studied topic, and Zexuan’s technical innovation has a wide applicability and it will prove very useful in future work.

In the **third chapter** of his dissertation, Zexuan analyzes the relationship between quality uncertainty and level of product differentiation. Bester (1998) shows that quality uncertainty may induce firms to reduce the level of horizontal product differentiation in the equilibrium. Zexuan tests this relationship using the airline data. He uses the variance of on-time performance to proxy for quality uncertainty, and uses the variation of flight departure times across carriers to proxy for the level of horizontal differentiation. Using an instrumental variable

to correct for endogeneity, Zexuan finds that higher quality uncertainty is linked to less horizontal differentiation, supporting Besters' theoretical prediction.

Zexuan has taught Principles of Macroeconomics as an independent instructor in Summer 2015, and has taught lab sections for numerous semesters. Our principle level classes have anywhere between 400 to 500 students. The whole class is divided into 10-15 lab sections and each lab section meets once a week for 50 minutes. Because of the smaller size and face-to-face interaction, there is usually a lot of teaching and learning taking place in the lab sections. Zexuan has always obtained excellent teaching evaluations, even the very first time when he taught the lab section in Fall 2013. While Zexuan's teaching experience is mostly for Principles of Macroeconomics, it is really not his choosing. Most of our TAs are assigned to lab sections of either Principle Micro or Principle Macro, and there apparently has been quite some path dependence once one is assigned to a specific course. Zexuan's communication and presentation skills are excellent and they have been further honed by his numerous presentations. I am confident that he can offer superb courses in Microeconomics, Applied Econometrics, Industrial Organization and Game Theory.

On the personal front, Zexuan is a very approachable and down to earth individual with a good sense of humor. Due to his broad interests, ability and friendly personality he can easily collaborate with other people. It has been a pleasure for me to work with Zexuan.

If I can provide any additional information, or be of any further assistance, please do not hesitate to contact me by phone at (405) 325-5846, or by e-mail at qliu@ou.edu.

Sincerely,

Zihong Liu

Qihong Liu
Associate Professor of Economics
University of Oklahoma

References:

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Kim, E. and V. Singal (1993). "Mergers and Market Power: Evidence from the Airline Industry," *American Economic Review* 83, 549-569.

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