ECO 3901
INDUSTRIAL ORGANIZATION II

University of Toronto. Department of Economics. Winter 2024

Instructor: Victor Aguirregabiria   E-mail: victor.aguirregabiria@utoronto.ca
Office: Dept. of Econ. Room 309   Course website: https://q.utoronto.ca/courses/339659

Lectures
- Wednesdays 11:00am to 1:00pm
- Room BL 312. Class find: https://www.classfind.com/toronto/room/BL312

Office Hours
- Tuesdays, 4:00pm to 5:00pm or under appointment.

A. COURSE DESCRIPTION

This course deals with Empirical Industrial Organization. It covers topics related to econometric models and empirical applications of competition in industries. We study a range of topics related to the determinants of firms' behaviour and market outcomes, including market entry/exit, investment, innovation, product design, networks, matching, and natural resources. Throughout the course, we scrutinize research papers employing **empirical dynamic games** to investigate firms' strategies and competition. An essential aspect of our focus is the pivotal role played by firms' information and beliefs in shaping competition, market outcomes, and overall welfare. The course underscores the need to integrate data, economic models, adept identification strategies to answer empirical questions in economics.

B. MEETINGS

- **Lectures:** Wednesdays from 11am to 1:00pm in room BL 312.
- **Office Hours**: Tuesdays, 4:00pm to 5:00pm or under appointment. Room GE 309.

C. EVALUATION
Your final grade will be based on a problem set and a take-home final exam. Both exercises involve computer coding and working with datasets.

- **Problem set (50%)**. I will post the problem set in Quercus on **Monday, February 19th**. Your completed problem set is **due on Monday, March 4th** before 11:59pm, via Quercus.

- **Final exam (50%)**. The final exam is a "Take Home Exam". I will post the problem set in Quercus on **Wednesday, April 3rd**. Your completed exam is **due on Monday, April 8th**, before 11:59pm, via Quercus.

D. GENERAL REFERENCES

The following are general references which are useful for all the topics covered in this course.

- Aguirregabiria, V. (2021): "Empirical industrial organization: Models, methods & applications".
- Aguirregabiria, V., A. Collard-Wexler, and S. Ryan (2021): "Dynamic Games in Empirical Industrial Organization," *Handbook of Industrial Organization*, Volume 4, Chapter 4.
- Aguirregabiria, V., and A. Nevo (2013): "Recent developments in empirical IO: Dynamic demand and dynamic games," *Advances in Economics and Econometrics*, 3, 53–122.
- Berry, S., and G. Compiani (2021): "Empirical Models of Industry Dynamics with Endogenous Market Structure," *Annual Review of Economics*, 13, 309–334.

E. OUTLINE AND REFERENCES

List of Topics
1. Dynamic games of oligopoly competition: Models and Solution methods
2. Identification of structural dynamic games
3. Structural estimation dynamic games
4. Market entry and exit
5. Dynamic spatial competition in retail markets
6. Uncertainty and firms' investment decisions
7. Dynamic games of innovation
8. Dynamic price competition
9. Airline networks
10. Dynamic games with firms' non-equilibrium beliefs and learning

Topic 1: <u>Dynamic games of oligopoly competition: Models and Solution methods</u>

<u>Main references</u>
- Aguirregabiria, V., and P. Mira (2007): "Sequential estimation of dynamic discrete games," *Econometrica*, 75, 1-53.
- Ericson, R. and A. Pakes (1995): "Markov-Perfect Industry Dynamics: A Framework for Empirical Work," *Review of Economic Studies,* 62, 53-82.
- Pakes, A. and P. McGuire (1994): "Computing Markov perfect Nash equilibrium: Numerical implications of a dynamic differentiated product model," *RAND Journal of Economics*, 25, 555-589.

<u>Additional references</u>
- Doraszelski, U., and K. Judd (2012): "Avoiding the curse of dimensionality in dynamic stochastic games," *Quantitative Economics*, 3 (1): 53–93.
- Doraszelski, U., and M. Satterthwaite (2010): "Computable Markov-Perfect Industry Dynamics," *The RAND Journal of Economics*, 41 (2): 215–243.
- Fershtman, C., & Pakes, A. (2012): "Dynamic games with asymmetric information: A framework for empirical work," *Quarterly Journal of Economics*, 127, 1611-1661.
- Weintraub, G., L. Benkard, and B. Van Roy (2008): "Markov perfect industry dynamics with many firms," *Econometrica*, 76 (6): 1375–1411.

Topic 2: <u>Identification of structural dynamic games</u>

<u>Main references</u>
- Aguirregabiria, V., and P. Mira (2019): "Identification of games of incomplete information with multiple equilibria and unobserved heterogeneity," *Quantitative Economics*, 10(4), 1659-1701.
- Bajari, P., H. Hong, J. Krainer and D. Nekipelov (2007): "Estimating Static Models of Strategic Interactions," *Journal of Business & Economic Statistics*, 28(4), 469-482.

<u>Additional references</u>
- Aguirregabiria, V., and J. Suzuki (2014): "Identification and counterfactuals in dynamic models of market entry and exit," *Quantitative Marketing and Economics*, 12 (3): 267–304.
- Abbring, Jaap, and Øystein Daljord (2020): "Identifying the discount factor in dynamic discrete choice models," *Quantitative Economics*, 11 (2): 471–501.
- An, Y., Y. Hu, and R. Xiao (2021): "Dynamic decisions under subjective expectations: A structural analysis," *Journal of Econometrics*, 222 (1): 645–675.
- Buchholz, N., M. Shum, and H. Xu (2021): "Semiparametric estimation of dynamic discrete choice models," *Journal of Econometrics*, 223 (2): 312–327.
- Hu, Y., and M. Shum (2012): "Nonparametric identification of dynamic models with unobserved state variables," *Journal of Econometrics*, 171 (1), 32–44.

Topic 3: <u>Structural estimation dynamic games</u>

<u>Main references</u>
- Aguirregabiria, V., and P. Mira (2007): "Sequential estimation of dynamic discrete games," *Econometrica*, 75, 1-53.
- Arcidiacono, P., and R. Miller (2011): "Conditional choice probability estimation of dynamic discrete choice models with unobserved heterogeneity," *Econometrica*, 79(6), 1823-1867.
- Bajari, P., L. Benkard and J. Levin (2007): "Estimating dynamic models of imperfect competition," *Econometrica*, 75, 1331-1370.
- Hotz, J., and R. Miller (1993): "Conditional choice probabilities and the estimation of dynamic models," *The Review of Economic Studies*, 60 (3), 497–529.
- Rust, J. (1994): "Structural estimation of Markov decision processes," *Handbook of Econometrics*, Volume 4, 3081–3143.

<u>Additional references</u>
- Aguirregabiria, Victor, and Mathieu Marcoux (2021): "Imposing equilibrium restrictions in the estimation of dynamic discrete games," *Quantitative Economics*, 12(4), 1223-1271.
- Aguirregabiria, V., and A. Magesan (2013): "Euler equations for the estimation of dynamic discrete choice structural models," In *Structural Econometric Models (Advances in Econometrics)*, 31, 3–44.
- Arcidiacono, P., P. Bayer, J. Blevins, and P. Ellickson (2016): "Estimation of dynamic discrete choice models in continuous time with an application to retail competition," *The Review of Economic Studies*, 83 (3): 889–931.
- Berry, S., and G. Compiani (2023): "An instrumental variable approach to dynamic models," *The Review of Economic Studies*, 90 (4), 1724-1758.
- Hotz, J., R. Miller, S. Sanders, and J. Smith (1994): "A simulation estimator for dynamic models of discrete choice," *The Review of Economic Studies*, 61 (2), 265–289.

- Kasahara, H., and K. Shimotsu (2012): "Sequential estimation of structural models with a fixed point constraint," *Econometrica*, 80 (5), 2303–2319.
- Pesendorfer, M., and P. Schmidt-Dengler (2008): "Asymptotic least squares estimators for dynamic games," *The Review of Economic Studies*, 75 (3): 901–928.
- Rust, J. (1987): "Optimal replacement of GMC bus engines: An empirical model of Harold Zurcher," *Econometrica*, 999–1033.

Topic 4: <u>Market entry and exit</u>

<u>Main references</u>
- Dunne, T., S. Klimek, M. Roberts, and D. Xu (2013): "Entry, exit, and the determinants of market structure," *The RAND Journal of Economics*, 4 (3): 462–487.
- Igami, M., and N. Yang (2016): "Unobserved heterogeneity in dynamic games: Cannibalization and preemptive entry of hamburger chains in Canada," *Quantitative Economics*, 7 (2), 483–521.

<u>Additional references</u>
- Bresnahan, T., and P. Reiss (1994): "Measuring the importance of sunk costs," *Annales D'Économie et de Statistique*, 31, 183–217.

Topic 5: <u>Dynamic spatial competition in retail markets</u>

<u>Main references</u>
- Ellickson, P., S. Houghton, and C. Timmins (2013): "Estimating network economies in retail chains: a revealed preference approach," *RAND Journal of Economics*, 44(2), 169-193.
- Holmes, T. (2011): "The diffusion of Walmart and economies of density," *Econometrica*, 79(1).
- Seim, K. (2006): "An Empirical Model of Firm Entry with Endogenous Product-Type Choices," RAND Journal of Economics 37(3).

<u>Additional references</u>
- Aguirregabiria, V. and J. Suzuki (2016): "Empirical Models of Market Entry and Spatial Competition in Retail Industries," in *Handbook on the Economics of Retail and Distribution*.
- Arcidiacono, P., P. Bayer, J. Blevins, and P. Ellickson (2016): "Estimation of dynamic discrete choice models in continuous time with an application to retail competition," *The Review of Economic Studies*, *83*(3), 889-931.

Topic 6: <u>Uncertainty and firms' investment decisions</u>

<u>Main references</u>
- Bueren, J., X. Gine, H. Jacoby, and P. Mira (2023): "Over-Drilling: Local Externalities and the Social Cost of Electricity Subsidies for Groundwater Pumping," Working Paper. World Bank.
- Collard-Wexler, A. (2013): "Demand fluctuations in the ready-mix concrete industry," *Econometrica*, 81(3), 1003-1037.
- Kalouptsidi, M. (2014): "Time to build and fluctuations in bulk shipping," *American Economic Review*, *104*(2), 564-608.

Additional references
- Kellogg, R. (2014): "The effect of uncertainty on investment: Evidence from Texas oil drilling," *American Economic Review*, *104*(6), 1698-1734.

Topic 7: <u>**Dynamic games of innovation**</u>

<u>Main references</u>
- Goettler, R. and B. Gordon (2011): "Does AMD spur Intel to innovate more?" *Journal of Political Economy*, 119(6), 1141-1200.
- Igami, M. (2017): "Estimating the Innovator's Dilemma: Structural Analysis of Creative Destruction in the Hard Disk Drive Industry," *Journal of Political Economy*, 125(3), 798-847

<u>Additional references</u>
- Hashmi, A., and J. Van Biesebroeck (2016): "The relationship between market structure and innovation in industry equilibrium: a case study of the global automobile industry," *The Review of Economics and Statistics*, 98 (1), 192–208.

Topic 8: <u>**Dynamic price competition**</u>

<u>Main references</u>
- Betancourt, J., A. Hortaçsu, A. Oery, and K. Williams (2022): "Dynamic price competition: Theory and evidence from airline markets," NBER Working Paper 30347.
- Kano, K. (2013): "Menu costs and dynamic duopoly." *International Journal of Industrial Organization*, 31 (1), 102–118.
- Liu, Y., and R. Luo (2023): "Network Effects and Multinetwork Sellers' Dynamic Pricing in the U.S. Smartphone Market," *Management Science*, 69(6), 3297–3318.
- MacKay, A., and M. Remer (2022): "Consumer Inertia and Market Power,". Working Paper. Harvard University.
- Sweeting, A., J. Roberts, and C. Gedge (2020): "A model of dynamic limit pricing with an application to the airline industry," *Journal of Political Economy*, 128 (3), 1148–1193.

<u>Additional references</u>
- Aguirregabiria, Victor (1999): "The dynamics of markups and inventories in retailing firms," *The Review of Economic Studies*, 66 (2): 275–308.
- Bray, R., and I. Stamatopoulos (2022): "Menu Costs and the Bullwhip Effect: Supply Chain Implications of Dynamic Pricing," *Operations Research*, 70(2), 748–765.
- Slade, M. (1998): "Optimal pricing with costly adjustment: evidence from retail grocery prices," *The Review of Economic Studies*, 65 (1), 87–107.
- Sweeting, A, X. Tao, and X. Yao (2021): "Dynamic Oligopoly Pricing with Asymmetric Information: Implications for Horizontal Mergers," manuscript. University of Maryland.

Topic 9: <u>**Airline networks**</u>

<u>Main references</u>
- Aguirregabiria, V., and C-Y. Ho (2012): "A dynamic oligopoly game of the US airline industry: Estimation and policy experiments," *Journal of Econometrics*, 168(1), 156-173.

- Benkard, C., A. Bodoh-Creed, and J. Lazarev (2019): "Simulating the dynamic effects of horizontal mergers: US airlines," *Manuscript, Yale University*.

Additional references
- Chen, Y. (2021): "Network Structure and Efficiency Gains from Mergers: Evidence from U.S. Freight Railroads," manuscript. University of Toronto.
- Yuan, Z. (2018): "Network Competition in the Airline Industry: A Framework for Empirical Policy Analysis," manuscript. University of Toronto.

Topic 10: <u>Dynamic games with firms' non-equilibrium beliefs and learning</u>

Main references
- Aguirregabiria, V., & Magesan, A. (2020): "Identification and estimation of dynamic games when players' beliefs are not in equilibrium," *The Review of Economic Studies* 87 (2): 582–625.
- Fudenberg, D., and D. Levine (1998): "The Theory of Learning in Games." Book. MIT Press.
- Fudenberg, D., and D. Levine (2009): "Learning and equilibrium," *Annual Reviews*, 1(1), 385-420.
- Jeon, Jihye (2020): "Learning and investment under demand uncertainty in container shipping," *The RAND Journal of Economics*, Forthcoming.

Additional references
- Aguirregabiria, V. (2021): "Identification of firms' beliefs in structural models of market competition," *Canadian Journal of Economics*, 54(1), 5-33.
- Doraszelski, U., Lewis, G., & Pakes, A. (2018): "Just starting out: Learning and equilibrium in a new market," *American Economic Review*, 108, 565-615.
- Hortacsu, A., Luco, F., Puller, S. & Zhu, D. (2019): "Does strategic ability affect efficiency? Evidence from electricity markets," *American Economic Review*, 109(12), 4302-42.

F. CLASS SCHEDULE

WEEK- DATE	TOPIC
Week 1: Jan. 10	Topic 1: Dynamic games of oligopoly competition: Models
Week 2: Jan. 17	Topic 1: Dynamic games of oligopoly competition: Solution methods
Week 3: Jan. 24	Topic 2: Identification of structural dynamic games
Week 4: Jan. 31	Topic 3: Structural estimation dynamic games
Week 5: Feb. 7	Topic 4: Market entry and exit
Week 6: Feb. 14	Topic 5: Dynamic spatial competition in retail markets
	*** READING WEEK – Monday 19th to Sunday 25th
	*** Monday, Feb 19th: Problem set is posted in Quercus
Week 7: Feb. 28	Topic 6: Uncertainty and investment decisions
Week 8: Mar. 6	Topic 7: Dynamic games of innovation
Week 9: Mar. 13	Topic 8: Dynamic price competition (I) / **Monday, Mar 4th: Problem set is due.**
Week 10: Mar. 20	Topic 8: Dynamic price competition (II)
Week 11: Mar. 27	Topic 9: Airline networks
Week 12: Apr. 3	Topic 10: Dynamic games with firms' non-equilibrium beliefs and learning
	*** Wednesday, April 3rd: Final exam is posted in Quercus
	*** Monday, April 8th: Final exam is due