

# **Empirical Industrial Organization**

## **A CentER Research Master Field Course in Two Parts**

**230319 and 230323**

**Fall 2027**

<b>Instruction language</b>	English
<b>Type of instruction</b>	Lectures (incl. MATLAB tutorials) and individual feedback on assignments
<b>Type of exams</b>	Each part (3 ECTS course) is graded based on homework assignments during the course (20%) and a take-home final exam (80%); Students can only pass each course if they pass the respective final assignment (receive at least 55 percent of the points in the final assignment; otherwise, the course grade is 1)
<b>Level</b>	Master (Research Master 2)
<b>Course load</b>	2 x 3 ECTS
<b>Lecturers</b>	Jaap Abbring (JA; coord. EIO2) Tobias Klein (TK) Nicola Pavanini (NP; coord. EIO1)

### **Prerequisites**

CentER Research Master's first year microeconomics and econometrics sequences, or equivalent, and some prior exposure to MATLAB (e.g. by studying the tutorials on the reading list). Students can only participate in Part 2 after successfully completing Part 1. Students who believe they should be exempted from this rule should contact the course coordinator (JA) before the start of Part 1.

Note: Non-CentER students should ask permission from the Director of Graduate Studies in Economics before enrolling. Please send your request for permission to the CentER Graduate School at [center-gs@uvt.nl](mailto:center-gs@uvt.nl).

### **Objectives**

This course targets second year Research Master and PhD students in business and economics with an interest in structural econometrics and computational economics. It aims at familiarizing them with current research in empirical industrial organization and preparing them to do their own research in the field.

### **Contents**

Recent developments in computational and econometric methods on the one hand and data availability on the other hand have boosted the literature on the structural empirical analysis of market structure and strategic interactions in markets. This course reviews a selection of these developments by providing in-depth discussions of key papers in the empirical industrial organization literature. It focuses on state-of-the-art econometric and computational methods and illustrates these with selected applications. The course is taught in two parts:

- Part 1 (230319; NP, JA, and TK; 3 ECTS) covers discrete choice and static demand estimation, static models of entry and market structure, consumer search, and the analysis of asymmetric information and contracts. It also provides a hands-on introduction to MATLAB, with applications to the estimation of static demand systems.
- Part 2 (230323; JA and TK; 3 ECTS) continues by studying *dynamic* models and the computational and econometric methods to analyse them. It reviews methods for the analysis of dynamic discrete choice, dynamic demand, dynamic models of entry and market structure, and more general dynamic games; studies empirical applications of these methods; and offers hands-on experience with their implementation using MATLAB.

Students are expected to actively prepare for and participate in *all* lectures and tutorials, and to work on regular computational and empirical assignments.

## Specifics

The course is taught in two parts of 3 ECTS (6 weeks x 2 lectures x 2 hours = 24 hours) each. Each of the two parts has (i) regular computational and empirical assignments and (ii) a final exam. Throughout, some of the lectures will be used for MATLAB tutorials and group feedback on the assignments. On top of that, each student will get individual feedback on and instructions for the assignments.

<u>Week</u>	<u>Lect.</u>	<u>Topic</u>	<u>Preparatory reading</u>
<i>PART 1 (230319; 3 ECTS)</i>			
1-2	NP	Static demand estimation	<a href="#">Gandhi and Nevo (2021)</a> <a href="#">Berry (1994)</a> <a href="#">Berry et al. (1995)</a> <a href="#">Nevo (2000)</a> <a href="#">Petrin (2002)</a>
3-4	NP	Asymmetric information and contracts	<a href="#">Einav et al. (2010b)</a> <a href="#">Einav et al. (2010a)</a> <a href="#">Einav et al. (2021)</a> <a href="#">Bundorf et al. (2012)</a> <a href="#">Handel (2013)</a> <a href="#">Crawford et al. (2018)</a>
5	TK	Search	<a href="#">De los Santos et al. (2012)</a> <a href="#">Kim et al. (2010)</a> <a href="#">Honka (2014)</a> <a href="#">Kim et al. (2016)</a>
6	JA	Static models of entry and market structure	<a href="#">Berry and Pakes (2007)</a> <a href="#">Bresnahan and Reiss (1991a)</a> <a href="#">Seim (2006)</a>
EXAM		Take-home computational and/or empirical assignment	
<i>PART 2 (230323; 3 ECTS)</i>			
7-8	JA/TK	Dynamic discrete choice	<a href="#">Rust (1994, Section 3.4)</a> <a href="#">Rust (1987)</a> <a href="#">Abbring and Klein (2015)</a> <a href="#">Su and Judd (2012)</a> <a href="#">Iskhakov et al. (2016)</a>
9	TK	Dynamic demand	<a href="#">Hendel and Nevo (2006)</a>
10-11	JA	Dynamic entry and market structure	<a href="#">ABBP, Section 3</a> <a href="#">Abbring &amp; Campbell (2010)</a> <a href="#">Abbring et al. (2018a)</a> <a href="#">Abbring et al. (2017)</a> <a href="#">Abbring et al. (2018b)</a>
12	TK	Two-stage estimation of dynamic games	<a href="#">Bajari et al. (2007)</a> <a href="#">Ryan (2012)</a>
EXAM		Take-home computational and/or empirical assignment	

## Reading

Good reviews of the field are

[ABBP] Akerberg, D., C.L. Benkard, S.T. Berry, and A. Pakes (2007), “Econometric Tools for Analyzing Market Outcomes”, Chapter 63 in J.J. Heckman and E. Leamer, eds., *Handbook of Econometrics*, vol. 6A, 4171-4276, Amsterdam: North-Holland.

Ho, K., Hortaçsu, A., and A. Lizzeri (2021), *Handbook of Industrial Organization*, Volumes 4-5.

MATLAB introductions and tutorials can be found at

<https://nl.mathworks.com/support/learn-with-matlab-tutorials.html>

Papers by course week, with \* indicating main (preparatory) reading:

### Weeks 1 and 2. Static demand estimation (Nicola Pavanini)

- \* Gandhi, A., and Nevo A. (2021), “Empirical Models of Demand and Supply in Differentiated Products Industries”, Chapter 2 of the *Handbook of Industrial Organization*, Volume 4, Issue 1, 63-139.
- \* Berry, S.T. (1994), “Estimating Discrete-Choice Models of Product Differentiation,” *Rand Journal of Economics*, 25(2), 242–262.
- \* Berry, S.T., J. Levinsohn, and A. Pakes (1995), “Automobile Prices in Market Equilibrium,” *Econometrica*, 63(July), 841–990.
- \* Nevo, A. (2000), “A Practitioner’s Guide to Estimation of Random Coefficients Logit Models of Demand”, *Journal of Economics & Management Strategy*, 9(4), 513–548.
- \* Petrin, A. (2002), “Quantifying the Benefits of New Products: The Case of the Minivan”, *Journal of Political Economy*, 110, 705–729.
- Berry, S.T, and Haile P.A. (2021), “Foundations of Demand Estimation”, Chapter 1 of the *Handbook of Industrial Organization*, Volume 4, Issue 1, 1-62.
- Cardell, N.S. (1997), “Variance Components Structures for the Extreme-Value and Logistic Distributions with Applications to Models of Heterogeneity”, *Econometric Theory*, 13(2), 185–213.
- Dube, J.P., J. Fox, and C.L. Su (2012), “Improving the Numerical Performance of BLP Structural Demand Estimators”, *Econometrica*, 80(5), 2231–2267.
- Egan, M., A. Hortaçsu, and G. Matvos (2017), “Deposit Competition and Financial Fragility: Evidence from the U.S. Banking Sector”, *American Economic Review*, 107 (1), 169-216.
- Kojien, R., and Yogo M. (2016), “Shadow Insurance”, *Econometrica*, 84(3), pp. 1265-1287.
- Kojien, R., and Yogo M. (2018), “An Equilibrium Model of Institutional Demand and Asset Pricing”, forthcoming at *Journal of Political Economy*
- Nevo, A. (2001), “Measuring Market Power in the Ready-to-Eat Cereal Industry,” *Econometrica*, 69(2), 307–342.
- Train, K. (2009), *Discrete Choice Methods with Simulation*, Chapter 13, Cambridge University Press.

### Weeks 3 and 4. Asymmetric information and contracts (Nicola Pavanini)

- \* Bundorf M.K., J. Levin, and N. Mahoney (2012), “Pricing and Welfare in Health Plan Choice”, *American Economic Review*, 102(7), 3214-3248.
- \* Crawford G.S., N. Pavanini, and F. Schivardi (2018), “Asymmetric Information and Imperfect Competition in Lending Markets”, *American Economic Review*, 108(7), 1659-1701.
- \* Einav, L., A. Finkelstein, and M.R. Cullen (2010a), “Estimating Welfare in Insurance Markets using Variation in Prices”, *Quarterly Journal of Economics*, 125(3), pp. 877-921.
- \* Einav, L., A. Finkelstein, and J. Levin (2010b), “Beyond Testing: Empirical Models of Insurance Markets”, *Annual Review of Economics*, 2, pp. 311-366.
- \* Einav, L., A. Finkelstein, and N. Mahoney (2021), “The IO of Selection Markets”, Chapter 14 of the *Handbook of Industrial Organization*, Volume 5, Issue 1, 389-426.
- \* Handel, B.R. (2013), “Adverse Selection and Inertia in Health Insurance Markets: When Nudging Hurts”, *American Economic Review*, 103(7), pp. 2643-2682.
- Abbring, J.H., P.A. Chiappori, and J. Pinquet (2003), “Moral Hazard and Dynamic Insurance Data”, *Journal of the European Economic Association*, 1(1), pp. 767-820.
- Chiappori P.A., and B. Salanié (2000), “Testing for Asymmetric Information in Insurance Markets”, *Journal of Political Economy*, 108(1), pp. 56-78.
- Chiappori, P.A., and B. Salanié (2012), “Asymmetric Information in Insurance Markets: Empirical Assessments”, *Handbook of Insurance*, 2<sup>nd</sup> Edition.
- Cohen, A., and L. Einav (2007), “Estimating Risk Preferences from Deductible Choice”, *American Economic Review*, 97(3), pp. 745-788.

- Einav, L., A. Finkelstein, and P. Schrimpf (2010c), "Optimal Mandates and the Welfare Cost of Asymmetric Information: Evidence from the U.K. Annuity Market", *Econometrica*, 78(3), pp. 1031-1092.
- Einav, L., and A. Finkelstein (2011), "Selection in Insurance Markets: Theory and Empirics in Pictures", *Journal of Economic Perspectives*, 25(1), pp. 115-138.
- Einav, L., M. Jenkins, and J. Levin (2012), "Contract Pricing in Consumer Credit Markets", *Econometrica*, 80(4), pp. 1387-1432.
- Starc A. (2014), "Insurer Pricing and Consumer Welfare: Evidence from Medigap", *RAND Journal of Economics*, 45(1), pp. 198-220.

#### Week 5. Consumer search (Tobias Klein)

- \* De los Santos, B., A. Hortacsu, and M.R. Wildenbeest (2012), "Testing Models of Consumer Search using Data on Web Browsing and Purchasing Behavior", *American Economic Review*, 102(6), 2955–2980.
- \* Kim, J., P. Albuquerque, and B. Bronnenberg (2010), "Online Demand under Limited Consumer Search", *Marketing Science*, 29(6), 1001–1023.
- \* Kim, J., P. Albuquerque, and B. Bronnenberg (2016), "The Probit Choice Model under Sequential Search with an Application to Online Retailing", *Management Science*, forthcoming.
- \* Honka (2014), "Quantifying Search and Switching Costs in the U.S. Auto Insurance Industry," *Rand Journal of Economics*, 45(4), 847–884.
- Weitzman, M.L. (1979), "Optimal Search for the Best Alternative", *Econometrica*, 47(3), 641–654.
- Stigler, G.J. (1961), "The Economics of Information", *Journal of Political Economy*, 69, 213–225.

#### Week 6. Static models of entry and market structure (Jaap Abbring)

- \* Berry, S.T., and P.C. Reiss (2007), "Empirical Models of Entry and Market Structure", Chapter 29 in M. Armstrong and R. Porter, eds., *Handbook of Industrial Organization*, vol. 3, 1845–1886, Amsterdam: North-Holland.
- \* Bresnahan, T.F., and P.C. Reiss (1991a), "Entry and Competition in Concentrated Markets", *Journal of Political Economy*, 99, 977–1009.
- \* Seim, K. (2006), "An Empirical Model of Firm Entry with Endogenous Product-Type Choices", *RAND Journal of Economics*, 37, 619–640.
- Bresnahan, T.F., and P.C. Reiss (1990), "Entry in Monopoly Markets", *Review of Economic Studies*, 57(4), 531–553.
- Bresnahan, T. F. and P.C. Reiss (1991b), "Empirical Models of Discrete Games", *Journal of Econometrics*, 48(1-2), 57–81.
- Berry, S. (1992), "Estimation of a Model of Entry in the Airline Industry," *Econometrica*, 60, 889–917.
- Mazzeo, M. (2002), "Product Choice and Oligopoly Market Structure", *RAND Journal of Economics*, 33(2), 1–22.
- Berry, S., and E. Tamer (2006), "Identification in Models of Oligopoly Entry," in R. Blundell, W. Newey, and T. Persson, eds., *Advances in Economics and Econometrics. Ninth World Congress of the Econometric Society*, vol. 2, 46–85, Cambridge: Cambridge University Press.
- Schaumans, C. and F. Verboven (2008), "Entry and Regulation: Evidence from Health Care Professions", *RAND Journal of Economics*, 39(4), 949–972.
- Ciliberto, F. and E. Tamer (2009), "Market Structure and Multiple Equilibria in Airline Markets", *Econometrica*, 77(6), 1791–1828.
- Ellickson, P. and S. Misra (2011), "Estimating Discrete Games," *Marketing Science*, 30(6), 997–1010.
- Vitorino, M.A. (2012). Empirical Entry Games with Complementarities: An Application to the Shopping Center Industry. *Journal of Marketing Research*, 49(2), 175–191.
- Gentzkow, M., J.M. Shapiro, and M. Sinkinson, M. (2014), "Competition and Ideological Diversity: Historical Evidence from US Newspapers", *The American Economic Review*, 104(10), 3073–3114.
- Berry, S., A. Eizenberg, and J. Waldfogel (2016), "Optimal Product Variety in Radio Markets", *The RAND Journal of Economics*, 47(3), 463–497.

#### Weeks 7 and 8. Dynamic discrete choice (Jaap Abbring and Tobias Klein)

- \* Rust, J. (1987), "Optimal Replacement of GMC Bus Engines: An Empirical Model of Harold Zurcher", *Econometrica*, 55, 999–1033.
- \* Abbring, J.H. and T.J. Klein (2015), "Dynamic Discrete Choice Models: Methods, Matlab code, and Exercises", Lecture notes, CentER, Tilburg University. Available online at <http://ddc.abbring.org>
- \* Rust, J. (1994), "Structural Estimation of Markov Decision Processes", Chapter 51 in R.F. Engle and D.L. McFadden, eds., *Handbook of Econometrics*, vol. 4, 3081–3143, Amsterdam: North-Holland.
- \* Su, C.-L., and K.L. Judd (2012), "Constrained Optimization Approaches to Estimation of Structural Models", *Econometrica*, 80(5), 2213–2230.

- Iskhakov, F., J. Lee, J. Rust, K. Seo, and B. Schjerning (2016), “Constrained Optimization Approaches to Estimation of Structural Models: Comment”, *Econometrica*, 84(1), 629–657.
- Hotz, V.J., and R.A. Miller (1993), “Conditional Choice Probabilities and the Estimation of Dynamic Models”, *Review of Economic Studies*, 60, 497–529.
- Hotz, V.J., R.A. Miller, S. Sanders, and J. Smith (1994), “A Simulation Estimator for Dynamic Models of Discrete Choice”, *Review of Economic Studies*, 61(2), 265–289.
- Arcidiacono, P., and R.A. Miller (2011), “Conditional Choice Probability Estimation of Dynamic Discrete Choice Models with Unobserved Heterogeneity”, *Econometrica*, 79(6), 1823–1867.

For reviews of models and methods that build on Rust (1987), Hotz and Miller (1993), and Hotz et al. (1994), see

- Aguirregabiria, V., and P. Mira (2010), “Dynamic Discrete Choice Structural Models: A Survey”, *Journal of Econometrics*, 156(1), 38–67.
- Arcidiacono, P., and P.B. Ellickson (2011), “Practical Methods for Estimation of Dynamic Discrete Choice Models”, *Annual Review of Economics*, 3(1), 363–394.

For a review of the literature on the identification of dynamic discrete choice models, see

- Abbring, J.H. (2010), “Identification of Dynamic Discrete Choice Models”, *Annual Review of Economics*, 2, 367–394.

#### Week 9. Dynamic demand (Tobias Klein)

- \* Hendel I., and A. Nevo (2006), “Measuring the Implications of Sales and Consumer Inventory Behavior”, *Econometrica*, 74(6), 1637–1673.
- Benítez-Silva, H., G. Hall, G. J. Hitsch, G. Pauletto, S. A. S. Brook, and J. Rust (2000): “A Comparison of Discrete and Parametric Approximation Methods for Continuous-State Dynamic Programming problems”, available at <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.28.1668>.
- Gowrisankaran, G., and M. Rysman (2012), “Dynamics of Consumer Demand for New Durable Goods”, *Journal of Political Economy*, 120(6), 1173-1219.

#### Weeks 10 and 11. Dynamic entry and market structure (Jaap Abbring)

- \* ABBP, Section 3.
- \* Abbring, J.H., and J.R. Campbell (2010), “Last-In First-Out Oligopoly Dynamics”, *Econometrica*, 78, 1491–1527. [See also “Last-In First-Out Oligopoly Dynamics: Corrigendum” for some corrections.]
- \* Abbring, J.H., J.R. Campbell, N. Yang, and J. Tilly (2018a), “Very Simple Markov-Perfect Industry Dynamics: Theory”, *Econometrica*, 86, 721–735.
- \* Abbring, J.H., J.R. Campbell, N. Yang, and J. Tilly (2017), “Very Simple Markov-Perfect Industry Dynamics: Empirics”, Discussion Paper 2017-021, CentER, Tilburg.
- \* Abbring, J.H., J.R. Campbell, N. Yang, and J. Tilly (2018b), “Matlab Programs for Very Simple Markov-Perfect Industry Dynamics: Empirics”, MATLAB code for experimentation with the methods in Abbring et al. (2017). Available online at <http://verysimple.abbring.org>
- Abbring, J.H., and J.R. Campbell (2011), “Matlab Programs for Last-In First-Out Oligopoly Dynamics”, Computational appendix to Abbring and Campbell (2010). Available online at <http://lifo.abbring.org>
- Abbring, J.H., J.R. Campbell, and N. Yang (2010), “Simple Markov-Perfect Industry Dynamics”, Federal Reserve Bank of Chicago Working Paper 2010-21.
- Abbring, J.H., J.R. Campbell, and N. Yang (2017), “Entry, Exit, and Technological Progress in Markov-Perfect Duopoly”, Mimeo, Tilburg University.

A focal point in the quantitative analysis of dynamic oligopoly models is the framework developed in

- Ericson, R., and A. Pakes (1995), “Markov-Perfect Industry Dynamics: A Framework for Empirical Work”, *Review of Economic Studies*, 62(1), 53–82.

For a review of computational methods for a framework like Ericson and Pakes’s (1995), see

- Doraszelski, U, and A. Pakes (2007), “A Framework for Applied Dynamic Analysis in IO”, Chapter 30 in M. Armstrong and R. Porter, eds., *Handbook of Industrial Organization*, vol. 3, 1887–1966, Amsterdam: North-Holland.

#### Week 12. Two-stage estimation of dynamic games (Tobias Klein)

- \* Bajari, P., L. Benkard, and J. Levin (2007), “Estimating Dynamic Models of Imperfect Competition”, *Econometrica*, 75(5), 1331–1370.
- \* Ryan, S.P. (2012), “The Costs of Environmental Regulation in a Concentrated Industry”, *Econometrica*, 80(3), 1019–1061.
- Aguirregabiria, V. and P. Mira (2007), “Sequential Estimation of Dynamic Discrete Games”, *Econometrica*, 75(1), 1–53.

- Pakes, A., M. Ostrovksy, and S. Berry (2007), "Simple Estimators for the Parameters of Discrete Dynamic Games, with Entry/Exit Examples", *RAND Journal of Economics*, 38(2), 373–399.
- Pesendorfer, M., and P. Schmidt-Dengler (2008), "Asymptotic Least Squares Estimators for Dynamic Games", *Review of Economic Studies*, 75(3), 901–928.

## AI Policy

The assignments (**AI - Index - Level 4**) allow you to use tools such as ChatGPT to complete certain elements of the tasks (e.g., literature search, data analyses, audio transcription). AI serves as a support tool (i.e., like your assistant), but you are responsible for critically evaluating its outputs to ensure they meet the assessment requirements. Because AI models such as ChatGPT do not have a transparent search function and it is often unclear where information comes from, searching for literature via academic databases such as Web of Science is strongly recommended. For other types of information, we also recommend using authentic and verifiable sources. For data analyses, AI may assist with calculations, visualization, or code suggestions, but it cannot replace your own interpretation, verification, or final analysis of results. Within the assignment, you may use AI tools for:

- Editing:
  - o Check narration or subtitles in videos/audio for grammar, clarity, and flow.
  - o Review instructions, labels, or UI text in prototypes for clarity in the prototypes.
  - o Check code comments, variable names, or textual descriptions in scripts, programming, or visualizations for readability and overall coherence.
- Inspiration and brainstorming: AI may be used to explore ideas. Verify all AI-generated information with reliable sources and reference these in your assignment. Incorrect, fabricated sources or missing references will not be tolerated.
- AI can support programming by suggesting solutions, assist with data analysis by performing calculations and visualizing data, and aid audio transcription by converting speech to text. Verify and edit all AI outputs to ensure accuracy, coherence, and alignment with assignment requirements.

It is not allowed to use AI to generate final products. It is a support tool. All content must be created, evaluated, verified, and edited by you. Any use of AI must be limited to assisting, not replacing, your own work.

- Transparency: Clearly document for each tool what you used it for in the technology statement. You must use the **Technology statement student(s)** (see text below). Incomplete transparency or presenting AI output as your own work is not permitted.
- Data confidentiality: Never enter sensitive or confidential data into AI platforms, as these may not comply with Tilburg University's or external organizations' privacy guidelines.

Improper or non-transparent use of AI within the assignment will lead to sanctions and may result in your assignment being declared invalid by the Examination Board.

### Technology statement student(s)

For the assignment, you must add the technology statement, using the text below. Replace the text in capital letters with the requested information.

During the preparation of this work, I/We used [NAME TOOL / SERVICE / VERSION OF AI TOOL] in order to [REASON]. The following parts of the assignment were affected/generated by AI tool usage: [INTRODUCTION / METHODS / xxx, DISCUSSION]. After using this tool/service, [NAME STUDENT(S)] evaluated the validity of the tool's outputs, including the sources that generative AI tools have used, and edited the content as needed. As a consequence, [NAME STUDENT (S)] take(s) full responsibility for the content of their work.