# Methods for Structural Microeconometrics

## Table of contents


**1 Topics** **1**

1.1 Identification, Credible Inference, and Marschak's Maxim . . . . . 1

1.1.1 Reading . . . . . 2

1.2 Dynamic Discrete Choice . . . . . 2

1.2.1 Reading . . . . . 2

1.3 Estimation of Dynamic Models with Unobserved Heterogeneity . . . . . 2

1.4 Identification of Dynamic Models with Unobserved Heterogeneity . . . . . 3

**2 Assessment** **3**

**3 Contact** **3**

**Reading List** **3**


Welcome to this course! Find details on the syllabus here, and check out the menu to find other materials.

Here is a link to the git repo for this course, which by cloning is probably the simplest way for you to get access to the data, code, and assignments. I will continue to add materials throughout the course. You may prefer to selectively download these materials.

# 1 Topics

## 1.1 Identification, Credible Inference, and Marschak's Maxim

We formally define identification and discuss (via examples) what people really mean when they talk about identification and **credible inference**. We use the **Generalized Roy Model** to compare identification via functional form to nonparametric identification.

We introduce **Marschak's Maxim** as a guide for doing empirical model-based research.

### 1.1.1 Reading

The two survey articles by Keane (2010) (link) and Angrist and Pischke (2010) (link) - although aging - provide two important perspectives on the issues of credible inference in economics. Low and Meghir (2017) provide a nice review of the advantages of the structural approach.

The original paper by Marschak (1953) may be of interest. Heckman and Vytlacil (2007) provide a nice discussion of Marschak's Maxim in the context of policy evaluation. They introduce (Heckman and Vytlacil 2005; Carneiro, Heckman, and Vytlacil 2011) the *Marginal Treatment Effect* as a tool for thinking about quasi-experimental estimators and policy evaluation.

## 1.2 Dynamic Discrete Choice

We introduce the dynamic discrete choice model and briefly discuss identification when all persistent state variables are observed. We review some of the basics of discrete choice such as the generalized extreme value distribution, which produces tractable choice probabilities with relatively flexible cross-price elasticities.

### 1.2.1 Reading

The main example that we work with throughout the course can be found in Mullins (2022) (pdf).

Rust (1987) is the canonical example demonstrating estimation of dynamic discrete choice models with maximum likelihood and a nested solution method.

We show that if one can directly estimate choice probabilities, several tractable approaches produce estimates of structural parameters without repeatedly solving the model. These include Hotz and Miller (1993), Aguirregabiria and Mira (2002), Aguirregabiria and Mira (2007), Pesendorfer and Schmidt-Dengler (2008), and Arcidiacono and Miller (2011). We will review these methods and why they are not appropriate to use in Mullins (2022).

## 1.3 Estimation of Dynamic Models with Unobserved Heterogeneity

Using Mullins (2022) as an example, we talk about the inferential pitfalls that can occur when models fail to account for **unobserved heterogeneity**. We briefly discuss how this can depend on estimation approaches and sources of identification.

We review methods for estimation of dynamic models, including the **Expectation-Maximization** algorithm (EM) (see, e.g. Arcidiacono and Miller (2011)) and the **clustering** approach of Bonhomme and Manresa (2015). We review practical considerations for these approaches and introduce the **Forward-Back algorithm** for implementing **EM** in hidden

Markov Models with **time-varying unobserved state variables**. We introduce a sparse matrix implementation of this algorithm.

### 1.4 Identification of Dynamic Models with Unobserved Heterogeneity

We discuss how either **panel data** or **instrumental variables** can facilitate identification of models with unobserved heterogeneity, and briefly review identification results for finite mixtures in panel data settings due to Kasahara and Shimotsu (2009) and Bonhomme, Jochmans, and Robin (2016). Berry and Compiani (2023) analyze identification and estimation of dynamic models with persistent heterogeneity using instrumental variables.

## 2 Assessment

There will be 6 problem sets. Your best 4 of these 6 problem sets will be worth 25%. Hence, you can skip two if you want.

Here is the proposed timeline of due dates. Submissions **must** be made through Canvas as a notebook (e.g. jupyter or quarto) formatted to html with printed output.

| Assignment | Due Date |
|---|---|
| Assignment 1 | November 7 |
| Assignment 2 | November 14 |
| Assignment 3 | November 21 |
| Assignment 4 | November 28 |
| Assignment 5 | December 5 |
| Assignment 6 | December 12 |

## 3 Contact

For appointments and questions, please email.

## Reading List

Aguirregabiria, Victor, and Pedro Mira. 2002. "Swapping the Nested Fixed Point Algorithm: A Class of Estimators for Discrete Markov Decision Models." *Econometrica* 70 (4): 1519–43.

———. 2007. "Sequential Estimation of Dynamic Discrete Games." *Econometrica* 75 (1): 1–53.

Angrist, Joshua D., and Jörn-Steffen Pischke. 2010. "The Credibility Revolution in Empirical Economics: How Better Research Design Is Taking the Con Out of Econometrics." *Journal of Economic Perspectives* 24 (2).

Arcidiacono, Peter, and Robert A Miller. 2011. "Conditional Choice Probability Estimation of Dynamic Discrete Choice Models with Unobserved Heterogeneity." *Econometrica* 79 (6): 1823–67.

Berry, Steven T, and Giovanni Compiani. 2023. "An Instrumental Variable Approach to Dynamic Models." *The Review of Economic Studies* 90 (4): 1724–58.

Bonhomme, Stéphane, Koen Jochmans, and Jean-Marc Robin. 2016. "Estimating Multivariate Latent-Structure Models."

Bonhomme, Stéphane, and Elena Manresa. 2015. "Grouped Patterns of Heterogeneity in Panel Data." *Econometrica* 83.

Carneiro, P., J. J. Heckman, and E. J. Vytlacil. 2011. "Estimating Marginal Returns to Education." *American Economic Review* 101 (October): 2754–81. http://www.nber.org/papers/w16474.

Heckman, James, and Edward Vytlacil. 2005. "Structural equations, treatment effects, and econometric policy evaluation." *Econometrica* 73 (3): 669–738.

———. 2007. "Chapter 70 Econometric Evaluation of Social Programs, Part i: Causal Models, Structural Models and Econometric Policy Evaluation." In, edited by James J. Heckman and Edward E. Leamer, 6:4779–874. Handbook of Econometrics. Elsevier. https://doi.org/https://doi.org/10.1016/S1573-4412(07)06070-9.

Hotz, V Joseph, and Robert A Miller. 1993. "Conditional Choice Probabilities and the Estimation of Dynamic Models." *The Review of Economic Studies* 60 (3): 497–529.

Kasahara, Hiroyuki, and Katsumi Shimotsu. 2009. "Nonparametric Identification of Finite Mixture Models of Dynamic Discrete Choices." *Econometrica* 77 (1): 135–75.

Keane, Michael P. 2010. "A Structural Perspective on the Experimentalist School." *Journal of Economic Perspectives* 24 (2).

Low, Hamish, and Costas Meghir. 2017. "The Use of Structural Models in Econometrics." *Journal of Economic Perspectives* 31 (2).

Marschak, Jacob. 1953. "Economic Measurements for Policy and Prediction." In *Studies in Econometric Method*, edited by W. Hood and C. Koopmans. John Wiley & Sons.

Mullins, Joseph. 2022. "Designing Cash Transfers in the Presence of Children's Human Capital Formation." *Working Paper*.

Pesendorfer, Martin, and Philipp Schmidt-Dengler. 2008. "Asymptotic Least Squares Estimators for Dynamic Games." *The Review of Economic Studies* 75 (3): 901–28.

Rust, John. 1987. "Optimal Replacement of GMC Bus Engines: An Empirical Model of Harold Zurcher." *Econometrica: Journal of the Econometric Society*, 999–1033.