RUTGERS
Rutgers Business School
Newark and New Brunswick

26.223.655.01: Econometrics - Time Series
Fall 2016
Newark, 1 Washington Park, Room 502
Thursdays 1:00-3:50 pm

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Office Hours: Please schedule appointments by email

COURSE DESCRIPTION

This course has a broad structure and covers many aspects of modeling and estimating financial/economic time series. In particular, we will be focusing on (*i*) linear regression models involving variables observed over time and (*ii*) "pure" univariate and multivariate time-series models. The objective is that participants gain a thorough understanding of the theory underlying time-series econometrics, which is the basis for any empirical time-series analysis of financial/economic market phenomena. The course places a particular emphasis on clearly identifying which econometric methods are appropriate under which scenarios. Estimation techniques covered will be Ordinary Least Squares (OLS) and Generalized Method of Moments (GMM).

COURSE MATERIALS

- **Textbook**

Author	*Fumio Hayashi*
Book title	*Econometrics*
Year	*2000*
Publisher	*Princeton University Press*
ISBN-10	*0-691-01018-8*

- Additional reading material (journal articles) may be introduced during the course
- Check the course website on Blackboard (`blackboard.rutgers.edu`) and your official Rutgers email account regularly
- Software: Participants can chose their preferred programming language. However, "lower"-level programming will be required using (statistical) programming languages such as Matlab (language used by instructor), R, Gauss, Ox, S-PLUS, or similar; please refrain from using Stata or EViews.

LEARNING GOALS AND OBJECTIVES

This course is designed to help students develop skills and knowledge in the following area(s):

- **Advanced Research Skills**. Students will be able to understand and apply advanced techniques for the statistical analysis of time-series data.

  Students who complete this course will demonstrate:

  - Advanced theoretical and practical econometric research skills that are necessary for their area of specialization.
  - The ability to use the advanced research techniques taught in this course in making their own research contributions.

- **Advanced Knowledge in Specialized Areas**. Acquiring advanced knowledge in any of the specialized research areas under the broad umbrella "Management" requires a thorough understanding of statistical analyses and techniques.

  Students who complete this course will demonstrate:

- The ability to understand and replicate econometric techniques used in existing research contributions in their area of specialization, which will aid them in acquiring advanced knowledge in these areas.
- The ability to apply the correct econometric techniques in different contexts. This will help students in completing their dissertation proposals.

Students develop these skills and knowledge through the following course activities and assignments:

- *Lectures.* Class lectures will cover many areas of time-series econometrics. Particular emphasis will be placed on the assumptions that the researcher needs to make on the underlying data generating process, if he/she wants to ensure that the correct econometric technique is being employed.
- *Homework Assignments.* Homework is assigned to reinforce concepts in the course and for students to practice newly acquired skills. Homework will be assigned weekly.
- *Small Group Project.* Students are assigned to two small group (2-3 students per group) projects. The idea is to apply the techniques learned in the lectures to small empirical research projects. Groups must work together as a team to research the topic, develop the programming code, and write a report on the findings. Each student must individually participate in the research, coding and writing of the report.
- *Tests.* The course includes two exams to formally assess students knowledge and comprehension. Tests consist of open-ended questions covering theoretical time-series econometrics. The exam format is "closed book". The midterm exam will be reviewed in class (during the following lecture) to ensure knowledge transfer.

PREREQUISITES

26.223.554: Econometrics - Cross-Sectional (and the prerequisites for that course). Knowledge of calculus, matrix algebra, probability theory and statistics are essential for this course.

ACADEMIC CONDUCT

All students are expected to know, understand and live up to the standards of RU Academic Integrity Policy (`https://slwordpress.rutgers.edu/academicintegrity/wp-content/uploads/sites/41/2014/11/AI_Policy_2013.pdf`). Don't let cheating destroy your hard-earned opportunity to learn. See `business.rutgers.edu/ai` for more details.

ATTENDANCE AND PARTICIPATION

Attendance is not part of your grade. However, there is a strong relationship between attendance/active participation and grades.

Students will be responsible for all work missed during an absence, no matter what the reason for the absence.

For weather emergencies, consult the campus home page. If the campus is open, class will be held.

GRADING POLICY AND EXAMS

- There are **four** graded items in this course: *Homework Exercises, Empirical Work, Midterm Exam, Final Exam.* You will receive a separate score between 0 and 100 for each of the four items. The final grade will be a weighted average of the four items using the weighting scheme indicated below.

- At the end of each lecture, a set of **Homework Exercises** will be handed out. You are asked to complete these individually and submit them before the following lecture. These homework exercises will be part of the final grade; understanding the problems will substantially assist students in learning the course material and performing well on the exams. Each homework exercise receives an equal weight. Forgiveness policy: the score for the worst homework set is discarded. No make-up exercises are possible. You will receive a score of zero (for the respective homework exercise) if you fail to submit/submit late.

- Two sets of **Empirical Work** projects will be assigned, one in the first half and one in the second half of the course. The projects are designed to introduce the course participants to the use of econometrics in the form of two small empirical studies to support the theoretical part of research. You are asked to complete these in small groups (groups to be formed during the first lecture) within 7 weeks. The deadline for "Empirical Work I" is October 30, and for "Empirical Work II" is December 15, 2016. Assignments should be submitted in .pdf format and should be uploaded to the appropriate folder ("Assignments" tab) on the Blackboard course website. The output will consist of a description of the results, a documentation of your findings, and a discussion of the implications. The programming code including annotations(!) should be added as an appendix to the text of the project. To assist participants in coding, I will upload programming code corresponding to the material covered in each lecture for reference. My code is written in Matlab. If you prefer to use a different language, necessary adaptations should be minimal. No make-up work is possible. You will receive a score of zero (for the respective assignment) if you fail to submit/submit late.

- The **Midterm Exam** is scheduled for October 27, 2016, during regular class hours. The format of the exam is closed-book. For your reference, a previous midterm exam is available on the Blackboard course page. Please only bring pencils, pens, erasers, a standard calculators (with the basic functions; not programmable and/or cell phone), and your Rutgers ID card with you to the exam; other items should be placed at the front of the classroom. The material covered in the exam will be the respective chapters from the textbook, journal articles, and the corresponding material from lectures 1 to 7. There will be no make-up midterm exam. You will receive a score of zero if you miss the exam.

- The **Final Exam** is scheduled for December 22, 2016, during regular class hours. The format of the exam is closed-book. For your reference, a previous midterm exam is available on the Blackboard course page. Please only bring pencils, pens, erasers, a standard calculators (with the basic functions; not programmable and/or cell phone), and your Rutgers ID card with you to the exam; other items should be placed at the front of the classroom. All course materials will be relevant for the final exam, with an emphasis on the course content covered in lectures 8 to 13. There will be no make-up final exam. You will receive a score of zero if you miss the exam.

- Grading distribution:

Homework Exercises	...	14%
Empirical Work	...	22%
Midterm Exam	...	32%
Final Exam	...	32%

- There are no opportunities for extra credit

- Grade allocation:

Weighted average of graded items		Corresponding grade
Minimum	Maximum	
86.68	100	A
80.01	86.67	B+
73.34	80	B
66.67	73.33	C+
60	66.66	C
0	59.99	F

- All (partial) scores received throughout the course will be added to the *Grade Center* on the Blackboard course website. Please note that the "Total Weighted Average" on *Grade Center* is a running total; in addition, the system does not properly account for discarding the lowest score of the homework exercises.
- Your partial scores/final grades are not subject to negotiation. If you feel I have made an error, submit your written argument to me within one week of receiving your grade/score. Clarify the precise error I made and provide all supporting documentation. If I have made an error, I will gladly correct it. But I will adjust grades only if I have made an error.

SCHEDULE AND TOPICS

The course follows the Rutgers Academic Calendar, which can be found here: `https://scheduling.rutgers.edu/scheduling/academic-calendar`. Classes will be held every Thursday from 1:00 pm to 3:50 pm in room 502, 1 Washington Park, Newark. We start classes on Thursday, September 8, 2016. Please note that there will be no lecture on November 24, 2016, due to *Thanksgiving Recess*. The make-up lecture will be held in the same week on Tuesday, November 22, 2016 from 1:00 pm to 3:50 pm in room 502. The last lecture will be held on December 8, 2016.

The following list of topics will be covered.

Topic	*Items*
Review of Large-Sample Theory	- Matrix Algebra - Law of Iterated Expectations - Convergence in Probability/Distribution - Law of Large Numbers - Different Central Limit Theorems - Stationariy/Ergodicity/Martingales/etc
Large-Sample OLS	- Large-Sample Distribution of the OLS Estimator - Hypothesis Testing - Estimating $E([\epsilon_t^2 x_t x_t])$ Consistently - Implications of Conditional Homoskedasticity - Testing Conditional Homoskedasticity (White's Test) - Estimation with Parameterized Cond. Heteroskedasticity, (F)GLS - Testing for Serial Correlation (Box-Pierce Test etc.)
Single-Equation GMM	- Failure of *Predeterminedness Assumption*: Endogeneity Bias - The General Formulation - Generalized Method of Moments Defined - Large-Sample Properties of GMM - Testing Overidentifying Restrictions - Implications of Conditional Homoskedasticity (2SLS)

Multiple-Equation GMM	- The Multiple-Equation Model - Equation GMM Defined - Sample Theory - Single-Equation versus Multiple-Equation Estimation - Special Cases of Multiple-Equation GMM: FIVE, 3SLS, and SUR - Common Coefficients
Serial Correlation	- Modeling Serial Correlation: Linear Processes - ARMA Processes - Vector Processes - Estimating Autoregressions
Time-Series Models of Heteroskedasticity	- ARCH - GMM estimation of ARCH - GARCH - IGARCH/EGARCH/GARCH-in-Mean
Serial Correlation in Linear Regressions	- Asymptotics for Sample Means of Serially Correlated Processes - Incorporating Serial Correlation in GMM (Newey-West Estimation) - Estimation under Conditional Homoskedasticity
Unit-Root Econometrics	- Time Regressions (trend-stationary variables) - Modeling Trends - Tools for Unit-Root Econometrics - Dickey-Fuller Tests - Augmented Dickey-Fuller Tests - Which Unit-Root Test to Use?
Cointegration	- Cointegrated Systems - Alternative Representations of Cointegrated Systems - Testing the Null of No Cointegration - Inference on Cointegrating Vectors

SUPPORT SERVICES

- Rutgers University welcomes students with *disabilities* into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: `https://ods.rutgers.edu/students/documentation-guidelines`. If the documentation supports your request for reasonable accommodations, your campuss disability services office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form on the ODS web site at: `https://ods.rutgers.edu/students/registration-form`. For more information please contact Kate Torres at (973)353-5375 or in the Office of Disability Services in the Paul Robeson Campus Center, in suite 219 or by contacting `odsnewark@rutgers.edu`.

- If you are a *military veteran* or are on active military duty, you can obtain support through the Office of Veteran and Military Programs and Services. `http://veterans.rutgers.edu/`

- If you are in need of *mental health* services, please use our readily available services. Rutgers University-Newark Counseling Center: `http://counseling.newark.rutgers.edu/`

- If you are in need of *physical health* services, please use our readily available services. Rutgers Health Services Newark: `http://health.newark.rutgers.edu/`

- If you are in need of *legal services*, please use our readily available services: `http://rusls.rutgers.edu/`
- If you are in need of additional *academic assistance*, please use our readily available services.
  - Rutgers University-Newark Learning Center: `http://www.ncas.rutgers.edu/rlc`
  - Rutgers University-Newark Writing Center: `http://www.ncas.rutgers.edu/writingcenter`

Your feedback is always welcome!