RUTGERS
Rutgers Business School
Newark and New Brunswick

Economics, Applied
Course Number: 26:223:655
Course Title: Econometrics - Time Series

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 (e.g. journal articles) may be introduced during the course

• Check the course website on Canvas (https://canvas.rutgers.edu/) and your official (Canvas-linked) Rutgers email account regularly

• Hardware: Since this is an online course, the following hardware is required: Stable high-speed internet connection & Webcam & Microphone & Scanner, smartphone camera, or other digital camera that takes high resolution pictures.

• Software: Participants can choose 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 and Discussion Sessions. Class lectures will cover many areas of time-series econometrics. The following meetings will ensure knowledge transfer of the lecture material. 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 Empirical Project. The idea is to apply the techniques learned in the lectures to small empirical research projects. Students must research the topic, develop the programming code, and write a report on the findings. Students can practice their presentation skills by recording a short video of their project.

• 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".

PREREQUISITES

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

ACADEMIC INTEGRITY

I do NOT *tolerate cheating*. Students are responsible for understanding the RU Academic Integrity Policy http://academicintegrity.rutgers.edu/

I will strongly enforce this Policy and pursue *all* violations. On all examinations and assignments, students must sign the RU Honor Pledge, which states, "On my honor, I have neither received nor given any unauthorized assistance on this examination or assignment." I will screen all written assignments through *SafeAssign* or *Turnitin*, plagiarism detection services that compare the work against a large database of past work. Don't let cheating destroy your hard-earned opportunity to learn. See business.rutgers.edu/ai for more details.

ATTENDANCE AND PARTICIPATION

Attendance at the weekly meetings is mandatory. Participation at these meetings will be graded. Students will be responsible for all work missed during an absence, no matter what the reason for the absence.

GRADING POLICY AND EXAMS

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

• We will hold weekly meetings to discuss lecture content. Students are expected to actively Participate in these meetings, demonstrating the ability to discuss the learning goals and review the new lecture material. An active participation of each participant is necessary to ensure optimal knowledge transfer for all students.

• A set of Homework Exercises will be assigned on Canvas (\Assign-
ments" tab). You are asked to complete these individually and submit them. 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. Solutions can be hand-written and photographed (ensuring high resolution and legibility is the students' responsibility) or scanned, and uploaded to the respective electronic dropbox on Canvas.

• Two sets of Empirical Work projects will be assigned on Canvas (\Assignments" tab), 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 individually within 7 weeks. The deadline for Empirical Work I", and for Empirical Work II
Assignments should be submitted in .pdf format and should be uploaded to the appropriate folder on the Canvas course website. The output will consist of a description of the results, a documentation of your findings, and a discussion of the implications. In addition, every course participant should record a short 5 minute video clip (using the Flipgrid application that is linked to the Canvas assignment), presenting the results, discussing how the solutions were obtained, explaining what he/she learned from the assignment etc. Once reviewed and graded, these videos will be shared with all course participants.

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. The format of the exam is
closed-book. For your reference, a previous midterm exam is available on the Canvas course page. The material covered in the exam will be the respective chapters from the textbook, journal articles, and the corresponding material from lectures 1 to 6. There will be no make-up midterm exam. You will receive a score of zero if you miss the exam.

. Throughout the exam, students must be online, with their camera and voice turned on, and sharing their screens. You will also be asked to demonstrate that no course-related materials are in your vicinity, and that your desk only has empty
white paper sheets, pencils, pens, erasers, and a standard calculator (with the basic functions; not programmable and/or cell phone) on it. The exam will be completed by hand-writing the solutions onto paper. Once completed, students will scan or photograph their solutions (ensuring high resolution and legibility is the students' responsibility) under the supervision of the instructor, and upload them to Canvas.

• The Final Exam will be held. The format of the exam is
identical to the midterm exam. All course materials will be relevant for the final exam, with an emphasis on the course content covered in lectures 7 to 13. There will be no make-up final exam. You will receive a score of zero if you miss the exam.

• Grading distribution:

Participation : : : 5%
Homework Exercises : : : 16%
Empirical Work : : : 15%
Midterm Exam : : : 32%
Final Exam : : : 32%
• There are no opportunities for extra credit
• Grade allocation:

Weighted average of graded items		Corresponding grade
Minimum	Maximum	
92.00	100	A
84.00	91.99	B+
76.00	83.99	B
68.00	75.99	C+
60.00	67.99	C
0	59.99	F

• All (partial) scores received throughout the course will be added to the grade center on the Canvas course website.

• 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.

COURSE SCHEDULE

The course follows the Rutgers Academic Calendar, which can be found here: https://scheduling.rutgers.edu/scheduling/academic-calendar.
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([_2t xtx0 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)
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

If you need accommodation for a ***disability***, obtain a Letter of Accommodation from the Office of Disability Services. The Office of Disability Services at Rutgers, The State University of New Jersey, provides student-centered and student-inclusive programming in compliance with the Americans with Disabilities Act of 1990, the Americans with Disabilities Act Amendments of 2008, Section 504 of the Rehabilitation Act of 1973, Section 508 of the Rehabilitation Act of 1998, and the New Jersey Law Against Discrimination. More information can be found at ods.rutgers.edu.

[Rutgers University-New Brunswick ODS phone (848)445-6800 or email dsoffice@echo.rutgers.edu]

[Rutgers University-Newark ODS phone (973)353-5375 or email ods@newark.rutgers.edu]

If you are ***pregnant***, the Office of Title IX and ADA Compliance is available to assist with any concerns or potential accommodations related to pregnancy.

[Rutgers University-New Brunswick Title IX Coordinator phone (848)932-8200 or email jackie.moran@rutgers.edu]

[Rutgers University-Newark Office of Title IX and ADA Compliance phone (973)353-1906 or email TitleIX@newark.rutgers.edu]

If you seek ***religious accommodations***, the Office of the Dean of Students is available to verify absences for religious observance, as needed.

[Rutgers University-New Brunswick Dean of Students phone (848)932-2300 or email deanofstudents@echo.rutgers.edu]

[Rutgers University-Newark Dean of Students phone (973)353-5063 or email DeanofStudents@newark.rutgers.edu]

If you have experienced any form of ***gender or sex-based discrimination or harassment***, including sexual assault, sexual harassment, relationship violence, or stalking, the Office for Violence Prevention and Victim Assistance provides help and support. More information can be found at http://vpva.rutgers.edu/.

[Rutgers University-New Brunswick incident report link: http://studentconduct.rutgers.edu/concern/. You may contact the Office for Violence Prevention and Victim Assistance at (848)932-1181]

[Rutgers University-Newark incident report link: https://cm.maxient.com/reportingform.php?RutgersUniv&layout_id=7 . You may also contact the Office of Title IX and ADA Compliance at (973)353-1906 or email at TitleIX@newark.rutgers.edu. If you wish to speak with a staff member who is confidential and does **not** have a reporting responsibility, you may contact the Office for Violence Prevention and Victim Assistance at (973)353-1918 or email run.vpva@rutgers.edu]

If students who have experienced a temporary condition or injury that is adversely affecting their ability to fully participate, you should submit a request via https://temporaryconditions.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/]

[Rutgers Counseling and Psychological Services–New Brunswick: http://rhscaps.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/]

[Rutgers Health Services – New Brunswick: http://health.rutgers.edu/]

If you are in need of ***legal*** services, please use our readily available services: http://rusls.rutgers.edu/

Students experiencing difficulty in courses due to ***English as a second language (ESL)*** should contact the Program in American Language Studies for supports.

[Rutgers–Newark: PALS@newark.rutgers.edu]

[Rutgers–New Brunswick: eslpals@english.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]

[Rutgers University-New Brunswick Learning Center: https://rlc.rutgers.edu/]

[Optional items that many faculty include:

- Students must sign, date, and return a statement declaring that they understand the RU Academic Integrity Policy.

- Students must sign, date, and return a statement declaring that they understand this syllabus.]