

Prefix, Number and Name of Course: **ACM 653 Markov Chain Models in Credit Risk Management**

Credit Hours: 1

In Class Instructional Hours: 1

Labs: 0

Field Work: 0

Catalog Description:

Prerequisites: Calculus, Linear Algebra, Linear Regression, and Introduction to Programming.

A course for students in the applied mathematics masters program and upper-level economics and finance students with a quantitative background. This is a hands-on introduction to mortgage lending and the practice of measuring and managing consumer credit risk. Students will be introduced to Markov chain theory and transition roll rate modeling while re-living the collapse of the U.S. mortgage industry in 2007 and 2008 and understanding the origins of the Great Recession.

Covered topics will include Markov chain applications to risk reporting and segmenting, probability of default, loss given default, house price dynamics, and loss forecasting with consideration of micro and macro-factors. Students will read financial industry reports and make extensive use of the statistical software package SAS to analyze loan-level datasets. Assessment will include problem sets, in-class quizzes on reading, and a course project involving mortgage loss forecasting that will include both written and oral components.

Suggested prerequisites: Previous coursework or experience in Calculus, Linear Algebra, Linear Regression, and Introduction to Programming.

Reasons for Addition:

To create a one-semester hour practicum class for the graduate Professional Applied and Computational Mathematics (PACM) program that integrates theory with direct applications in banking and finance. Course is intended to be cross-registered for advanced/upper-level students outside of the PACM program, specifically economics.

The PACM curriculum is designed to integrate mathematical theory with real-world applications. This course provides students with hands-on, experiential learning, very similar to the type of work they might find in the workplace should they choose to pursue a career in banking or finance. The instructor can be a professional in the banking industry with interest and background in academia.

Student Learning Outcomes	Course	Assessment
Students will:	Content References	

1. assess the strengths and benefits of transition roll rate modeling for credit risk forecasting using Markov Chain Theory	I, II, IV	Problem Sets, Examination, Course Project
2. analyze credit risk and forecast losses on a portfolio of loans using SAS and Excel models.	I, II, IV, V	Problem Sets, Course Project, Class Labs and Discussion
3. analyze the U.S. mortgage industry and the origins of the subprime mortgage crisis and the Great Recession.	II, III, IV	Problem Sets, Examination, Course Project
4. demonstrate ability to manage and communicate with team members when solving problems.	I,II,III,IV, V	Problem Sets, Course Project
5. communicate, both orally and in writing, sophisticated technical analysis with emphasis on important findings	I, II, III, IV, V	Course Project

Course Content:

I. Markov Chain Theory

- A. Principles of Linear Algebra
- B. Graphing State Relationships
- C. Markov Chain Models
- D. Chapman-Kolmogorov Equations
- E. Classification of States
- F. Ergodicity

II. Transition Roll Rate Models

- A. Calculating roll rates by cohort
- B. Limiting Probabilities and Probability of Default
- C. Portfolio segmentation and reporting
- D. Calibration and testing of roll rate models
- E. Sensitivity Testing

III. Mortgage Market Synopsis

- A. History of mortgage lending
- B. The mortgage loan life-cycle
- C. The rise of subprime mortgage lending and the ensuing Great Recession

IV. Consumer Credit Risk

- A. Probability of Default, Loss Given Default, and Expected Loss
- B. House Price Dynamics and Loss Severity
- C. Vintage Analysis and Maturation Curves
- D. Macroeconomic Risk: House Prices, Interest Rates, and Unemployment

V. SAS Programming

- A. Programming in SAS/IML
- B. Data Management in SAS (Data Step, Proc Import, Proc Export, Merging Datasets)
- C. Data Analysis in SAS (Proc Tabulate)

Resources

Scholarship:

Bair, Sheila C. Keynote Address to the "Mortgages and the Future of Housing Finance" Symposium Sponsored by the Federal Deposit Insurance Corporation and the Federal Reserve System; Arlington, VA October 25, 2010

<http://www.fdic.gov/news/news/speeches/chairman/spoct2510.html>

Breeden, Joseph L. *Portfolio Forecasting Tools: What You Need To Know*. Strategic Analytics. 2003.

Bhutta, Neil, et. al. “The Depth of Negative Equity and Mortgage Default Decisions.” Federal Reserve Board of Governors Working Paper. May 2010.

Delwiche, Lora D. and Susan J. Slaughter. *The Little SAS Book: A Primer, Third Edition*. SAS Publishing 2003. <http://www.amazon.com/Little-SAS-Book-Primer-Third/dp/1590473337>

Dungey, Doris. “The Complete UberNerd”. August 2007. (Especially articles on mortgage servicing, FICO, MBS, delinquency and default, and REO and foreclosure).
<http://www.calculatedriskblog.com/2007/07/compleat-ubernerd.html>

Foote, Christopher L., et. al. “Negative Equity and Foreclosure: Theory and Evidence”. Federal Reserve Bank of Boston Working Paper. June 2008.

Frankel, Allen, et. al. “The Danish Mortgage Market”. BIS Quarterly Review, March 2004.

Jozoff, Matthew, et. al. *JPMorgan Mortgage Backed Securities Credit Monthly*. 2011.

Ross. *Introduction to Probability Models*. 4th Edition. Chapter 13 – Markov Chain Models.

SAS/IML(R) 9.2 User's Guide

<http://support.sas.com/documentation/cdl/en/imlug/59656/HTML/default/imlstart.htm>

SAS PROC TABULATE User's Guide.

<http://support.sas.com/documentation/cdl/en/proc/61895/HTML/default/viewer.htm#a002473736.htm>

Schuermann, Til. “What Do We Know About Loss Given Default?” Wharton Financial Institutions Center Working Paper. February 2004

Searle, S.R. and W. H. Hausman. *Matrix Algebra For Business and Economics*. 1970. Chapter 2 – Matrix Arithmetic.

Searle, S.R. and W. H. Hausman. *Matrix Algebra For Business and Economics*. 1970. Chapter 8 – Markov Chains.

Sinkey, Joseph. *Commercial Bank Financial Management*. 6th Edition. 2002. Chapter 12 – Consumer and Small Business Lending.

“The Supervisory Capital Assessment Program: Design and Implementation.” Board of Governors of the Federal Reserve System . April 24, 2009.

“The Supervisory Capital Assessment Program: Overview of Results.” Board of Governors of the Federal Reserve System . May 7, 2009.

Yezer, Anthony M. "A Review of Statistical Problems in the Measurement of Mortgage Market Discrimination and Credit Risk". Research Institute for Housing America. September 2010.

Periodicals:

American Banker

Financial Times

SAS Journal

The Journal of Credit Risk

The Wall Street Journal

Electronic and/or Audiovisual Resources:

SAS 9.3 Documentation <http://support.sas.com/documentation/93/index.html>