Федеральное государственное автономное образовательное учреждение высшего образования
"Национальный исследовательский университет "Высшая школа экономики"

Факультет экономики, менеджмента и бизнес-информатики
Департамент экономики и финансов

Рабочая программа дисциплины
Анализ временных рядов
(Time series analysis)

для образовательной программы «Экономика»
направления подготовки 38.03.01 «Экономика»
уровень бакалавр

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Руководитель департамента Молодчик М.А. _____

Утверждена академическим советом образовательной программы «Экономика» направления подготовки 38.03.01 Экономика, образовательной программы «Финансы» направления подготовки 38.04.08 Финансы и кредит
« 16 » декабря 2017 г., протокол № _____

Академический руководитель образовательной программы
Е.М. Ожегов_____

Пермь, 2017

Аннотация курса

1. Краткое описание курса

Курс “Данные и аналитика в финансах” направлен на ознакомление студентов с основами анализа данных и машинного обучения применительно к финансовым задачам и овладение навыков реализации изученных методов с помощью специального программного обеспечения. Курс начинается с изучения того, как финансовые данные могут быть собраны и обработаны. В рамках этой части студенты научатся находить, собирать, загружать, трансформировать и визуализировать финансовые данные. Следующая часть направлена на формирование аналитических и научно-исследовательских навыков и ознакомление с такими методами, как метод главных компонент, кластеризация, методы аппроксимации функции и Лассо-регрессия. В завершение студенты научатся применять методы машинного обучения на примере обнаружения мошенничества.

В курсе используются открытые данные и данные по финансовым показателям российских и европейских публичных компаний, собранные Международной лабораторией экономики нематериальных активов НИУ ВШЭ, а также данные по продажам и продуктовой аналитике реальных компаний, предоставленных лабораторией GAMES. В результате освоения дисциплины студенты будут обладать навыками анализа данных, оптимизации портфеля активов, продуктовой аналитики и обнаружения мошенничества.

2. План курса

№	Название раздела	Всего часов	Контактные часы				Самостоятельная работа
			Лекции	Семинары	Практические занятия	Другие виды работ	
I.	**Анализ одномерных временных рядов**						
1	Стационарные временные ряды	24		4			20
2	Нестационарные временные ряды	48		8			40
II.	**Многомерный анализ временных рядов**						
3	Векторная авторегрессионная модель (VAR)	34		4			30
4	Структурная векторная авторегресионная модель (SVAR)	36		6			30
5	Векторная модель коррекции ошибок (VECM)	48		8			40
Итого		**190**		**30**			**160**

3. Требования к уровню знаний студентов

Настоящая дисциплина относится к математическому и естественно-научному циклу дисциплин и входит в вариативную часть профиля образовательной программы «Экономика».

Изучение данной дисциплины базируется на следующих дисциплинах:

- Теория вероятностей;
- Математическая статистика;
- Эконометрика

Для освоения учебной дисциплины, студенты должны владеть следующими знаниями и компетенциями:

- обладать навыками применения теории вероятностей и математической статистики;
- обладать навыками использования эконометрических моделей.

4. Преподаватель:

- Шенкман Евгения Андреевна

Course Syllabus

Time series analysis

Faculty: Shenkman Evgeniya

1. Course Description

A. Title of a Course

Time series analysis

B. Pre-requisites:

- Theory of Probability
- Mathematical Statistics
- Econometrics

C. Course Type:

Elective course

D. Abstract

The course aims to provide students with a theoretical understanding of the basics of time series modeling and demonstrate their application on real data. This course is blended. Students learn theory from the online course “Macroeconometric forecasting” on the EDX platform, developed by the International monetary fund. On practical session, they will apply models to macroeconomic and financial data. The course begins with essentials of working with time series data. The next part of the course covers all basic time series models, such as: ARIMA, SARIMA, ARCH and GARCH, VAR and VECM. As a result of the course, student will make a project on real data: prepare data for analysis, choose appropriate model, apply it and interpret results.

2. Course objectives

The objective of the course is, that students should be able to:

- analyze economic data in accordance with the task, make preliminary data analysis;
- build appropriate econometric time series models for the research question, analyze and interpret results;
- understand limitation and relevance of the models.

3. Learning Outcomes

Level of competence building:

RB – resource base, this level includes theoretical knowledge and knowledge of basics;
AT – activity types, this level includes implication of the competence;

MV – motivation and value, with this level people realize the value of the competence and are ready to apply it.

By the end of the course, a student develops the following competencies, where
GK – general competence
GPK – general professional competence

Competencies	Code	Level of competence building	Indicators of knowledge acquisition	Methods of instruction	Form of assignment
Is able to identify the scientific nature of problems in the professional field	GK-2	RB, AT, MV	Analyzes a problem situation, formulates a research question	Seminars	Exam
Is able to solve problems in professional activities based on analysis and synthesis	GK-3	AT, MV	Analyzes the problem situation and is able to choose appropriate model for solving the problem	Seminars	Exam
Is able to work with information: find, evaluate and use information from various sources, necessary to solve scientific and professional problems (including on the basis of a systematic approach)	GK-5	RB, AT, MV	Demonstrates knowledge of various information processing methods, of choosing appropriate method for various tasks	Seminars	Exam
Capable of conducting research, including analyzing problems, setting goals and objectives, identifying the object and subject of research, choosing the type of research and methods of research, as well as assessing its quality	GK-6	RB, AT, MV	Demonstrates the ability to formulate a research question in economics, choose appropriate time series models for answering research questions	Seminars	Exam, microtest
Is able to analyze socially significant problems and processes and predict their possible development in the future	GPK-3	RB, AT, MV	Demonstrates the ability to analyze economic processes and formulates a research question	Seminar	Exam, microtest
Is able to collect, analyze and process statistical data, information, scientific and analytical materials needed to solve economic problems	GPK-11	RB, AT	Formulates data requirements needed to solve a problem, is able to prepare data for analysis	Seminar	Exam, microtest
Is able to choose tools for processing economic data	GPK-12	RB, AT, MV	Proves the use of various methods,	Seminar	Exam

in accordance with the task, analyze the results of calculations and substantiate the findings			interprets results, constructs speech.		
Based on the description of economic processes and phenomena, is able to build theoretical and econometric models, analyze and meaningfully interpret the results obtained.	GPK-13	RB, AT, MV	Is able to build econometric models of time series, selects the appropriate model specification, is able to interpret the results	Seminar	Exam, microtest
Is able to analyze and interpret data of domestic and foreign statistics on socio-economic processes and phenomena, to identify trends in socio-economic indicators	GPK-15	RB, AT, MV	Is able to conduct a preliminary analysis of time series and interpret the results of this analysis.	Seminar	Exam
Is able to use modern hardware/software and information technologies for solving analytical and research problems.	GPK-17	RB, AT	Explains the need for econometric modeling, explains model specification depending on the task	Seminar	Exam
Is able to organize the activities of a small group established to implement a specific economic project	GPK-22	MV	Demonstrates the ability to work in a group, in particular the ability of task distribution among group members	Seminar	Exam

4. Course plan

№	Topics	All hours	Lecture hours	Seminar hours	Self-study hours
Topic 1. Univariate time series analysis					
1	Stationary Time Series	24	-	4	20
2	Nonstationary Time Series	48	-	8	40
Topic 2. Mutivariate time series analysis					
3	Vector Autoregression (VAR)	34	-	4	30
4	Structural Vector Autoregression (SVAR)	36	-	6	30
5	Vector Error Correction Model (VECM)	48	-	8	40
Sum		**190**	**0**	**30**	**160**

Course plan in details

Topic 1. Univariate time series analysis

1. Stationary Time Series

Dealing with time series data. Concept of stationary and covariate-stationary series, autocorrelation and partial-autocorrelation functions, white Noise, autoregression models (AR), moving average (MA) models, ARMA models: properties, specification, estimation and forecasting. the Box–Jenkins methodology, diagnostic testing for model adequacy.

Topic 2. Nonstationary Time Series

Problems arise due to nonstationary, unit roots and characteristic relations, testing nonstationary: the Dickey–Fuller and augmented Dickey–Fuller tests, KPSS test and Philip-Pearson test; series transformation: differencing, selecting order of difference and ARIMA model. Dealing with seasonal data: series decomposition into stationary and trend and(or) seasonal component, Fourier decomposition and periodogram, SARIMA models. ARCH-GARCH model to deal with nonstationarity due to non-constant dispersion.

Literature:

1. Required [1], [2]
2. Optional [1], [2], [3]
3. Online lectures [1]

Topic 2. Mutivariate time series analysis.

3. Vector Autoregression (VAR).

Reduced and structural VAR Forms, model estimation, model conditions, vector AR(p) models, vector moving average models, lag specific criteria: LM test, Granger causality test, exogeneity in a VAR, the impulse-response function, forecasting with VAR: dynamic, static, stochastic and deterministic solutions.

4. Structural Vector Autoregression (SVAR).

SVAR specification, comparison with reduced form VAR, structural impulse responses, Choleski decomposition, Blanchard-Quah decomposition, variance decomposition, identification strategies: recursive and non-recursive.

5. Vector Error Correction Model (VECM).

The concept of cointegration and LR relations, the Engle–Granger cointegration test, the Johansen full-information maximum likelihood cointegration test, VECM specifications and estimation, lag length and causality tests, forecasting with VECM.

Literature:

1. Required [1], [2]
2. Optional [3]
3. Online lectures [1]

5. Reading list

5.1. Required

1. Neusser, K. (2016). Time Series Econometrics. Springer, Cham (access by https://www.springer.com/us/book/9783319328614).
2. Palma W. (2016) Time Series Analysis. John Wiley & Sons, Incorporated (access by https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=4517503).

5.2. Optional

1. Shumway, R. H., & Stoffer, D. S. (2017). Time series analysis and its applications. Springer, Cham. (access by https://www.springer.com/gp/book/9783319524511).
2. Bleikh, H. Y., & Young, W. L. (2016). Time Series Analysis and Adjustment: Measuring, Modelling and Forecasting for Business and Economics. Routledge (access by https://www.taylorfrancis.com/books/9781315550954)
3. Montgomery, D. C., Jennings, C. L., & Kulahci, M. (2015). Introduction to time series analysis and forecasting. (access by https://ebookcentral.proquest.com/lib/hselibrary-ebooks/detail.action?docID=1895570#)

5.3. Online lectures

1. Course “Macroeconometric forecasting” on Edx platform (https://www.edx.org/course/macroeconometric-forecasting-0)

6. Grading system

In the classroom the teacher assesses:

- microtests on the explored topics, that are basically held in a written form at the beginning of the seminar;
- group discussion and responses to the questions;
- active work at the seminars;
- written report of performed tasks in class.

Seminar activities are assessed on a 10 point scale and that results in the grade for seminar activities (O_{aud}).

The teacher assesses a self-study students’ work:

- written report of performed tasks in class;
- individual and team hometasks.

Self-study work is assessed on a 10 point scale and that results in the grade for self-studies (O_{self}).

Cumulative grade is calculated on the base of mentioned above grades as follows:

$$O_{cum} = 0{,}6 * O_{aud} + 0{,}4 * O_{self}$$

And **the resulting course grade** is calculated as follows:

$$O_{result} = 0,6* O_{cum} + 0,4*\cdot O_{exam}$$

with O_{exam} – a grade for the exam on a 10 point scale.

7. Guidelines for Knowledge Assessment

Final student assessment is a project of team of no more than 2 people. The project should be based on a dataset with variables that are time series. Within the project should be applied one of the following model's type: ARIMA dealing with seasonality, the autoregressive conditional heteroskedasticity (ARCH or GARCH) model, the vector autoregressive model (VAR), the structural vector autoregressive model (SVAR)or the vector error correction model (VECM). The dataset can be related to students' course works.

As a result of the project each team write down the report which contains R script, which is replicating the results. The final presentation of result is up to the lecturer. The grade for the exam includes the grade for the report and for lecturer or audience questions.

The project report should include:

1. Research question (its description and actuality), for example, forecasting with explanation for whom it can be important;
2. All necessary pretesting with interpretation (stationarity, ACF or PACF, the choice of lags etc);
3. Apply chosen model:
    a. Write down equation;
    b. Interpret coefficients
    c. Estimate model coefficients and conclude about quality of the model;
    d. Interpret the results;
4. Conduct all necessary posttesting (usually about residuals) and conclude about quality model
5. Conclusion (answering the research question).

Possible project topics:

- Index arbitrage and nonlinear dynamics between the S&P 500 futures and cash;
- The relationships between trade and labor productivity in different countries;
- Energy consumption, economic growth and prices for developed and developing countries;
- Forecasting cryptocurrency returns;
- etc.

8. Methods of Instruction

Students prepare to each seminar by learning video lectures. Each seminar starts with oral questioning about basic concepts and models, that student learned from video lectures. At the rest part of seminar students apply models to real data. The lecturer should make emphasis on interpretation of models.

9. Special Equipment and Software Support

Software that is essential for the course is:

- Statistical package R (http://r-project.org/) and its libraries;
- RStudio (http://rstudio.com/).

The course is conducted with the use of projector for seminar classes and group project presentations. Course materials, assignments for individual work, requirements and questions for the final exam are posted on lms.hse.ru.