



## Course and Examination Fact Sheet: Spring Semester 2023

### 8,318: Financial Volatility

ECTS credits: 4

#### Overview examination/s

(binding regulations see below)

Decentral - examination paper written at home (in groups - all given the same grades) (50%)

Examination time: term time

Decentral - Oral examination (in groups - individual grades) (50%)

Examination time: term time

#### Attached courses

Timetable -- Language -- Lecturer

[8,318,1.00 Financial Volatility](#) -- Englisch -- [Audrino Francesco](#)

#### Course information

#### Course prerequisites

Basic knowledge in Statistics, Econometrics, and Time Series Econometrics/Analysis.

#### Learning objectives

This course provides the basic, fundamental knowledge needed to understand the main concepts in financial econometrics. It will teach students how to deal with possible practical applications related to that subject, going from data acquisition and filtering to the choice and use of the different packages in the freely online available R software. The course will prepare students to work for institutions belonging to the financial sector or to continue the academic studies by doing a Ph.D. in quantitative finance.

Students will learn how to estimate and predict volatility and how to solve concrete problems that need to understand the behavior of financial volatility as a key ingredient, such as risk management or portfolio selection applications. In particular, students will properly apply the gained theoretical knowledge on a concrete dataset of their choice using the statistical R software and prepare a research paper summarizing their results.

#### Course content

Topic of this course is the estimation, modelling, and forecasting of the second-order time-varying dynamics of financial asset returns.

Prices of commodities or assets produce what is called time-series. Different kinds of financial time-series have been recorded and studied for decades. Nowadays, all transactions on a financial market are recorded, leading to a huge amount of data available, either for free in the Internet or commercially. Financial time-series analysis is of great interest to practitioners as well as to theoreticians, for making inferences and predictions. Furthermore, the stochastic uncertainties inherent in financial time series and the theory needed to deal with them make the subject especially interesting not only to economists, but also to statisticians and physicists.

One of the most important common features exhibited by financial time series is time-varying volatility. Time-varying volatility refers to the tendency of small values to be followed by small values and large values to be followed by large values. It is now 20 years since the publication of Engle's (1982) seminal paper, which introduced ARCH to the world. The ARCH model was the first published paper that considered a parametric model for volatility. It had an enormous influence on both theoretical and applied econometrics, and was influential in the establishment of the discipline of Financial Econometrics.



In this lecture I provide an introduction to the subject of modeling and forecasting financial volatility, starting from the univariate and multivariate ARCH/GARCH classes of models (and their extensions) to models for stochastic volatility and realized volatility. Recent tests proposed to evaluate differences in the forecasting ability of two or more competitive approaches are also reviewed.

## Course structure and indications of the learning and teaching design

This class takes place as a weekly lecture covering the following aspects:

### A. Financial time series and their characteristics

Asset returns; Distributional properties of returns; Stationary Processes; ARMA and ARIMA models; Random Variance Models.

### B. Univariate conditional heteroskedastic models

ARCH/GARCH: properties; estimation; testing for ARCH effects; prediction.

### C. Extensions of univariate ARCH/GARCH models Exponential

GARCH; Threshold GARCH; Asymmetric Power GARCH; Semi- and non-parametric ARCH; Long-memory GARCH; Markov-Switching ARCH/GARCH; Varying coefficient GARCH.

### D. Multivariate GARCH models Overview of existing models; BEKK; CCC; DCC; estimation; diagnostic checking.

### E. Alternative approaches

Stochastic volatility: Introduction and overview. Realized volatility: Introduction; definition; measures; microstructure noise; HAR-type models.

### F. Evaluating volatility and correlation forecasts

Direct/Indirect comparisons of volatility forecasts; pairwise vs. multi-models comparisons; robust comparisons; Reality Check test; MCS.

### G. Financial applications

Extreme values, quantiles, and risk measures.

## Course literature

### Main references:

- F. Audrino, *Lecture Notes*.
- Tsay, R.S. (2010), *Analysis of Financial Time Series*, (third edition), Wiley Series in Probability and Statistics.
- Francq, C. and Zakoian, J.-M. (2010), *GARCH Models: Structure, Statistical Inference and Financial Applications*, John Wiley & Sons, Incorporated.
- Andersen, T.G., Davis, R.A., Kreiss, J.-P., and Mikosch, T. (2009), *Handbook of Financial Time Series*, Springer, Berlin. (selected chapters)
- Bauwens, L., Hafner, C., and Laurent S. (2012), *Handbook of Volatility Models and their Applications*, Wiley Handbooks in Financial Engineering and Econometrics Series, John Wiley & Sons, Incorporated. (selected chapters)

## Additional course information

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## Examination information



## Examination sub part/s

### 1. Examination sub part (1/2)

#### Examination time and form

Decentral - examination paper written at home (in groups - all given the same grades) (50%)

Examination time: term time

#### Remark

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#### Examination-aid rule

Free aids provision

Basically, students are free to choose aids. Any restrictions are defined by the faculty members in charge of the examination under supplementary aids.

#### Supplementary aids

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#### Nature of examination

analog

#### Examination languages

Question language: English

Answer language: English

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### 2. Examination sub part (2/2)

#### Examination time and form

Decentral - Oral examination (in groups - individual grades) (50%)

Examination time: term time

#### Remark

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#### Examination-aid rule

Closed Book

The use of aids is prohibited as a matter of principle, with the exception of pocket calculator models of the Texas Instruments TI-30 series and, in case of non-language exams, bilingual dictionaries without any handwritten notes. Any other aids that are admissible must be explicitly listed by faculty members in the paragraph entitled "Supplementary aids" of the course and examination fact sheet; this list is exhaustive.

Procuring any aids, as well as ensuring their working order, is the exclusive responsibility of students.

#### Supplementary aids

Students must bring a hardcopy of the group examination paper to the oral exam.

#### Nature of examination

analog

#### Examination languages

Question language: English

Answer language: English

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## Examination content



The examination will cover the following aspects:

*A. Financial time series and their characteristics.*

Asset returns; Distributional properties of returns; Stationary Processes; ARMA and ARIMA models; Random Variance Models.

*B. Univariate conditional heteroskedastic models*

ARCH/GARCH: properties; estimation; testing for ARCH effects; prediction.

*C. Extensions of univariate ARCH/GARCH models*

Exponential GARCH; Threshold GARCH; Asymmetric Power GARCH; Semi- and non-parametric ARCH; Long-memory GARCH; Markov-Switching ARCH/GARCH; Varying coefficient GARCH.

*D. Multivariate GARCH models*

Overview of existing models; BEKK; CCC; DCC; estimation; diagnostic checking.

*E. Alternative approaches*

Stochastic volatility: Introduction and overview.

Realized volatility: Introduction; definition; measures; microstructure noise; HAR-type models.

*F. Evaluating volatility and correlation forecasts*

Direct/Indirect comparisons of volatility forecasts; pairwise vs. multi-models comparisons; robust comparisons; Reality Check test; MCS.

*G. Financial applications.*

Extreme values, quantiles, and risk measures.

## Examination relevant literature

F. Audrino, *Lecture Notes*, available on StudyNet at the beginning of the course.

Group examination paper.



## Please note

Please note that only this fact sheet and the examination schedule published at the time of bidding are binding and takes precedence over other information, such as information on StudyNet (Canvas), on lecturers' websites and information in lectures etc.

Any references and links to third-party content within the fact sheet are only of a supplementary, informative nature and lie outside the area of responsibility of the University of St.Gallen.

Documents and materials are only relevant for central examinations if they are available by the end of the lecture period (CW21) at the latest. In the case of centrally organised mid-term examinations, the documents and materials up to CW 12 are relevant for testing.

Binding nature of the fact sheets:

- Course information as well as examination date (organised centrally/decentrally) and form of examination: from bidding start in CW 04 (Thursday, 26 January 2023);
- Examination information (regulations on aids, examination contents, examination literature) for decentralised examinations: in CW 12 (Monday, 20 March 2023);
- Examination information (regulations on aids, examination contents, examination literature) for centrally organised mid-term examinations: in CW 12 (Monday, 20 March 2023);
- Examination information (regulations on aids, examination contents, examination literature) for centrally organised examinations: two weeks before the end of the de-registration period in CW 15 (Monday, 10 April 2023).