Quantitative Methods

PART 1: Introduction

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PART .:. CHAPTER 1 .:.

Practical Information

Questions?

contact

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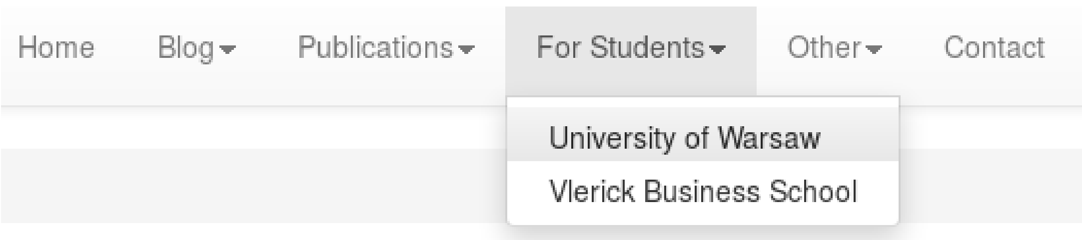
Availability of Slides

. . . and eventually other materials

1. url: `http://www.de-brouwer.com`
2. select "For Students" and then "Jagiellonian University in Krakow"



3. locate your program
4. locate the relevant course and download your materials

All Slides . . .

- feature in the header a dynamic table of contents
- page numbers at the bottom right
- table of contents after the front matter
- as the second last section the bibliography
- have as last page(s) the nomenclature (list of acronyms, symbols, etc.)

Contents

PART .:. CHAPTER 2 .:.

Your Teacher

About Philippe J.S. De Brouwer

Dr. Philippe De Brouwer studied theoretical physics and later acquired a second Master –Business Engineer– while working full time. Finishing this Master he solved the "fallacy of large numbers puzzle" that was formulated by P.A. Samuelson 38 years earlier. In this Ph.D. he successfully challenged the assumptions of the Noble price winning "Mean Variance Theory" of H. Markovitz that dominated our thinking about suitability of investments for more than 60 years.

In the start of his career he moved from insurance to banking focusing and from IT to asset management. For Fortis (BNP) he helped the young investment management company grow, stood at the cradle of one of the first capital guaranteed funds and got promoted to director in 2000. In 2002 he moved to KBC where he merged 4 companies and became CEO of the merged entity in 2005. Under his direction the company climbed from number 11 to number 5 on the market. In the aftermath of the crisis he helped creating a new investment management company for KBC in Ireland that soon accommodated the management of ca. 1000 investment funds and had about 24 Bln Euro under management. In 2012 he widened his scope to financial risk management and specializing in statistics, analytics, data and numerical methods. In 2015 Philippe was head of Analytics Development for the Royal Bank of Scotland Group and is now director at HSBC and oversees the Independent Model Review Centre of Excellence.

Philippe also found a passion in coaching on team leadership and teamwork as well as teaching (mainly for Vlerick Business School and the University of Warsaw).

Who are you

Question

Who are you?
What do you expect from this program?
What do you want from this program?
What should we focus on?

PART .:. CHAPTER 3 .:.

The Program Quantitative Methods

3.1 Objectives

Objectives of the program

know	the basics of statistics and data manipulation
know	at least one analytical tool (R)
understand	the importance of data in decision making
understand	uses and limits of various methods
apply	understand limits of models
apply	make informed decisions
apply	write a technical paper
apply	write a presentation and present it

3.2 The content of the program

The content of the program

1. part 1: Introduction
2. part 2: Introduction to statistics with the software R
3. part 3: Valuation of companies and basic financial instruments.
4. part 4: Multi Criteria Decision Analysis
5. part 5: Crowdfunding and Fintech
6. part 6: Big Data, quantum computing and other new developments
7. part 7: Guest lectures and your own presentation

Grading of the course

- 10% presence in classroom
- 40% collaboration in classroom (including in-class assignments)
- 50% selected assignment (including the presentation)

3.3 Assignments

Assignment

Students are expected to gather data, analyse it and report the results in the last session.

During the last lesson each project can be presented in a "10 minutes elevator pitch" Elevator pitch presentations are assessed as more or less as follows

- 20% for the idea and conclusions
- 40% for the written materials (paper and/or slides)
- 40% for the presentation itself (quality of slides if used + oratorical qualities)

The assignments are individual works (but collaboration is allowed).

Ideas for the content of the Assignment

1. solve a problem by using data and rely on one or more of the methods studied (eg. regression, MCDA), etc.
2. write an extention to this course (eg. a non-discussed MCDA method)
3. use one of the ideas on the following slides.

3.3.1 Bring your own data

Assignment

Question

Consider your company or business, identify a problem worth solving, get the data and present a solution.

3.3.2 Returns

Assignment

Question

Assume that returns on the stock exchange are normally distributed with an average return of 5% and a volatility of 20%. Investigate the distribution after 10 years. Is that still a normal distribution?
What if you would assume that the log-returns were normally distributed?

Note that return $R := \frac{V_f}{V_i} - 1$ and that a log-return is defined as $r := \log\left(\frac{V_f}{V_i} - 1\right)$.

3.3.3 Crimes in the USA

Assignment

Question

Based on the data-set UScrime (in the package MASS), what would you recommend to reduce crime? Write also about the limitations of your findings.

Variant: find your own data.

3.3.4 What influences the GDP-growth?

Assignment

Question

Find out what governments should focus on in order to improve the GDP per capita, using public data.

Suggestions:

1. use `https://data.oecd.org` to download data,
2. think of a simple method to make it work (correlate the result to the chosen indicators N-years in the past (better still, use averages, etc.)

PART .:. CHAPTER A .:.

Levels of Measurement

Levels of Measurement

Introduction

It is customary to refer to the theory of scales as having been developed by Stevens (1946). In that paper he argues that all measurement is done by assuming a certain scale type. He distinguished four different types of scale: nominal, ordinal, interval, and ratio scales.

A.1 Nominal Scale

Nominal Scale

The nominal scale is the simplest form of classification. It simply contains labels that do not even assume an order. Examples include asset classes, first names, countries, days of the month, weekdays, etc. It is not possible to use statistics such as average or median, and the only thing that can be measured is which label occurs the most (modus of mode).

Scale Type	**Nominal**
Characterization	labels (e.g. asset classes, stock exchanges)
Permissible Statistics	mode (not median or average), chi-square
Permissible Scale Transformation	equality
Structure	unordered set

Table A.1: *Characterization of the Nominal Scale of Measurement.*

Note that it is possible to use numbers as labels, but that this is very misleading. When using an nominal scale, none of the traditional metrics (such as averages) can be used.

A.2 Ordinal Scale

Ordinal Scale

This scale type assumes a certain order. An example is a set of labels such as very safe, moderate, risky, very risky. Bond rating such as AAA, BB+, etc. also are ordinal scales: they indicate a certain order, but there is no way to determine if the distance between, say, AAA and AA- is similar to the distance between BBB and BB-. It may make sense to talk about a median, but it does not make any sense to calculate an average (as is sometimes done in the industry and even in regulations)

Scale Type	**Ordinal Scale**
Characterization	ranked labels (e.g. ratings for bonds from rating agencies)
Permissible Statistics	median, percentile
Permissible Scale Transformation	order
Structure	(strictly) ordered set

Table A.2: *Characterization of the Ordinal Scale of Measurement.*

Ordinal labels can be replaced by others if the strict order is conserved (by a strict increasing or decreasing function). For example AAA, AA-, and BBB+ can be replaced by 1, 2 and, 3 or even by -501, -500, and 500,000. The information content is the same, the average will have no meaningful interpretation.

A.3 Interval Scale

Interval Scale

This scale can be used for many quantifiable variables: temperature (in degrees Celsius). In this case, the difference between 1 and 2 degrees is the same as the difference between 100 and 101 degrees, and the average has a meaningful interpretation. Note that the zero point has only an arbitrary meaning, just like using a number for an ordinal scale: it can be used as a name, but it is only a name.

Scale Type	**Interval Scale**
Characterization	difference between labels is meaningful (e.g. the Celsius scale for temperature)
Permissible Statistics	mean, standard deviation, correlation, regression, analysis of variance
Permissible Scale Transformation	affine
Structure	affine line

Table A.3: *Characterization of the Interval Scale of Measurement.*

Rescaling is possible and remains meaningful. For example, a conversion from Celsius to Fahrenheit is possible via the following formula, $T_f = \frac{9}{5}T_c + 32$, with T_c the temperature in Celsius and T_f the temperature in Fahrenheit.

An affine transformation is a linear transformation of the form $\boldsymbol{y} = \boldsymbol{A}.\boldsymbol{x} + \boldsymbol{b}$. In Euclidean space an affine transformation will preserve collinearity (so that lines that lie on a line remain on a line) and ratios of distances along a line (for distinct collinear points p_1, p_2, p_3, the ratio $||p_2 - p_1||/||p_3 - p_2||$ is preserved).

In general, an affine transformation is composed of linear transformations (rotation, scaling and/or shear) and a translation (or "shift"). An affine transformation is an internal operation and several linear transformations can be combined into one transformation.

A.4 Ratio Scale

Ratio Scale

Using the Kelvin scale for temperature allows us to use a ratio scale: here not only the distances between the degrees but also the zero point is meaningful. Among the many examples are profit, loss, value, price, etc. Also a coherent risk measure is a ratio scale, because of the property translational invariance implies the existence of a true zero point.

Scale Type	**Ratio Scale**
Characterization	a true zero point exists (e.g. VAR, VaR, ES)
Permissible Statistics	geometric mean, harmonic mean, coefficient of variation, logarithms, etc.
Permissible Scale Transformation	multiplication
Structure	field

Table A.4: *Characterization of the Ratio Scale of Measurement.*

Bibliography

De Brouwer, P. J. S. (2012). *Maslowian Portfolio Theory, a Coherent Approach to Strategic Asset Allocation*. Brussels: VUBPress.

Stevens, S. S. (1946). On the theory of scales of measurement. *Science 103*(2684), 677–680.

Nomenclature

GDP Gross Domestic Product, page 12

MCDA Multi Criteria Decision Analysis, page 11