VILNIUS UNIVERSITY

FACULTY OF MATHEMATICS AND INFORMATICS

INSTITUTE OF APPLIED MATHEMATICS

Guidelines for Writing Master Thesis

Dr. Jurgita Markevičiūtė

APPROVED BY STUDY PROGRAMME SPC 07/02/2024

VILNIUS
2024

Table of Contents

Introduction

Master Thesis is an important part of the study process. It allows to verify the level of knowledge achieved during studies; student's ability to apply properly the knowledge acquired, student's critical and analytical thinking, creativity, ability to collect and process information, and understanding and use of the latest scientific material.

These guidelines contain recommendations for Modelling and Data Analysis students. In Section 2 the requirements for Master Thesis' design are presented. Remaining sections provide some guidance to the presentation of results. In general, we expect student to follow given recommendations unless different approach is suggested by the thesis supervisor.

The final section contains recommendations for presentation during Thesis defence. All instructions are indicative.

Requirements for thesis design

General remarks

Before writing Master Thesis, student should read the "Regulations for the Preparation, Defence and Storage of Research Papers of Students Studying at Vilnius University" [1] and "The Description of the Procedure for the Administration of Research Papers in Vilnius University Study Information System" [2]. Microsoft Office, OpenOffice, Latexor another program of student's choice can be used to write thesis. By the set date, pdf version of thesis is submitted to the Vilnius University Study Information System (https://is.vu.lt/) and, in case it is requested, to Virtual Learning Environment (https://emokymai.vu.lt/). Students are informed about the time deadline for uploading of the thesis.

Preparation for Master Thesis begins from the choice of thesis topic and thesis supervisor. If, during process of writing, serious problems arise, then the topic may be revised and changed in agreement with thesis supervisor and the chair of the study programme committee. About two weeks before the thesis submission deadline, its final title in Lithuanian and English must be sent to the Studies Office by e-mail. After that, any changes in the title cannot be made. Students are informed about the deadline for the final thesis title submission by e-mail.

The length of Master Thesis

There are no formal requirements regarding the length of thesis. A common sense should prevail. For example, it is very doubtful that proper introduction allowing to reveal problem's importance and previous research; analysis of data used, the proposed statistical model, interpretation of the results, conclusions and reference list can be squeezed into 11 pages (title page included). On the other hand, extra-long thesis usually raises some doubts about student's ability to distinguish between important and not so important facts. We expect Master Thesis to be concise and to the point.

Master Thesis can be very short if student presents already published or accepted by journal scientific paper. However, such presentations are not encouraged. Usually scientific papers contain somewhat shortened versions of the proofs with many of

intermediate steps omitted. In Master Thesis every step in the proofs must be made explicit.

General text

The format of the worksheets should be A4. The text should be without unnecessary spacing between paragraphs or other objects of the text. Recommended spacing throughout the text is either 1 or 1.5 lines. If a table or timetable is inserted in a paragraph, it shall be removed from the text in the same way as a new paragraph. Start with 0,57 cm indent: The space between the paragraphs shall be the same as between the rows. It is also possible though not recommended to use extra space between paragraphs *instead* of an indent, just like below.

The text must not protrude into margins. Recommended margins: 2 cm at the top, 2 cm at the bottom, 3 cm on the left and, 1,5 cm on the right. If work is written with the LaTeX, then the following commands `\textwidth 6.5in` and `\textheight 9.00in` can be used. The pages are numbered at the bottom right or in the middle.

The most commonly used fonts can normally be subdivided into variable width and constant width, and serif and sans serif.

1. Serif type font (variable width): The random size is a function of Mati.
2. Sans serif type font (variable width): The random size is a function of Mati.
3. Continuous width font: `Incidental size is a function of Mati.`

The variable width serif fonts are used for the main text. The fonts of the sans serif are generally used for headings and for the computer programs' texts of constant width. **Bold text** or *text in italics* are reserved for highlighting or singling out something. It should not be used too often. It is not advisable to use underlined text or text highlighted in another color. If thesis is written with Microsoft Office or Open Office applications, the following text settings for Times New Roman are used for parts of the work:

1. The title 14pt, style bold;
2. Basic text 12pt, normal font style;
3. Annexes 12pt, normal font style;
4. Reference list:12pt.

A Courier New font size of 10pt shall be used for the text of the computer programs.

For text written in LaTeX standard fonts are used. Recommended font size is 11pt or 12pt. For the text of computer programs, the following command is used: `\verb` or `\begin{verbatim}` `\end{verbatim`. In addition, the text of computer programs must be smaller than the rest of thesis, so the command `\begin{small}` and `\end{small}` is applied.

Mathematical text

Fonts used for mathematical text must differ from remaining text but of the same size, such as: $F(x) = P(X < x)$. Please note that functions are not written in italics, e.g. max, rather than *max*.

In some cases, LaTeX does not have predefined functions, these should be defined manually. For example, symbol d rather than d should denote differential. This can be achieved by introducing macro `\newcommand{\dd}{\, \mathrm{d}}`.

Similarly, e should be used instead of e to denote exponential function. Extended formula or mathematical expressions shall be separated into separate rows. Do not forget to end formula by dot, if the sentence is not continued. If the formula continues to be

followed by the related text, no new paragraph is needed and no indent is used. For interpretation of variables, formula is followed by a new sentence beginning with "Here" rather than comma and "where". For example,

$$
\begin{aligned}
EX + 7 &= \int_{\Omega} X(\omega) P(\,\mathrm{d}\omega) + 7 \\
&= \int_{R} x\,\mathrm{d}F(x) + 7.
\end{aligned}
$$

Here EX denotes the mean of random variable X.

The following rules apply for breaking of mathematical expressions into separate lines: a) new line begins with the equality (or inequality) sign, rather than previous one ends with it; b) all signs ($=, >, <$) for new lines are in the same column at equal spaces from the left margin; c) for other mathematical symbols, the new line begins slightly further from the left margin, e.g.:

$$
\begin{aligned}
T_{\alpha,n}(\varepsilon_1, \ldots, \varepsilon_n) &= \max_{1 \le \ell \le n-1} \ell^{-\alpha} \max_{1 \le k \le n-\ell} \left| \sum_{j=k+1}^{k+\ell} \tilde{\varepsilon}_j - \frac{\ell}{n} \sum_{j=1}^{n} \tilde{\varepsilon}_j \right| \\
&= \max_{1 \le \ell \le n-1} \ell^{-\alpha} \max_{1 \le k \le n-\ell} \left| \sum_{j=k+1}^{k+\ell} (\varepsilon_j + a_j) - \frac{\ell}{n} \sum_{j=1}^{n} (\varepsilon_j + a_j) \right| \\
&\ge \max_{1 \le \ell \le n-1} \ell^{-\alpha} \max_{1 \le k \le n-\ell} \left| \sum_{j=k+1}^{k+\ell} a_j - \frac{\ell}{n} \sum_{j=1}^{n} a_j \right| \\
&\quad - \max_{1 \le \ell \le n-1} \ell^{-\alpha} \max_{1 \le k \le n-\ell} \left| \sum_{j=k+1}^{k+\ell} \varepsilon_j - \frac{\ell}{n} \sum_{j=1}^{n} \varepsilon_j \right|
\end{aligned}
$$

If brackets are used in the formula, they must be of an appropriate size: external larger than inner ones. The mathematical text strictly prohibits the use of computer characters, i.e. the text $X^2 Y^2$ cannot be written as X^2*Y^2. Formula can be numbered, but only if it is referred further in the text.

Requirements for graphs and tables

The graphs must be of good quality, i.e. they must be clearly visible and distinguishable. The graph fonts are of a similar size to the main body of the text. For citation purposes graphs shall be marked with headers and numbers written in bold fonts of 10pt size. It is advisable to use black and white graphs and different types of lines. The proper form for a graph title is 'variable of y-axis vs variable of x-axis.' For example, 'beginning salary vs previous experience'. Some abbreviations are allowed, but in all cases the title of graph and labels of axes must be understandable to the readers.

Table covering less than half of a page is placed in the text. Like graphics, tables are marked with headers and numbers written in bold fonts of 10pt size. Both, tables and graphs, should not exceed the width of the text on the sheet. Separate sheets and, if needed, landscape orientation are used for larger tables. As a rule, large tables are placed in the Appendices and only references to them are included in the main body of the text. If thesis contains multiple tables and graphs, then it is advisable to add the list of tables and figures.

Requirements for content

Recommended example of thesis table of contents:

The table of contents contains the title of the paper, titles of parts, chapters and sections with references to page numbers, which have to be in Arabic numbers. The Part, chapter and section numbers are separated from each other by points, e.g. 2.1 The abstract, introduction, conclusions, reference list may or may not be numbered. The appendices are numbered separately. If a number of abbreviations are used, they shall be included in a separate list of abbreviations. A separate list is used for the mathematical notation used in the text. These lists, like the lists of tables and graphs, are not numbered.

2.6.1   Cover page

The cover page includes:

- the name of university;

- the name of faculty;

- the study programme;

- research paper title;

- author's name;

- author's email address;

- a supervisor;

- a year.

An example of a cover page is given in Appendix A.1. Please, use pdfLatex to get a picture on the title page.

2.6.2   Abstract

When writing an abstract, students should bear in mind that reader tries to grasp the main idea of a thesis first. Therefore, the abstract in 5 - 8 sentences should describe the essence of the research (objective of the work, main tasks, novelty, methodology, scope of work, stages of work, results, and expected areas of use).

The abstract shall be accompanied by the keywords. An example of the summary form is given in Appendix A.3. Appendix A.4 contains a similar example in LaTeX.

Never start writing from an abstract! It should summarize the final version of the Thesis.

2.6.3   Introduction

An introduction describes the topics covered in the thesis, demonstrates their relevance to other research, provides student's motivation, and contains the formulation of the objectives and the problems to be addressed. After reading the introduction, the reader should understand:

- what are the objectives of the work;

- what problems are solved;

- what studies have been carried out;

- what results are achieved;

- the structure of the thesis.

2.6.4   Literature review/analysis

The literature review shall provide analytical material and support the methodology for the whole thesis. Start from the actuality of the problem. Then present a comparative analysis of the known results discussing their advantages and disadvantages. Statistical and analytical methods used in the thesis must also have relevant references. Please note that the literature review/analysis is not an introduction.

2.6.5   Analytical part

This part describes models, systems, technologies used in the research, algorithms developed; detailed discussion of results obtained and conclusions drawn.

It is up to the student to decide how many sections should be included in the research part. Concise presentation void of unrelated information is expected.

Student's contribution (new models, statements proved, algorithms developed, etc.)

should be clearly identifiable in the text.

All cited results must contain accurate references. For example,

Relation (**) was proved in [35].

or

This model was introduced in Yang et al. (2016).

The thesis structure should be agreed with the supervisor.

2.6.6 Conclusions and recommendations

Conclusions and recommendations summarize the main findings of research, and put forward recommendations for the application and further development of the obtained results. This part must be closely related to the introduction. If the problem is formulated in the introduction, then here its (at least partial) solution is given. However, not merely a statement of the results, but also some discussion is expected. In essence, conclusions must answer the question 'So what?', i.e., to explain the importance of results. This section also contains suggestions for further research.

2.6.7 Bibliography

The reference list contains bibliographical descriptions of the sources used in alphabetical order.

- Each source cited in the text must be included in the reference list.

- Each item from the reference list must be cited in the text.

- References are given in the original language. An exception is languages with non-Latin fonts. In that case, the English translation is used and additional information about the original language is included in brackets at the end. For example,

  Yu.V. Prokhorov. *Selected works*, v. 1. Moscow, Torus Press, 2012, 775 pp. (Russian)

- Reference list shall be drawn up in alphabetical order of the (first) authors' surnames.

General rules for references:

1. A. Author, K. Author. Title of article, *title of Journal*, Year, Volume (number), p. Page-page.

2. B. Author. Title of article, In *Title of book (package),* City: Publishing house, Year, p. page-page.

3. C. Author. *Name of book,* City: Publishing house, Year, number of pages p.

4. D. Author. *Name of book (scientific publication),* http:// www.mif.vu.lt

Examples:

1. Yang Yang; R. Leipus, J. Šiaulys, Asymptotics for randomly weighted and stopped dependent sums, *Stochastics: an international journal of probability and stochastic processes,* 2016, **88**(2), p.p. 300-319.

2. T. Erhardsson. Stein's method for Poisson and compound Poisson approximation, In*: An Introduction to Stein's Method. Lect. Notes Ser. Inst. Math. Sci. Natl. Univ.*

Singap. v. 4, Singapore: Singapore Univ. Press, 2005, p.p. 61–113.

3. R. Kaas, M. Goovaerts, J. Dhaene and M. Denuit. *Modern Actuarial Risk Theory: using R*. (Secon. edt.), Springer-Verlag, Berlin, Heidelberg, 2008, 393 p.

4. V. Stakėnas, *Probability theory and Mathematical Statistics (handouts)*, 2012, 178p. , http://www.statistika.mif.vu.lt/atsisiuntimui/statistika/

It is not allowed to use various types of bibliography styles: e.g. there should not be full name used for one author, and for others only the first letter of the name, etc.

2.6.8 Appendices

Appendices contain texts of computer programs, tables, diagrams, pictures, and other material that complements the thesis. If the tables and pictures are small and there are only a few of them, they must appear in the main body of the text. Proofs of propositions (if any) can be given in the text or in a separate appendix. It is for the student, after consulting the supervisor, to decide how to proceed in this case. The software used must be named in the final work and the appendices must provide program code to assess the complexity of the Master's thesis.

2.6.9 Citing

By citing the idea, it is possible to reword it in your own words by mentioning who is the author of the idea and where it comes from. It is also possible to cite exact phrases. In both cases, reference is compulsory. Examples of citing are given in subsection 2.6.5. There is no need to cite trivial ideas, formulas, and definitions. If the mathematical idea you cite is essential to the research paper, it is *always necessary* to cite the source of its proof or prove it.

Requirements for statistical model's presentation

Usually, students design, assess, and test statistical models. *It is not allowed* to insert the copy of statistical program text from the used R package into the main body of the Master Thesis. If needed, such text is added in Appendices according the rules described in section 2.8 below. All information related to the modelling must be provided in a concise manner in tables or formulae. A basic rule for modelling information: it is clear, concise, easy to read. We will provide some examples of good and bad practices.

2.7.1 Example 1: Presenting model

Let's assume that we have data for young men from the US on pay, education and work experience in 1980 and 1987. We want to see whether work experience and education have an impact on pay and whether that influence is the same at different times. To this end, we will have two linear regression models. Please note that the methodology used here is simply illustrative, and the panel model is likely to deliver better results in your work. We have logarithms of men's salaries (variable *wage*), work experience in years (variable *Exper*) and learning time (variable *school*).

Bad practices:

We form two linear regression models.

Initial: 9

```
Call:
lm(formula = wage ~ exper + school, data = y1980)

Residuals:
     Min      1Q   Median      3Q     Max
-2.53660 -0.21063  0.06176  0.34430  1.49669

Coefficients: Estimate Std. Error t value Pr(>|t|)
(Intercept)  -0.16110    0.22438  -0.718     0.473
exper         0.09231    0.01701   5.427  8.66e-08 ***
school        0.10846    0.01611   6.734  4.22e-11 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5349 on 542 degrees of freedom
Multiple R-squared:  0.08266,   Adjusted R-squared:   0.07927
F-statistic: 24.42 on 2 and 542 DF,    p-value: 7.014e-11
```

Second:

```
Call:
lm(formula = wage ~ exper + school, data = y1987)

Residuals:
     Min      1Q   Median      3Q     Max
-1.90164 -0.26437  0.01545  0.28797  1.44935

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.861972   0.264053   3.264  0.00117 **
exper       -0.003362   0.014001  -0.240  0.81032
school       0.088228   0.013259   6.654  6.98e-11 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4403 on 542 degrees of freedom
Multiple R-squared:  0.1138,    Adjusted R-squared:   0.1105
F-statistic: 34.79 on 2 and 542 DF,    p-value: 6.107e-15
```

We see that both experience and education had a positive impact on pay in 1980, and Exper *became* negative and insignificant already in 1987. R^2 is very small in both models.

Comments:

1. Although the text of the program meets the requirements, it is certainly not informative, even for a professional audience, because searching for the proofs of the statements in a lengthy text is needed.

2. It is not good practice to use the names of the variables in the text, even if they are previously explained. Instead phrase "and *exper* already becomes negative and insignificant in 1987" should be written as "and already in 1987 experience affects remuneration negatively and makes the coefficient insignificant".

3. The phrase "R2 is very small in both models" is ambiguous. What is "very small" in mathematics?

4. In this example, there are some methodological problems. Data of the same respondents is used in both models. Therefore, it is natural that more work experience in 1987 was confirmed. How to deal with this problem?

We will now demonstrate how these two models should be presented correctly (methodological contradictions are not yet taken into account):

We form two linear regression models.

Good practice:

Initial:

$$wage = \underset{(0.22)}{-0.16} + \underset{(0.02)}{0.09 exper} + \underset{(0.02)}{0.11 school}$$
$$R^2 = 0.08$$

Second:

$$wage = \underset{(0.26)}{0.86} + \underset{(0.01)}{-0.003 exper} + \underset{(0.01)}{0.09 school}$$
$$R^2 = 0.08$$

2.7.2 Example 2: Presentation of the results in the table

Let, for example, to investigate Canada's data: productivity, number of people employed, unemployment rate and net wage. We want to create a vector-authorization (VAR) model for this data. To do this, we need to choose the order of the model. We will use 4 information criteria.

Bad practice:

We use the VAR select function in the R program, which delivers the following results:

```
> VARselect(Canada, lag.max=4)
$selection
AIC(n)   HQ(n)   SC(n)
     FPE(n) 3       2            2       3

$criteria
                1            2            3            4
AIC(n) −5.70832549   −6.238366753   −6.359392786   −6.119193878
HQ(n)  −5.46956983   −5.808606566   −5.738628071   −5.307424635
SC(n)  −5.11281884   −5.166454767   −4.811075473   −4.094471239
FPE(n)  0.00332039    0.001960529    0.001750655    0.002258874
```

So, we choose the 2nd row's model.

Comments:

1   Again, the code presented is not easy to read.
2   All 4 information criteria should have been mentioned above and their definitions should have been included in the text.
3   You must be aware of models and formulae implemented in R that are used in Your research. For example, what is AIC in above?
4   The criteria suggest different orders of the VAR model. If you choose one (in this case 2), some reasoning must be given.

Good practices:

It is most convenient to present this information in a table (see Table 1). We again will omit the methodological discussion on which information criterion would be best to use.

Criterion	Proposed queue	Value of the criterion
AIC(n)	3	*-6.36*
HQ(n)	2	*-5.81*
SC(n)	2	*-5.17*
FPE(n)	3	*-0.0017*

Table 1: Selection of the order of the model VAR.

Requirements for the text of computer programs

The text of the computer programs must contain comments indicating which program and what version of it is used. The used packages must be named, all their functions explained. If students write functions themselves, they have to comment what they perform. The requirements for computer programs' fonts are described in section 2.3.

Artificial Intelligence Tools

All AI tools used must be cited in the reference list with the name of the tool, version, internet link, and date of usage.

If generative tools were used, the method of usage should be described in the appendices.

For example, if a tool generates an output after a text prompt is submitted to it, the prompts submitted must be indicated; if a tool generates an output when given file(s) (image, audio, etc.), such files used in applications must be described; if a tool was used to write a text, the extent of its usage must be explained (a full text of meaningful content was generated, which later was adjusted by the author; a text was translated; mathematical formulas, a code, proofs of theorems were generated; etc.).

Descriptions should be informative enough so that a reviewer could replicate them based on the usage session.

Acknowledging the use of AI, an author of a thesis has to describe his contribution to those parts of work where AI tools were used.

Only free AI tools can be used.

Originality of thesis

Master theses must contain original research. A student may not cite more than one paragraph from referred paper. Such behavior is treated as plagiarism. Master Theses are uploaded in the Vilnius University Information System, where the system will automatically search for the existence of any potential plagiarism.

Writing Master thesis

As a master degree is the first scientific degree, students must demonstrate not only their ability to apply theory in practice, but also their contribution to science. review of known results is not acceptable as Master thesis.

Choice of the topic and supervisor

Topics of the master theses and supervisors' names are announced in the first year of studies. Students choose a supervisor and a topic. Master's thesis is written on an individual basis.

The Master thesis writing process

Once the topic and the supervisor have been agreed, the student draws up his/her Master Thesis plan with the help of the supervisor. Writing of a master's thesis consists of several stages:

- Preparatory phase;
- The research phase;
- Finalizing thesis.

During preparatory phase, the student defines the subject of his/her research and performs comparative analysis of results from relevant literature. As a rule, the second semester is devoted to achieve this goal. During the research phase, statistical modeling and deep data analysis is performed. Master thesis seminar ensures continuity of research during final semester. Results, their feasibility and applicability are validated during the final phase of Master Thesis writing.

Suggestion on the structure of Thesis.

Typical Master Thesis consists of three parts:

- Literature review;
- Scientific research;
- Practical application.

The main aspects of the literature review are discussed in section 2.6.7.

During the research phase, the student first formulates the research methodology. It must clearly reflect how the main stated objective is to be achieved. See section 3.4.5 for more details on the research methodology.

In the second part of the research, student works with data. Monte Carlo and similar data simulation methods are also allowed. There must be a clear distinction between student's contribution and contribution of other researchers.

After research phase, the student presents obtained results, conclusions and discussion. If a new model or method of data analysis is proposed, then its beneficial comparison with existing models or methods must be given.

What is Master thesis?

This section provides useful information on what scientific research is and what is required for it.

The scientific objective is the *discovery* of new knowledge. They are *written in* a clear logical sequence. Researchers have to *prove* their facts. The researcher must convince the reader of the *correctness of* his*/her* research. The correctness is defined as the proper use *of the chosen survey methodology*. All this ensures reliability. All the words marked in italics are explained in the following subsections.

3.4.1   Discovering new knowledge

At the beginning, student should clearly highlight his contribution to the research, i.e. he/she must explain what is new and the original master's theses. The arguments of originality must be based on the author's knowledge of the current situation and historical development, which is the result of reading the relevant literature. The student must convince the reader that the work is innovative and what is important and correct according to the author.

3.4.2   Writing of the text

The text must be written in such a way that it is easy for the reader to follow all the steps in succession. Reading is facilitated by references to text and formulae as well as to literature sources. However, essential and non-trivial information should be included in the text. If the idea is continued, it must be marked. For example, "…the properties of this estimate will be demonstrated in section 3.4…". In order to recall the previous chapters, the words "...as defined in Chapter 2.3..." may be used.

All chapters of the main body, if they have sections, must contain introductory paragraph. These introductory paragraphs will help the reader (and the author himself/herself) to follow the logical division of the chapter into sections. The introductory paragraph can include:

1) presentation of further sections (the titles can be named);

2) the reasons for the inclusion of the sections;
3) how these sections relate to the issue under consideration;
4) how they will contribute to achieving the research target.

3.4.3   Argumentation

While implementing the research, it is necessary to prove or substantiate the case under investigation. The theses consist of two types of reasoned argumentation: statements and options. This will be discussed below.

Statements. Thesis usually includes statements in some form. For example, "Lithuania's GDP growth also depends on foreign GDP growth". However, this statement must be explained in detail: there must be a definition of GDP (real, nominal), what foreign countries author has in mind, what

period is covered and so on. All this must be proved or demonstrated by data. It is not enough to believe that something is right or rely on your personal experience. The author must convince the reader. There are two ways of doing so. The most common way is citing of relevant literature. Another possible way is to base the statement on well-known facts or acceptable knowledge. This approach is quite "dangerous" for the student, as it will not necessarily be well known to the reader. If there is a doubt about the statement, it should be better based on literature sources. There are also claims that are trivial and well-known. In such a case, there is no need to state reasons, but the boundary between known and unknown is very narrow. If you have serious doubts, consult with your supervisor.

Options: Options arise when there is a need to choose among several alternatives. Alternatives may include the choice of different research methods, the choice of different criteria for comparison, etc. The student must always give reasons for any choices she/he makes. For example, after constructing several models, the best of them is selected. The performance criteria may relate to model residue testing, prediction or other model characteristics, etc.

3.4.4   Correctness

In research, it is not sufficient to know that the result is correct. The author must convince the others that this is the case. Alternative approaches to the problem should be considered too. Note that modelling of phenomena always means certain simplification of reality, since strict mathematical assumptions for model (independence, normality etc.) are made. Models reliability depends on the degree to which these assumptions are met. Apart from satisfying purely formal mathematical assumptions any model should be consistent also with the field of research it is applied to. Thus, econometric models must be supported by Economics theory.

3.4.5   Research Methodology

Different approaches lead to different models and different conclusions. Therefore, the particular choice of research method must be reasoned and explained. Knowledge of research methods used by other researchers can be of great help. A possible alternative is to modify known method. In such a case, the modifications must be clearly defined, reasoned and commented. It does not suffice that student is certain that his/her approach to problems solution is excellent. It is necessary also to convince the reviewer. Presenting results without any reliable method, literature, motivation and reasoning might result in rejected Master thesis.

3.4.6   What is incompatible with the Master thesis?

This section describes which types of theses (or parts thereof) are not acceptable. Characteristics are accompanied by a statement of reasons why it is not permitted to do so.

- **Report.**
  Characteristics

  The report is limited to the model, algorithm or method applied. It does not contain context, a literature review, a clearly defined study methodology, and author's contribution to the field of research.

  Substantiation

One specific case lacking any comparisons and research background.

- **Daily notes.**

  Characteristics

  This work is very much about what the author has done as an individual. It has many phrases such as "I have travelled to the library...”; “I have communicated with scientists...”, etc.

  Substantiation

  Such descriptions are often wrongly considered as steps in the testing methodology. However, they are only steps taken by the author as an individual, but are not recognized as scientific methods.

- **Literature review.**

  Characteristics

  The theses consist only of a literature review. There is no student's contribution.

  Substantiation

  Although a literature review is a very important part of the Master 's thesis, the researcher must contribute to science and create new knowledge.

Recommendations for presentations

All research papers (term papers, final theses, practices) are defended at the meeting with the Commission. Students must prepare presentation material for defence. Presentation can be prepared with PowerPoint, Latex or other applications, but all must be converted to pdf file to avoid problems with displaying on computers during the defence.

It is recommended that all students prepare slides with LaTeX (beamer class is used). A lot of information can be found online on how to create slides with *beamer*. Some possible sources below:

1. http://web.mit.edu/rsi/www/pdfs/beamer-tutorial.pdf

2. Http://www.stat.washington.edu/courses/stat539/spring14/Resources/beamer2pdf

3. http://www.cs.ox.ac.uk/activities/concurrency/resources/example.pdf

4. Http://science.iit.edu/sites/science/files/elements/am/pdfs/igor_tutorial_ slides.pdf

5. Etc.

Concluding remarks

We hope that these all guidelines and recommendations will provide support for the writing final theses. However, we want to stress that every work and topic are unique, so not all the points proposed can be applied to specific cases. It is recommended to consult with your supervisor if you have any doubts or issues.

Literature

[1] Regulations for the Preparation, Defence and Storage of Research Papers of Students Studying at Vilnius University

[2] The Description of the Procedure for the Administration of Research Papers in Vilnius University Study Information System

Apendices
Cover page

VILNIUS UNIVERSITY
FACULTY OF MATHEMATICS AND INFORMATICS
MASTER'S STUDY PROGRAMME
(NAME OF STUDY PROGAMME)

(Final thesis title)

Master's thesis

Author: (Student's Name Surname)
VU email address: (Student's VU email address)

Supervisor: (pedagogical name Name Surname)

Vilnius
(Year)

19

Abstract

(Text must be inserted here)

Key words: (Key words must be inserted here)