

**Graph Neural Networks:**  
**The state of the art for recommendation systems?**

submitted to

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## **Abstract**

This is the template for a thesis at the Chair of Econometrics of Humboldt–Universität zu Berlin. A popular approach to write a thesis or a paper is the IMRAD method (Introduction, Methods, Results and Discussion). This approach is not mandatory! You can find more information about formal requirements in the booklet ‘Hinweise zur Gestaltung der äußeren Form von Diplomarbeiten’ which is available in the office of studies.

The abstract should not be longer than a paragraph of around 10 to 15 lines (or about 150 words). The abstract should contain a concise description of the econometric/economic problem you analyse and of your results. This allows the busy reader to obtain quickly a clear idea of the thesis content.

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## List of Abbreviations

CPI	Consumer Price Index	ETF	Equity Traded Funds
ETH	Eat the Horse	XLM	Xetra Liquidity

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## 1 Introduction

- What is the subject of the study? Describe the economic/econometric problem.
- What is the purpose of the study (working hypothesis)?
- What do we already know about the subject (literature review)? Use citations: *Gallant (1987) shows that... Alternative Forms of the Wald test are considered (Breusch and Schmidt, 1988).*
- What is the innovation of the study?
- Provide an overview of your results.
- Outline of the paper:  
*The paper is organized as follows. The next section describes the model under investigation. Section 3 describes the data set and Section 4 presents the results. Finally, Section 5 concludes.*
- The introduction should not be longer than 4 pages.

## 2 Method/Model/Theory

- How was the data analyzed ?
- Present the underlying economic model/theory and give reasons why it is suitable to answer the given problem.
- Present econometric/statistical estimation method and give reasons why it is suitable to answer the given problem.
- Allows the reader to judge the validity of the study and its findings.
- Depending on the topic this section can also be split up into separate sections.

### 3 Data

- Describe the data and its quality.
- How was the data sample selected?
- Provide descriptive statistics such as:
  - time period,
  - number of observations, data frequency,
  - mean, median,
  - min, max, standard deviation,
  - skewness, kurtosis, Jarque–Bera statistic,
  - time series plots, histogram.
- For example:

	3m	6m	1yr	2yr	3yr	5yr	7yr	10yr	12yr	15yr
Mean	3.138	3.191	3.307	3.544	3.756	4.093	4.354	4.621	4.741	4.878
StD	0.915	0.919	0.935	0.910	0.876	0.825	0.803	0.776	0.768	0.762

**Table 1:** Some descriptive statistics of location and dispersion for 2100 observed swap rates for the period from February 15, 1999 to March 2, 2007. Swap rates measured as 3.12 (instead of 0.0312). See Table 2 in the appendix for more details.

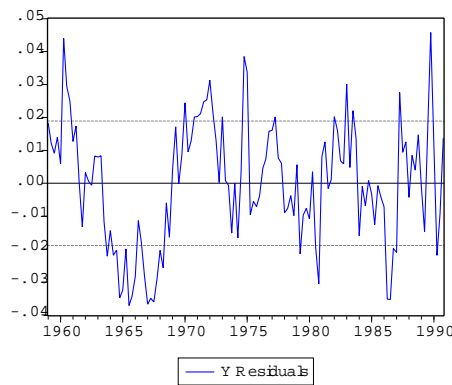
- Allows the reader to judge whether the sample is biased or to evaluate possible impacts of outliers, for example.



## 4 Results

- Organize material and present results.
- Use tables, figures (but prefer visual presentation):
  - Tables and figures should supplement (and not duplicate) the text.
  - Tables and figures should be provided with legends.

*Figure 1 shows how to include and reference graphics. The graphic must be labelled before. Files must be in .eps format.*



**Figure 1:** Estimated residuals from model XXX. ...

- Tables and graphics may appear in the text or in the appendix, especially if there are many simulation results tabulated, but is also depends on the study and number of tables resp. figures. The key graphs and tables must appear in the text!
- Latex is really good at rendering formulas:

*Equation (1) represents the ACs of a stationary stochastic process:*

$$f_y(\lambda) = (2\pi)^{-1} \sum_{j=-\infty}^{\infty} \gamma_j e^{-i\lambda j} = (2\pi)^{-1} \left( \gamma_0 + 2 \sum_{j=1}^{\infty} \gamma_j \cos(\lambda j) \right) \quad (1)$$

*where  $i = \sqrt{-1}$  is the imaginary unit,  $\lambda \in [-\pi, \pi]$  is the frequency and the  $\gamma_j$  are the autocovariances of  $y_t$ .*

- Discuss results:
  - Do the results support or do they contradict economic theory ?
  - What does the reader learn from the results?
  - Try to give an intuition for your results.
  - Provide robustness checks.
  - Compare to previous research.

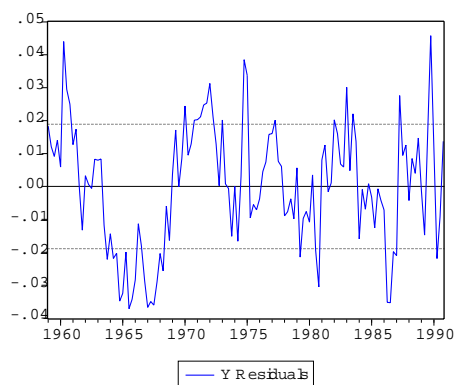
## 5 Conclusions

- Give a short summary of what has been done and what has been found.
- Expose results concisely.
- Draw conclusions about the problem studied. What are the implications of your findings?
- Point out some limitations of study (assist reader in judging validity of findings).
- Suggest issues for future research.

## References

- BREUSCH, T. S. AND P. SCHMIDT (1988): “Alternative Forms of the Wald test: How Long is a Piece of String,” *Communications in Statistics, Theory and Methods*, 17, 2789–2795.
- GALLANT, A. R. (1987): *Nonlinear Statistical Models*, New York: John Wiley & Sons.

## A Figures



**Figure 2:** Estimated residuals (2) from model XXX. ...

## B Tables

	3m	6m	1yr	2yr	3yr	5yr	7yr	10yr	12yr	15yr
Mean	3.138	3.191	3.307	3.544	3.756	4.093	4.354	4.621	4.741	4.878
Median	3.013	3.109	3.228	3.490	3.680	3.906	4.117	4.420	4.575	4.759
Min	1.984	1.950	1.956	2.010	2.240	2.615	2.850	3.120	3.250	3.395
Max	5.211	5.274	5.415	5.583	5.698	5.805	5.900	6.031	6.150	6.295
StD	0.915	0.919	0.935	0.910	0.876	0.825	0.803	0.776	0.768	0.762

**Table 2:** Detailed descriptive statistics of location and dispersion for 2100 observed swap rates for the period from February 15, 1999 to March 2, 2007. Swap rates measured as 3.12 (instead of 0.0312).

## **Declaration of Authorship**

I hereby confirm that I have authored this Bachelor's/Master's thesis independently and without use of others than the indicated sources. All passages which are literally or in general matter taken out of publications or other sources are marked as such.

Berlin, September 30, 2007

your name (and signature, of course)