Non-parametric estimation and inference for conditional mass based Granger causality measures for high-dimensional Markov chains

Xiaoxiao Ma* Kaveh Salehzadeh Nobari†

University of Leeds Durham University

August 20, 2020

This is a preliminary draft. Please do not cite or distribute without the permission of the authors.

*Institute for Transport Studies (ITS), University of Leeds. Address and email: Institute for Transport Studies (ITS), University of Leeds, 34-40 University Road, Leeds, LS2 9JT

†Department of Economics and Finance, Durham University. Address and email: Department of Economics and Finance, Durham University Business School, Mill Hill Lane, Durham, DH1 3LB.

Non-parametric estimation and inference for conditional mass based Granger causality measures for high-dimensional Markov chains

ABSTRACT

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

Journal of Economic Classification: C12, C13, C14

Keywords: Causality measures; Non-parametric estimation; Vine decomposition; Markov chains; Bernstein copula density; Local bootstrap.

Contents

1 Introduction **4**

2 Motivation **4**

3 Copula-based Granger causality measures for qualitative processes **4**

4 Estimation and inference **4**

4.1 Estimation 4

4.2 Inference 4

5 Measuring causality in high-dimensional Markov chains **4**

6 Monte Carlo simulations **4**

6.1 Bootstrap bias-corrected estimator of Granger causality measures 4

6.1.1 Bootstrap bias-correction 4

6.1.2 Simulation study 4

6.2 Empirical size and power 4

7 Empirical application **4**

8 Conclusion **4**

9 Appendix: Proofs **5**

1 Introduction

2 Motivation

3 Copula-based Granger causality measures for qualitative processes

4 Estimation and inference

4.1 Estimation

4.2 Inference

5 Measuring causality in high-dimensional Markov chains

6 Monte Carlo simulations

6.1 Bootstrap bias-corrected estimator of Granger causality measures

6.1.1 Bootstrap bias-correction

6.1.2 Simulation study

6.2 Empirical size and power

7 Empirical application

8 Conclusion

9 Appendix: Proofs