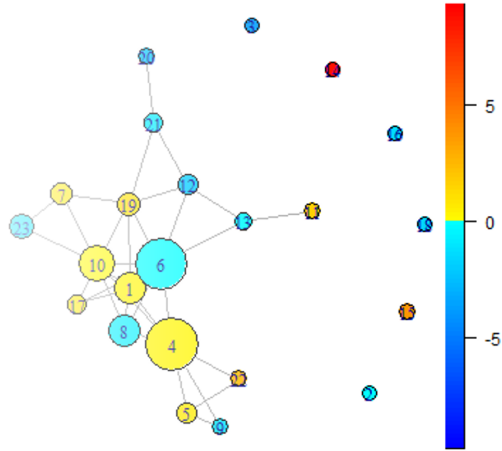
Regional Analysis with Topological Data Analysis Ball Mapper

Session 2: The Application of Ball Mapper in Regional Analysis

Dr Simon Rudkin
University of Manchester



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In this Session...

- Regional resilience and growth trajectories - Prof Don Webber
- Artificial Data
- Scatterplots
- TDA Ball Mapper algorithms

This session represents a discussion of the application of Toplogical Data Analysis Ball Mapper (TDABM) as based upon the original working paper of Dłotko (2019).

Three Questions

How can development trajectories be understood through TDA BM?

How does visualizing multi-dimensional data sets help guide policy and practice in regional science?

What pressing questions can TDA BM help us to understand?

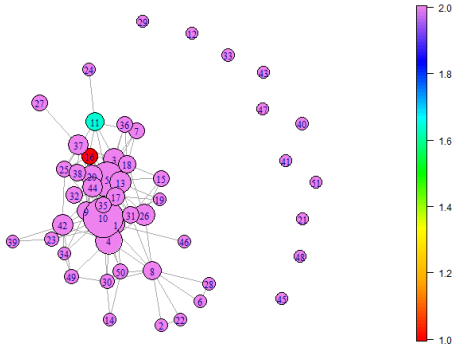
Question 1: Development Trajectories?

- Discussion

Question 2: Guiding Policy

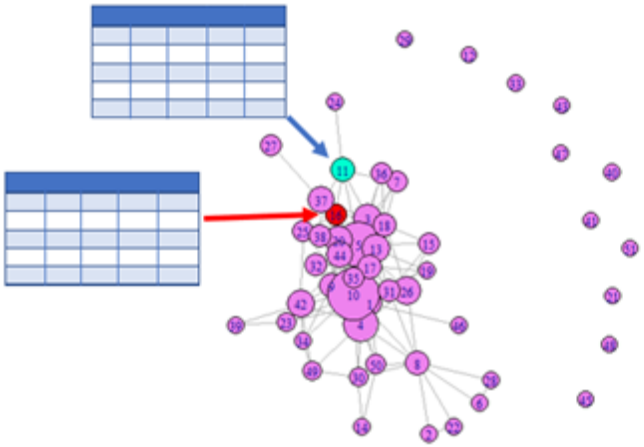
- First consider a little more theory...
- Example 1: Covid-19 in the UK (joint with Pawel Dlotko)
- Example 2: Brexit (Dlotko, Minford, Qiu and Rudkin, 2022)
- Further thoughts...

Understanding Outcomes



- Artificial examples can create outcome desired
- Colouration rule is chosen carefully
- However, real data may still produce this pattern - "when the stars align"

Understanding Outcomes 2



Data sits behind all of the pictures so we may query, gain insight, compare and evaluate

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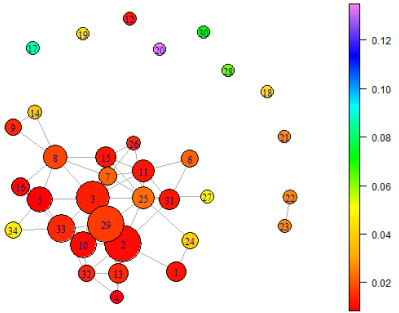
Covid-19 in England



- Axes are age, income, hours worked, population density and GVA
- Initial position with low covid

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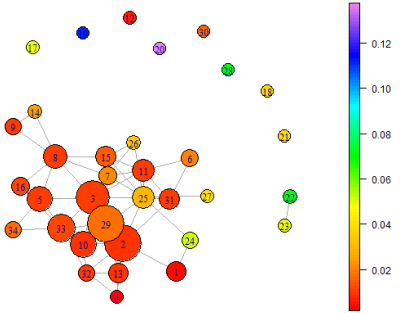

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- First hotspots emerge

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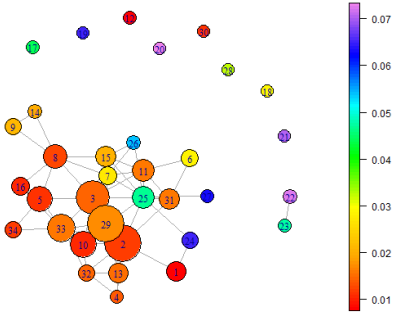

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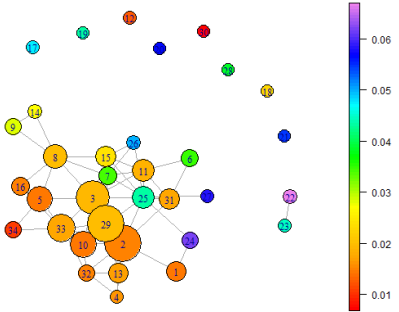

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- Concentration in space holds

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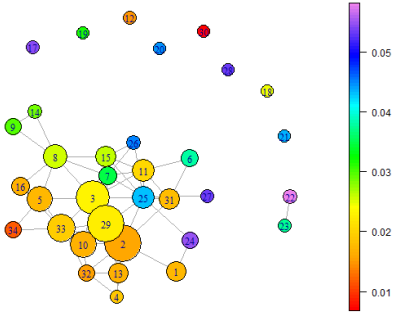

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- Northern cities become hotspots

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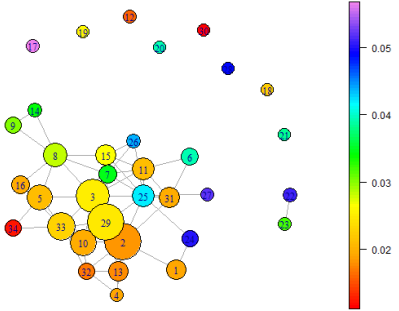

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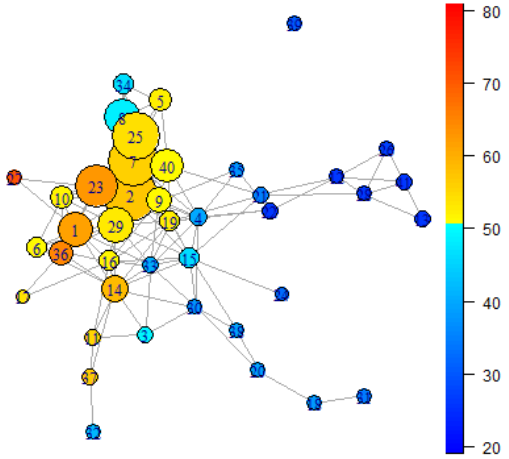
An Economic Topology of Brexit

- Joint work with Dr Pawel Dlotko (Discouri Centre in Topological Data Analysis), Dr Wanling Qiu and Dr Lucy Minford (Swansea University)
- Brexit referendum modelled in many ways - how did polls get it wrong?
- Subsequent discussion of the "red wall" and the subsequent collapse
- Create a dataset of constituencies - Publically available data from Census 2011
- Axes include home ownership, marital status, social classification, car ownership, education, health and deprivation

Under review at Regional Studies since September 2021

An Economic Topology of Brexit



- Leave percentage by constituency
- Concentration of Leave versus Remain

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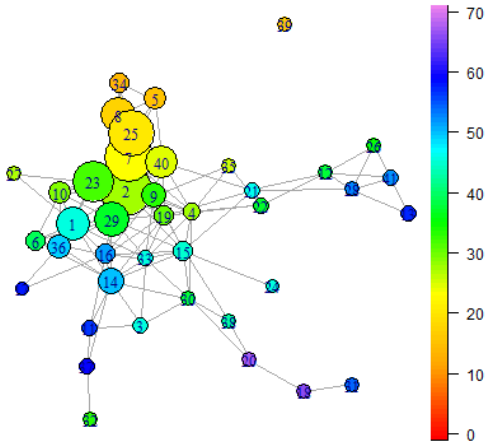

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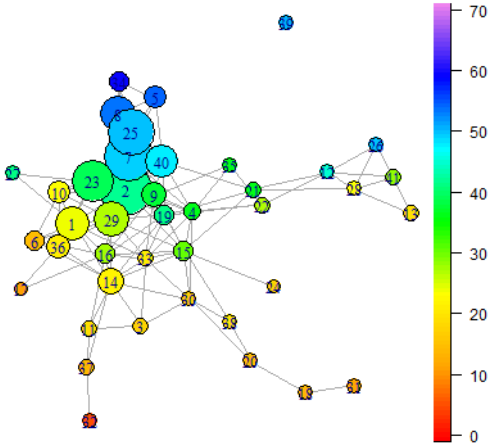

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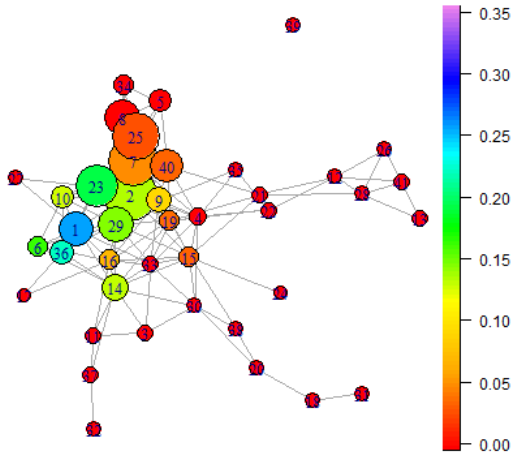

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- Gains of conservatives in 2017 vs 2015

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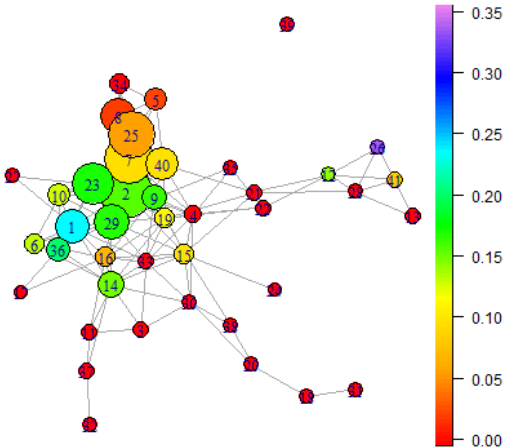
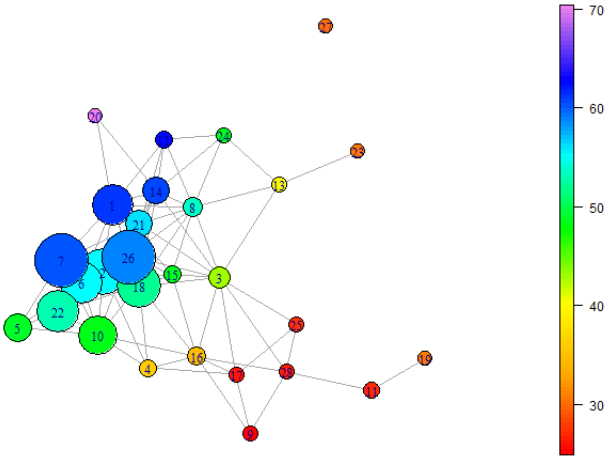


- Leave percentage by constituency
- Concentration of Leave versus Remain
- Labour majorities link to Remain
- Conservatives in the Leave
- Gains of conservatives in 2017 vs 2015
- More "red wall" falling in 2019 vs 2015

An Economic Topology of Brexit 2



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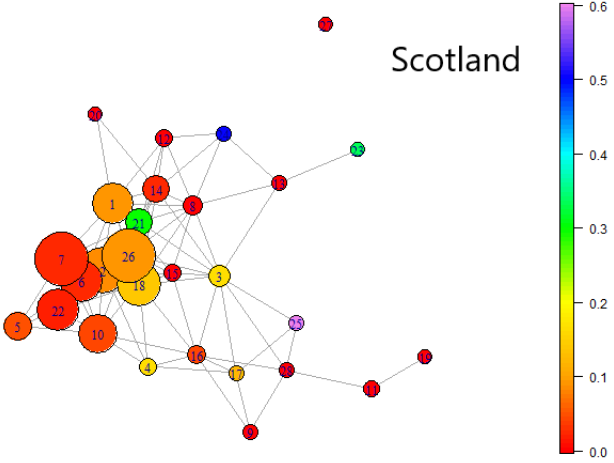

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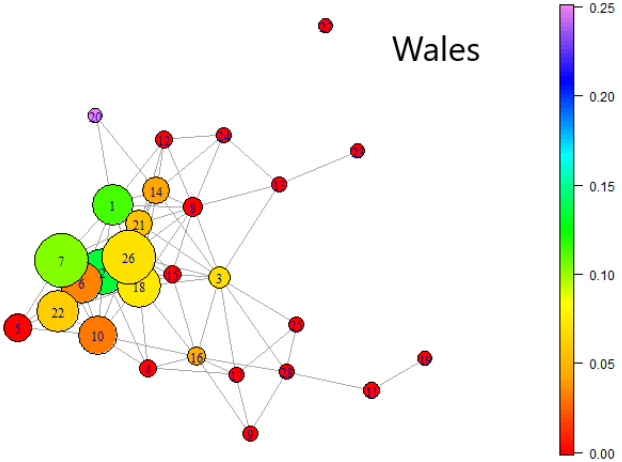

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- Wales spreads into Brexit and Labour

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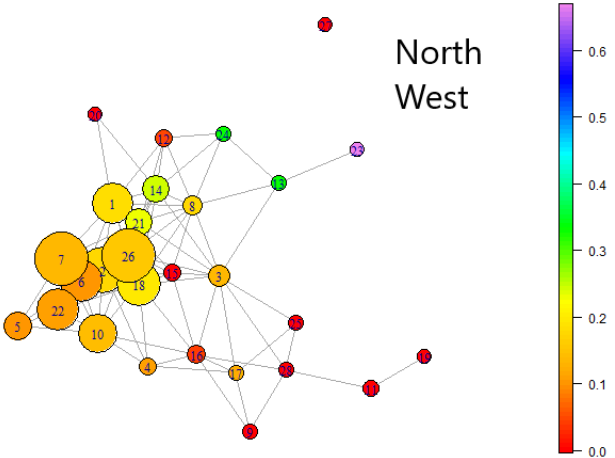

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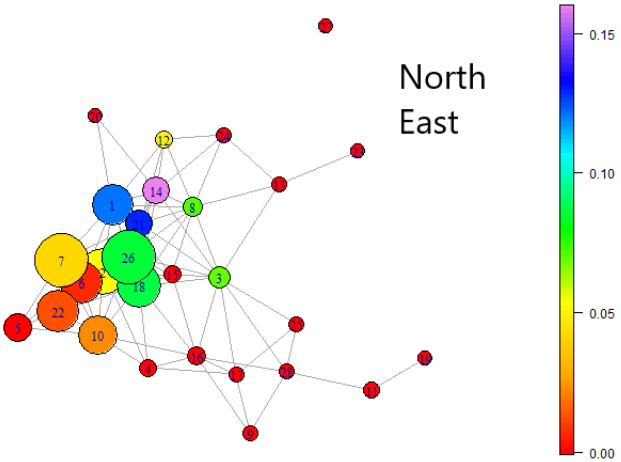

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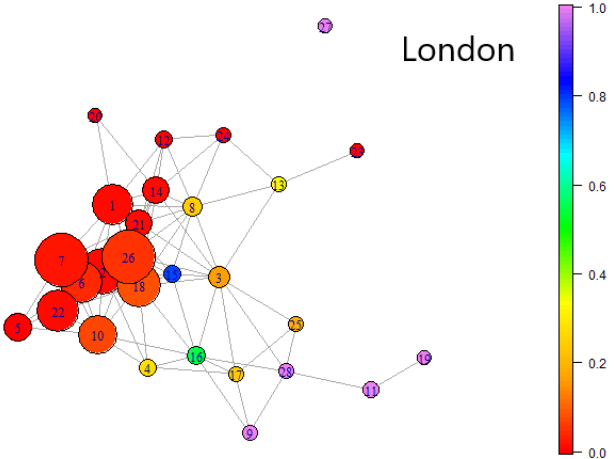

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- Track according to regions... Scotland
- Wales spreads into Brexit and Labour
- London is very different

Lessons from Two Examples

- BM shows the joint distribution of characteristics
- Where characteristics are fixed we may track evolution through colour - Regions stay similar whilst regular time series evolve
- Linking shape and outcomes allows us to comment on the likely effectiveness of policy measuring - easier in dense homogenous regions
- Is there scope to do more?

Question 2: Guiding Policy?

- Discussion

Question 3: Questions for TDA BM

- This session is an open discussion ahead of the lunch break

Three Questions

How can development trajectories be understood through TDA BM?

How does visualizing multi-dimensional data sets help guide policy and practice in regional science?

What pressing questions can TDA BM help us to understand?

Summary of Session 2

- Ball Mapper offers many routes to aid policy
- Trajectory example shows how Ball Mapper may be used to understand growth of regions
- Changes in colouration can be understood across fixed characteristics
- Messages may be directed to aid the success of policies
- Opportunities to do much more...
- Next session looks at using R for Ball Mapper

Dłotko, P. (2019). Ball mapper: a shape summary for topological data analysis. *arXiv preprint arXiv:1901.07410*.