

Network Models and Simulations - Research Note

Travel Network

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Word count: 600/600

Tables: 0

Figures: 4

Introduction

Travel is a significant contributor to economic growth and development with worldwide growth in international tourist arrivals leading to increased employment and profitability in the travel export industry (www.wttc.org). If countries have more travel exports now than in the past, that is an indication that they are more connected. According to an article by Song and Li in 2018, “Tourism has long been claimed as a crucial force shaping globalization.” In addition to this claim, a past research study by (Cerovic et al, 2015) said, “Tourism is an industry that can be considered an increasingly important industry within the global economy.” Furthermore, “This influence can be observed in a constant rise in the number of tourists and travels...” Our research focuses on analyzing 55 major exporting countries and their travel export connections to one another in 2008 and 2017.

Methods

Our data was downloaded from, <https://data.wto.org>, which is the portal for World Trade Organization data. The data are sourced from UN Comtrade, the International Monetary Fund, Eurostat, national sources, etc.

We downloaded an excel document with 1M rows. Since our focus is to find how connected countries are through travel exports, we filtered the data and worked with the rows that deal with travel exports. Along with this, we converted all the missing values, “NA”, to 0. On top of this, in order to create an adjacency matrix, we made our dataset symmetric i.e., we created new columns and populated it with 0, to make the count of rows equal to columns. After the adjacency matrix has been made, we used the “igraph” package to transform our matrix into a network graph. In our network, nodes represent countries and the travel exports between them are edges. We looked at the changes between travel exports in 2008 and 2017, in terms of graph connectedness, mutual connections, and assortativeness. We found that New Zealand was our only common articulation point, so we made induced subgraphs for 2008 and 2017 where the only vertices are New Zealand and the countries connected to New Zealand (Fig. 1, Fig. 2). Further, we created full network graphs of our countries where New Zealand and its connections are highlighted in red (Fig. 3, Fig. 4) to show how the number of connections has changed.

Results

The assortativity values for 2008 and 2017 travel exports are -0.264 and -.134, respectively. Both values are significantly different than expected ($p = 0$). The reciprocity for travel exports in 2008 and 2017 are 0.3725 and 0.5596, respectively. Number of connections to common articulation point New Zealand increased from four in 2008 (Fig. 1) to 18 in 2017 (Fig. 2).

Discussion

In 2008, only 37% of countries with travel exports had mutual travel exports and connections were likely between countries in different degree categories. The percentage of mutual connections increased to 56% by 2017 and countries with the same degree category were sharing more travel exports. These results tell us that the connectivity between the countries in our travel network improved from 2008 to 2017. The increase in the number of connections to New Zealand tells us that our common articulation point significantly increased its number of connections. In context, our results show that the increase in globalization has led to an increase in connectivity of travel exports and countries. We think countries in our network should be aware of this and increase their spending on the travel and tourism industries to further increase their connectivity.

We recommend future researchers develop a layered network model where continents are nodes in one layer and countries are the nodes in the second layer.

Author contributions

Alec Henriksen and Mugdha Danda combined efforts and contributions on all sections of this research.

Conflicts of Interest and Financial Disclosures

None to declare.

Acknowledgements

The authors would like to thank Sergey Berg, PhD for guiding this research project to its completion.

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Table 1 Descriptive measures of network model in 2008 and 2017

Year	Assortativity	Reciprocity	Connections to New Zealand
2008	-0.264	0.3725	4
2017	-0.134	0.5596	18

Figures

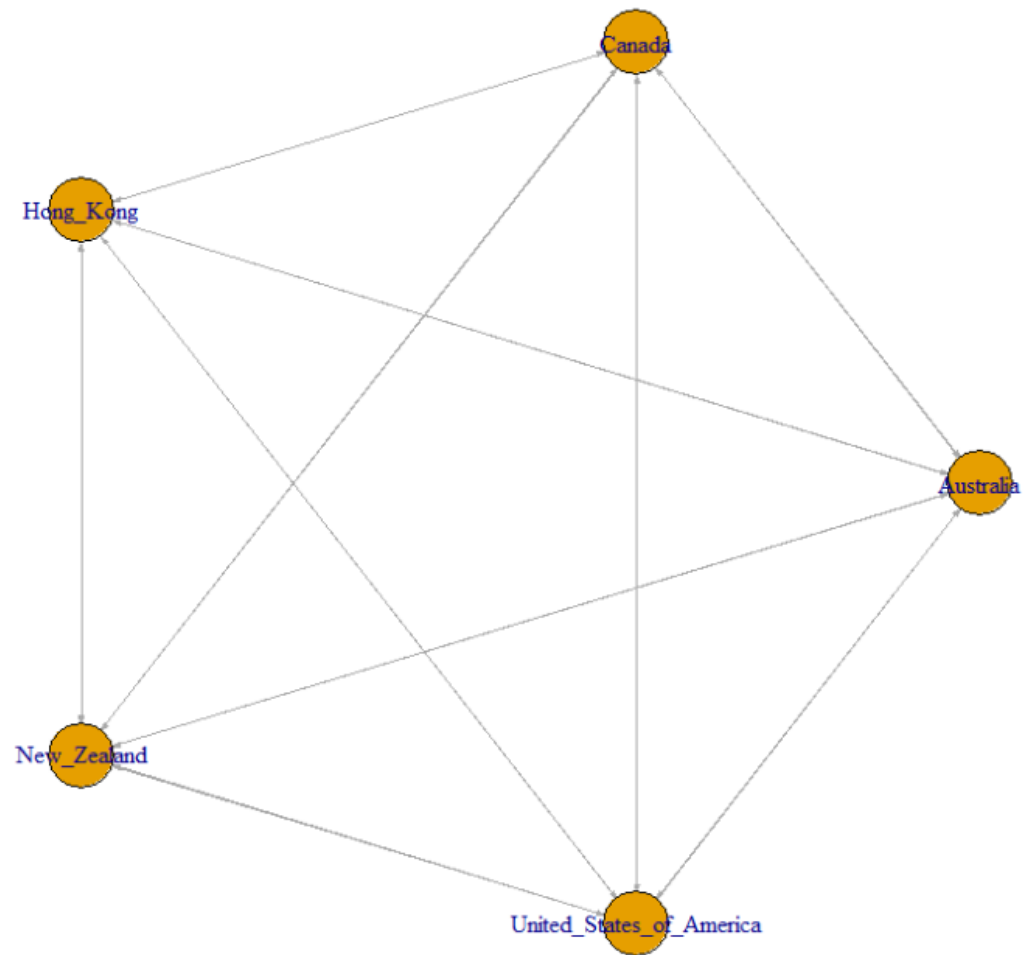


Fig. 1 Induced subgraph of New Zealand and countries connected to New Zealand through travel exports in 2008. Vertices are countries and edges are travel exports.

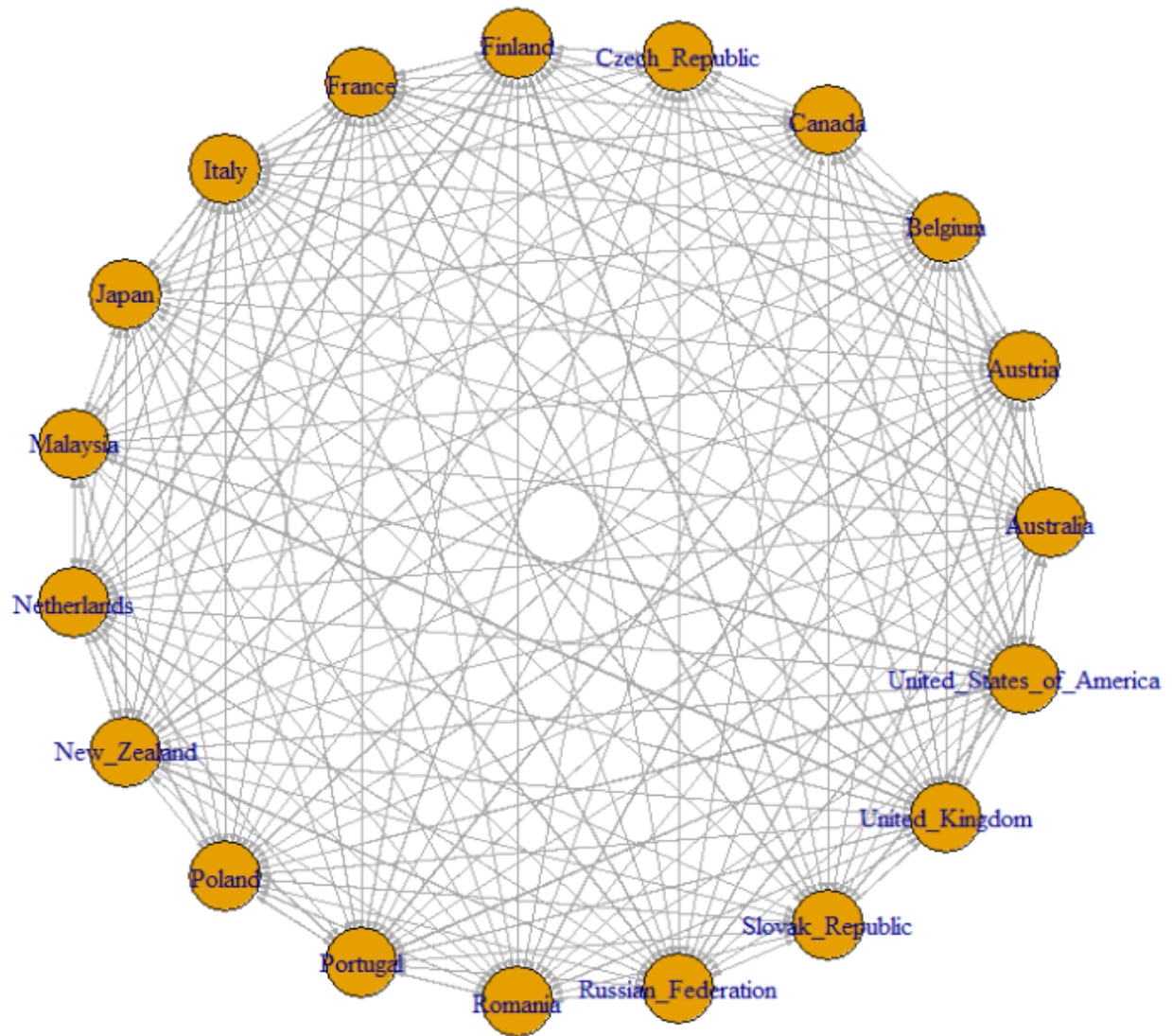


Fig. 2 Induced subgraph of New Zealand and countries connected to New Zealand through travel exports in 2017. Vertices are countries and edges are travel exports.

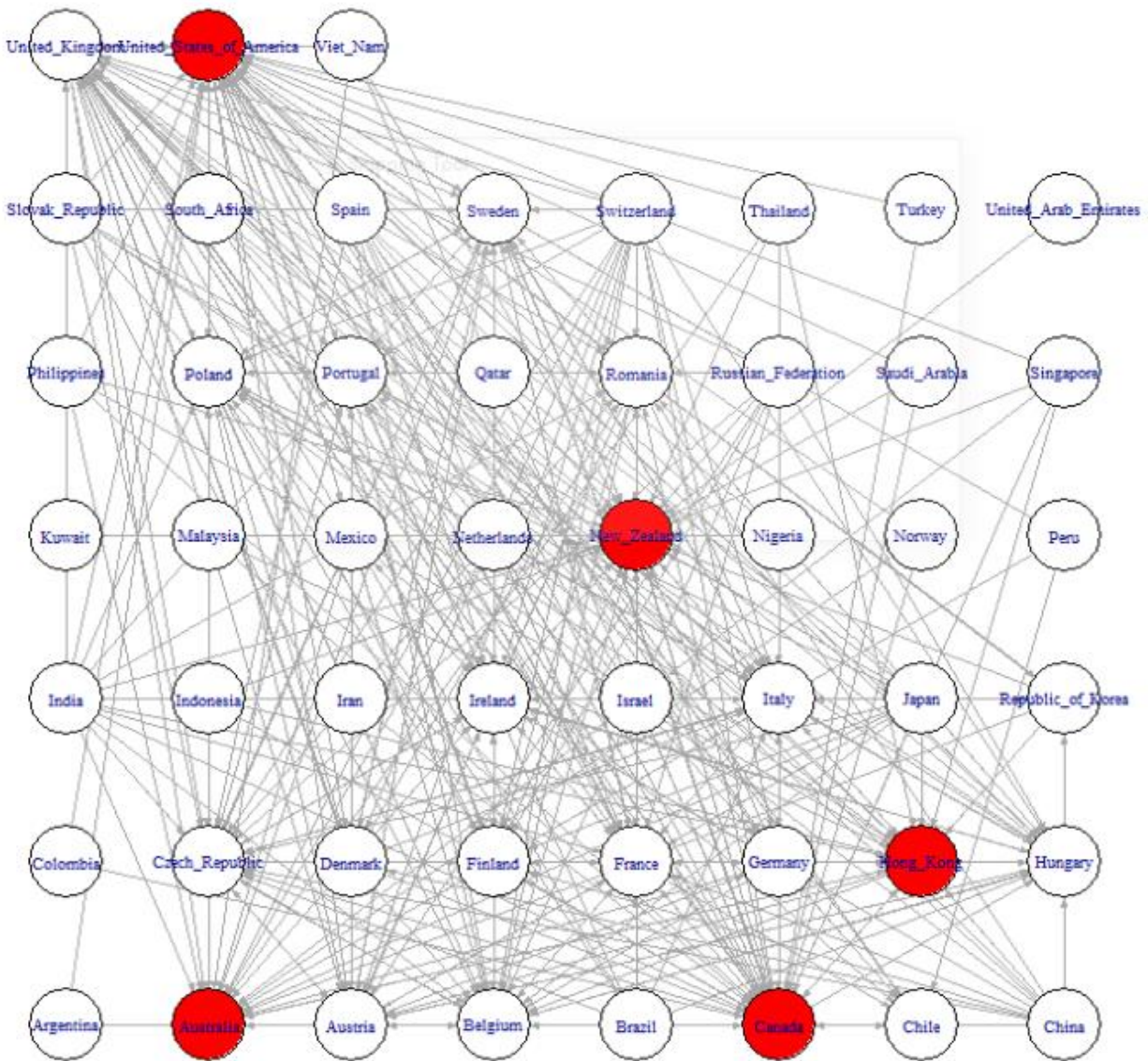


Fig. 3 Network graph of our selected countries 2008 with countries that have connections to New Zealand in red and all other countries that have at least one connection in white. Vertices are countries and edges are travel exports.

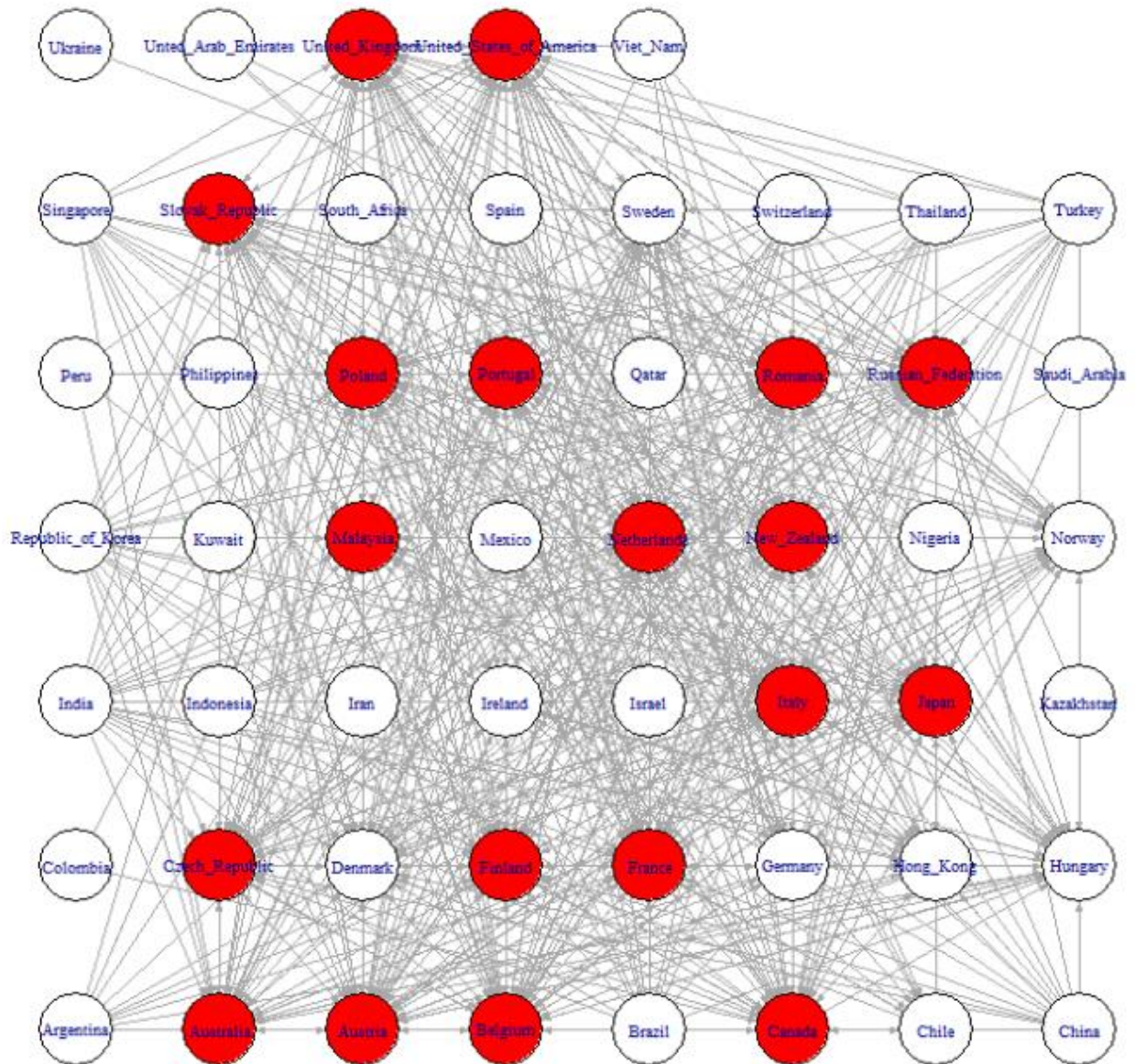


Fig. 4 Network graph of our selected countries 2017 with countries that have connections to New Zealand in red and all other countries that have at least one connection in white. Vertices are countries and edges are travel exports.