Spatial and temporal patterns of economic growth and its cascading effects

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Abstract

Economies over the world are interconnected and therefore changes in the economy of one actor(country or region) can have influence on other actors over time and space. This change might take different time periods to be reflected for different actors. Also, the spatial scale of these effects might differ from actor-to-actor. Creating an interconnected network of these actors and simulating with an economical metric like GDP can inform us about how they might influence each other and whether it leads to some spatial and temporal patterns. The goal of this thesis is to discover such patterns and comment on their causal/correlation effects. Moreover, we intend to find the spatial and time scale over which such patterns/clusters emerge.

1. Introduction

In an interconnected world like ours, the economies(or rather changes in them) influence each other, directly or indirectly and the effects can spread over space and time. The influence of such changes might take months to reflect and it might only be significantly visible at a provincial geographical level while for some other countries the temporal scale might be weeks and the spatial scale might be at a town or city level. The current literature has methods to study these kinds of effects and one particular study that we came across discussed the mesoscale for chain of conflicts[1]. We drew inspiration from such examples to find mesoscale for economic activities and its cascading effects over space and time.

2. Use case of the research

The complexity of the interconnected network of economies(across administrative borders or within them) raises the following questions: first, does the economic growth of a region(be it a country or any other geographically defined place) imply that all the subregions are growing more or less equally? In other words, is the economic growth of a region distributed evenly? Second, does growth of a subregion affect the growth of other connected subregions?

The answers to these questions can help developing nations to understand poverty better because poverty is many times pocketed or isolated in sub-regions as the existing literature also suggests[5]. It can also advise them on targeting their investment to a more connected subregion as it can affect and influence other subregions which might not be getting direct resources.

Moreover, we hypothesize the following based on the strength of correlation between the economic growth of sub-regions: weak correlation suggests that the subregion might be in economic isolation from other places while a strong correlation suggests a better flow/distribution of goods leading to an inclusive economic growth.

Additionally, we would be investigating cross country dependencies. For example the economic growth of the subregions on either side of the border of two countries might be correlated which would be interesting to see.

3. Research Methods

To be able to compare economic growths of cities or any entity smaller than a country, we first need to disaggregate the GDP to the resolution of our interest(for instance, a city level resolution). Since GDP is only available at a national level, we plan to use the night-time light(NTL) data provided by NASA[2] which gives brightness over a region at night time. But NTL is a proxy to GDP so we first need to establish a mathematical dependency between the two. We plan to use the methods present in the current literature[3]. After establishing the relationship between the two, GDP disagreggation can be done with higher accuracy.

The next step would be create a network where nodes represent a geograhical region. The edges would be weighted and the weight of an edge would depend on the transfer entropy(or conditional mutual information) of economic growth of two nodes over the time period of interest.

For developing nations, a major proportion of GDP is due to trading and most of the trading is done through sea routes. So, as our next step we start distributing the trading volume in the network described above, starting from the port cities.

As part of our experiements, we aim to simulate the above step over time and space to observe patterns/clusters of economic growth for different regions. Various methods like KNN and DBSCAN[4] exist in the current literature to find such patterns. Moreover, we expect to gather more information about the geographical scale over which such correlations(potential causal relations) might occur. To try out different scales(temporal and spatial), we propose using Voronoi tessellations based on NTL for automatic gridding instead of defining administrative boundaries. Finding these spatial and time scale is an outcome of the research.

4. Tentative Timeline

- February – March: Literature review, formalize research objectives.
- April – May: Network development and initial experiementation.
- June-July: Experimentation, observing results and thesis writing.
- August: Defense, extra time if required.

References

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