

How the value flows through international trade

Sotaro Sada and Yuichi Ikeda

Graduate School of Advanced Integrated Studies in Human Survivability,
Kyoto University, Japan

Summary

We analyzed the networks of the world economy from 2000 to 2014 by applying flow based community analysis to annual world input-output tables.

Results show the dichotomy between trade and value-added network:

- the structure of international value-added networks was much more connected than trade ones which were connected in similar industries,
- only the value-added network has communities of economic regions, and structural change of the international value-added networks through the 2008 economic crisis:
- under the economic crisis, EU and Pacific Rims are the same community,
- after the crisis, EU communities were more fragmented and a community of Pacific Rims placed emphasis on service from industries which induced the difference between trade growth and GDP growth.

Introduction

Background

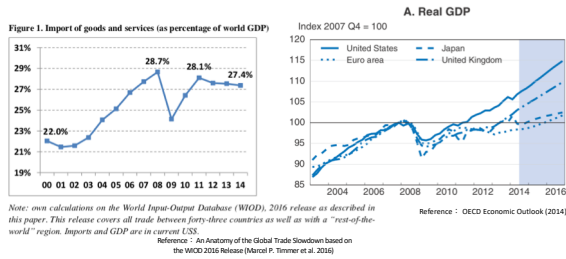
More than 10 years ago, the world economy had been damaged by economic crisis. After the event, world trade importance against GDP was decreased.

Goal 1

To unravel the dichotomy between trade and value-added network

Goal 2

To unravel the change of trade structure around the economic crisis by analyzing world input-output tables 2000 to 2014.



Data

Data is from WIOD, World Input-Output Database (2016 release version), which includes 15 years trade data from 2000 among 56 industries of each 43 countries and ROW (Rest of the World). From the data we construct two networks: International Intermediates Network (IIN) and International Value-Added Network (IVAN). Trade values within each of the countries are eliminated in these International Networks.

Nodes: 2408 (country-industry)
Links: 5798464

Method

Input-Output Model

Contracting IVAN, adjacent matrix can be calculated as below.

$$\hat{V} \cdot (I - A)^{-1} \cdot \hat{F}$$

where \hat{F} is a diagonal matrix of value-added coefficient,

\hat{V} is a diagonal matrix of final demand and

$(I - A)^{-1}$ is Leontief inverse.

This matrix means value-added price induced by final demand in each industry, which also means how amount of value is provided by each country-industry.

Basic Characteristics of Network

For understanding the feature of networks, we check distributions of in-/out-degree and in-/out-strength.

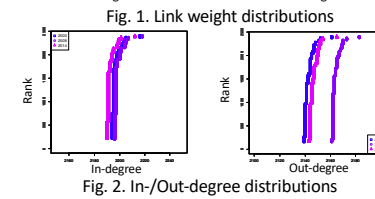
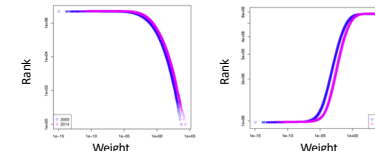
Community Structure

Networks was analyzed by flow based community analysis method: map equation which is one of the most efficient community detection algorithm. This method is application of Huffman coding. Community is decided by minimizing a objective function "map equation" which is the cord length of representing a network.

Results

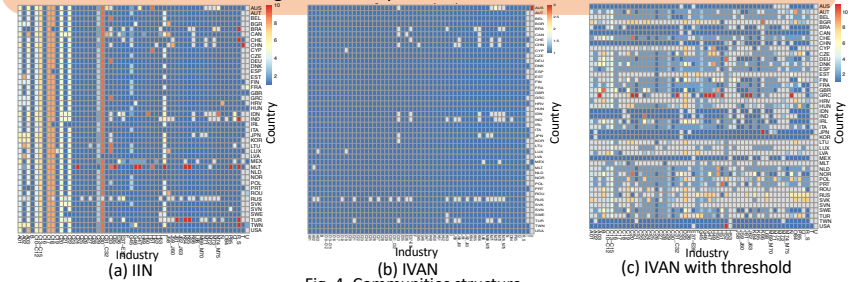
Feature of IVAN

IVAN is densely connected. All the degrees are more than 2100, where 980 thousands links are zero weight.



Goal 1: Difference of networks

IINs have industry-communities (column), on the other hand, IVANs have one large community. Eliminating insignificant links with a threshold, there are internal communities of Pacific Rims and some industries in EU in their own structure although there are no links within each of the countries. It means value-added networks are totally connected in the world due to the economic regions as compared with trade networks.



Goal 2: Change of value-added structure before and after the crisis

Under the 2008 economic crisis, IVAN indicates that Pacific Rims and EU are in the same large community which has many components of public and service industries. Moreover communities structures are changed through the crisis: EU becomes fragmented and industries in Pacific Rims community put more emphasis on service. These are structural changes on the international GDP relation which could not seen on trade networks.

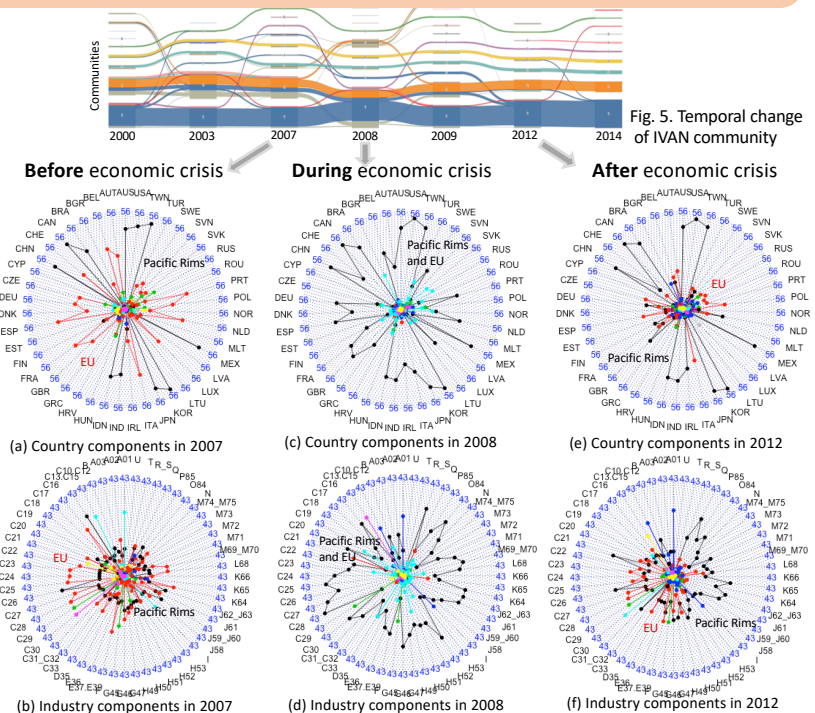


Fig. 5. Rader charts of communities components