Evaluating Countries and Products in international trade

An Evolutionary Bipartite Graph Approach

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Two Questions?

In International trade

Which countries do better?

Which products are more “valuable”?

Let’s call them “Great” countries and products!
Hypotheses

Criteria for “Great” countries

1) Such countries export many “Great” products.

2) Such countries do not really depend on any other specific country.

3) Such countries export some products which other “Great” countries import.
Hypotheses (cont’d)

Criteria for “Great” products

1) Such products are imported a lot.

2) Such products are imported by many “Great” countries.
Intuitions

For “Great” countries

1) A country makes money by exporting products to other countries.
2) A country spends money by importing products from other countries.
3) “Great” countries make more money at last.

For “Great” products

1) “Great” products are imported by “Great” countries a lot.
Dataset

**Internal dataset**


**External dataset**

Trade Network

OEC: Imports/Exports data (1962-2014)

OEC: The Observatory of Economic Complexity
Bipartite Network

Results
Evolutional Model

\[ \frac{4}{5} \alpha = \frac{4}{50}, \quad \alpha = \frac{9}{110} \]

\[ 1 - \alpha = \frac{9}{10} \]

\[ \alpha \approx e^{\text{GNI}} \approx 1 \]

\[ 1 - \alpha \approx 9 \]

\[ \alpha \approx 110 \]

\[ \approx 9 \]

Year 1

\[ 192/200 \]

\[ 195/200 \]

\[ 213/200 \]

Year 2

\[ 408/2000 \]

\[ 192/2000 \]

\[ 195/200 \]

Year n

\[ 3792/4000 \]

\[ 4100/4000 \]

\[ 4008/4000 \]

Canada

China

USA

Import

Export

Meat

TV

Export
Product Value

- 1973 Oil Crisis
- 1980s Personal Computers
- 2008 Smart Phones
National Wealth

- 1973 Oil Crisis
- 1978 Chinese Economic Reform
- 1980s Japan’s Bubble Economy
Technical details

Country-to-Product transition matrix

\[ U = \begin{bmatrix}
w_{11} & w_{12} & w_{13} & \cdots & w_{1m} \\
w_{21} & w_{22} & w_{23} & \cdots & w_{2m} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
w_{n1} & w_{n2} & w_{n3} & \cdots & w_{nm}
\end{bmatrix} \]

Product-to-Country transition matrix

\[ V = \begin{bmatrix}
v_{11} & v_{12} & v_{13} & \cdots & v_{1n} \\
v_{21} & v_{22} & v_{23} & \cdots & v_{2n} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
v_{m1} & v_{m2} & v_{m3} & \cdots & v_{mn}
\end{bmatrix} \]

Country-to-Country transition matrix

\[ M = U \cdot V \]
Denote $\vec{a}$ as the 1-by-n country score vector.

$M$ is the Country-to-Country transition matrix. Note that it’s also a right stochastic matrix.

Do power iterations as follows:

$$\vec{a}' = \vec{a} \cdot M$$

Note that we are guaranteed to get a converged $\vec{a}^*$ which is an approximation of the largest eigenvector of matrix $M$.

Furthermore, we can easily get the converged product score vector which is denoted as $\vec{b}^*$

$$\vec{b}^* = \vec{a}^* \cdot U$$
Technical details (cont’d)

**Evolutionary Model**

What if we want to apply our model into a **period of time** rather than a single year?

**Cumulative** transition matrix!

\[ M = M_1 \cdot M_2 \ldots M_t \]

Then do the same thing as we did before.

\[ \tilde{a}' = \tilde{a} \cdot M \quad \tilde{b}^* = \tilde{a}^* \cdot U \]

To make our evolutionary model more accurate, we allow each country only use a factor of earnings to import products which works well in practice.
Open Questions & Future Work

Are our bipartite and evolutionary models general enough?

More data, more experiments!

Is doing well in exports a necessary condition to win in international trade?

Yes!!? Big question, go deeper!