Exploring Space-Time Dynamics of Human Activities in Non-geographic Spaces

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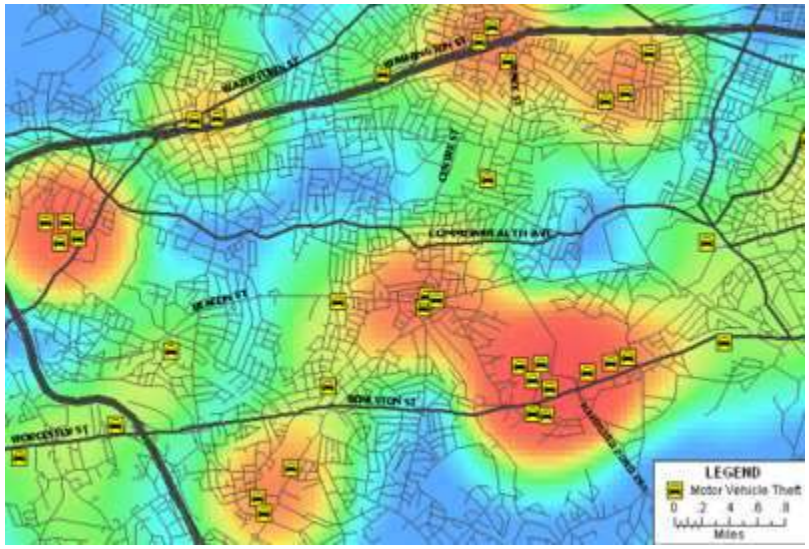
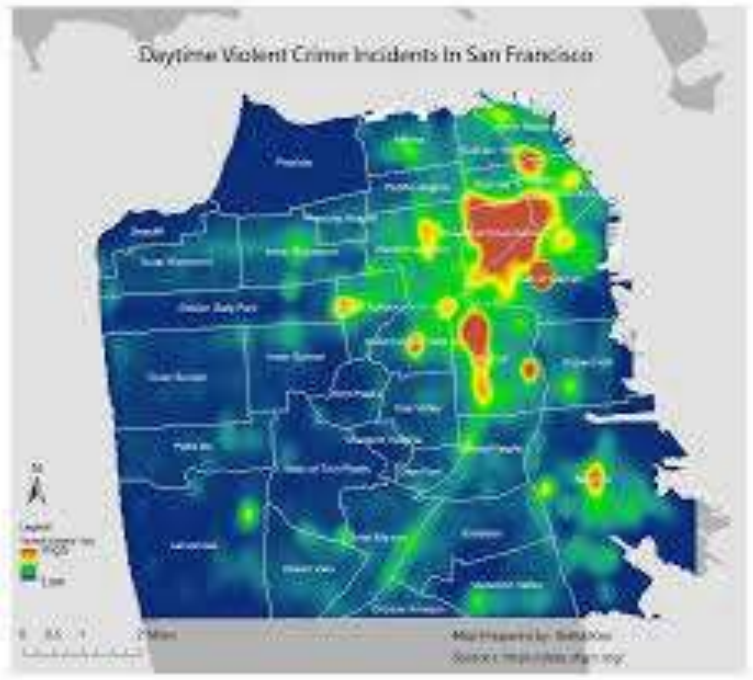
University of Texas at Dallas

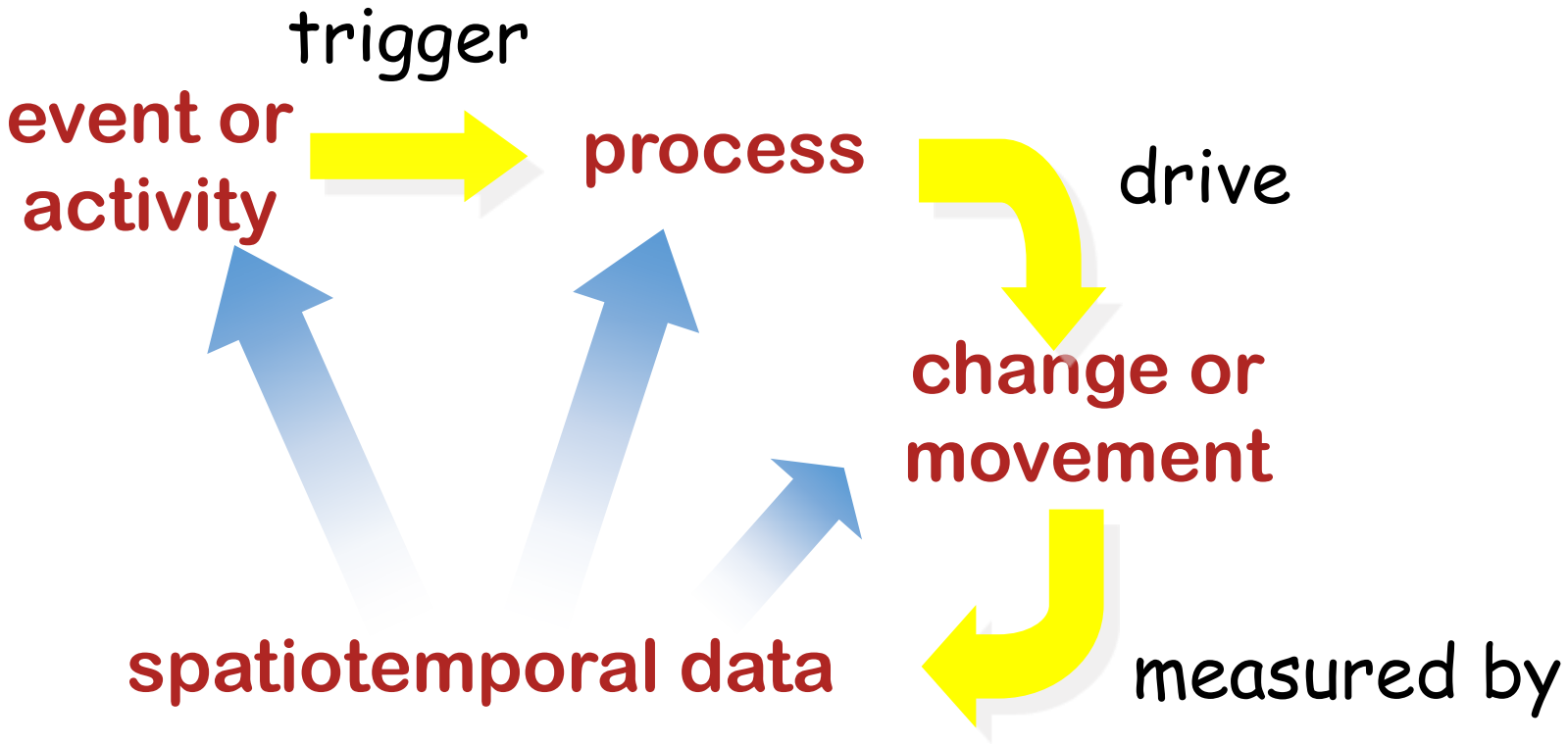
Human Dynamics

- Activities and processes in human dimensions
- Changes of hot spots over time: crime, flu, traffic, opinions, etc.





The conceptual workflow



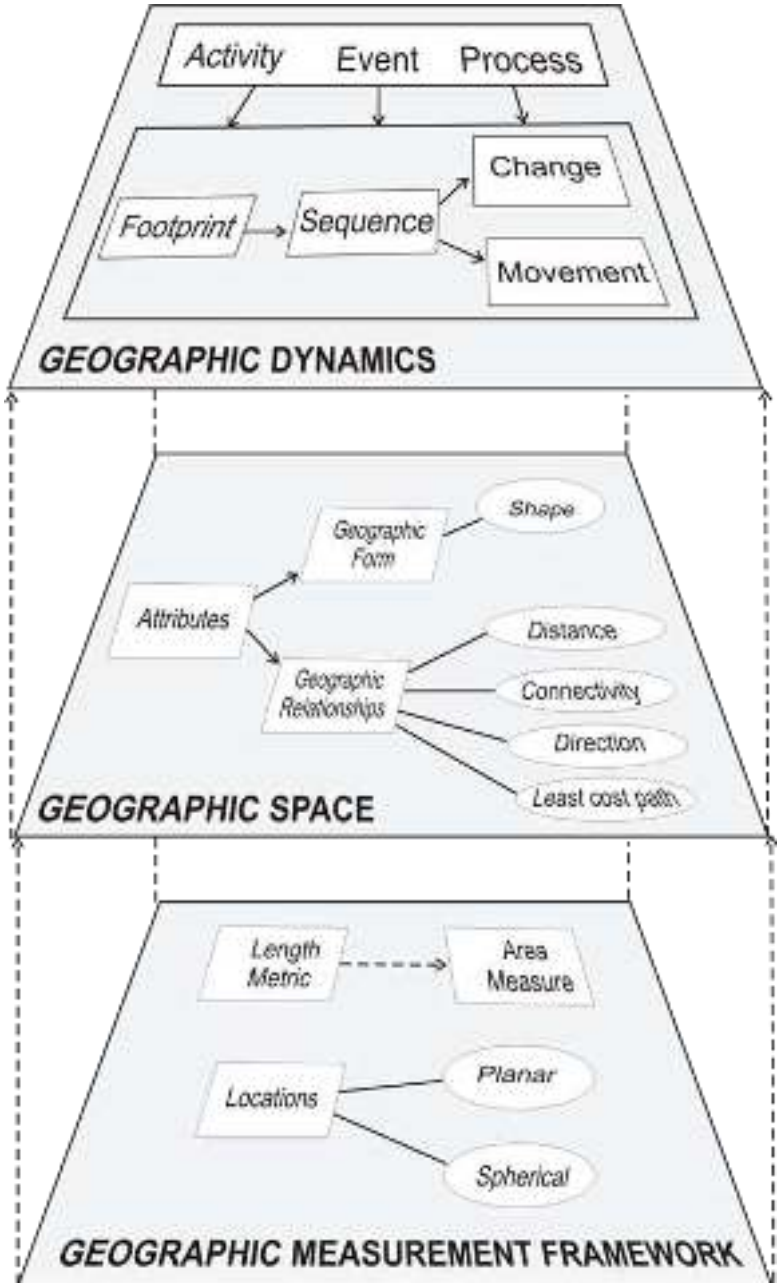
Space-time Dynamics

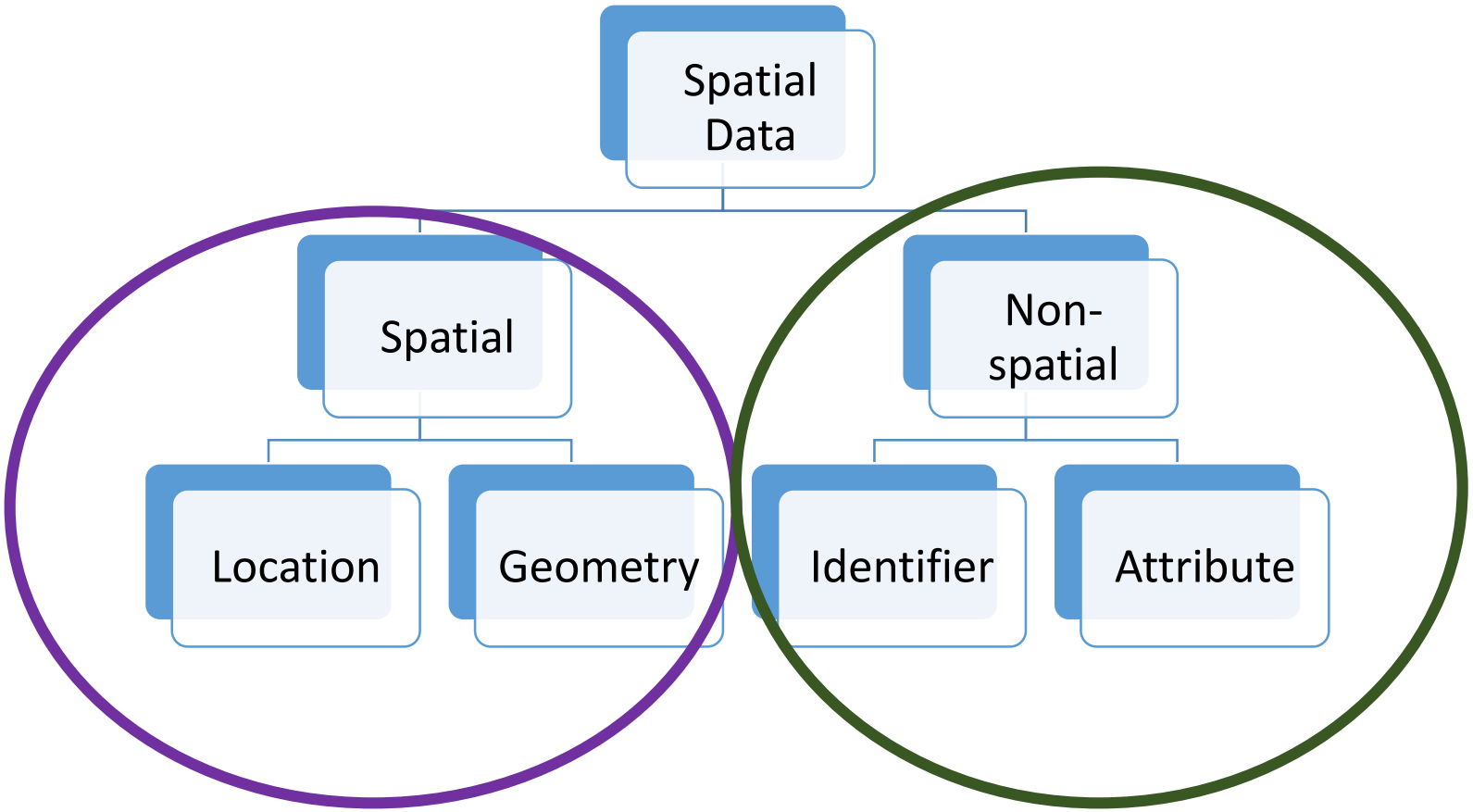
McIntosh, J. and Yuan, M., 2005. Assessing similarity of geographic processes and events. *Transactions in GIS*, *9*(2), pp.223-245.

Spatial Forms

Miller, H.J. and Wentz, E.A., 2003. Representation and spatial analysis in geographic information systems. *Annals of the Association of American Geographers*, *93*(3), pp.574-594.

Spatial Measurements





Mapping based on a cartographical framework

Mapping based on a semantical framework

- Experiences over space and time
- Degrees of similarity among these experiences

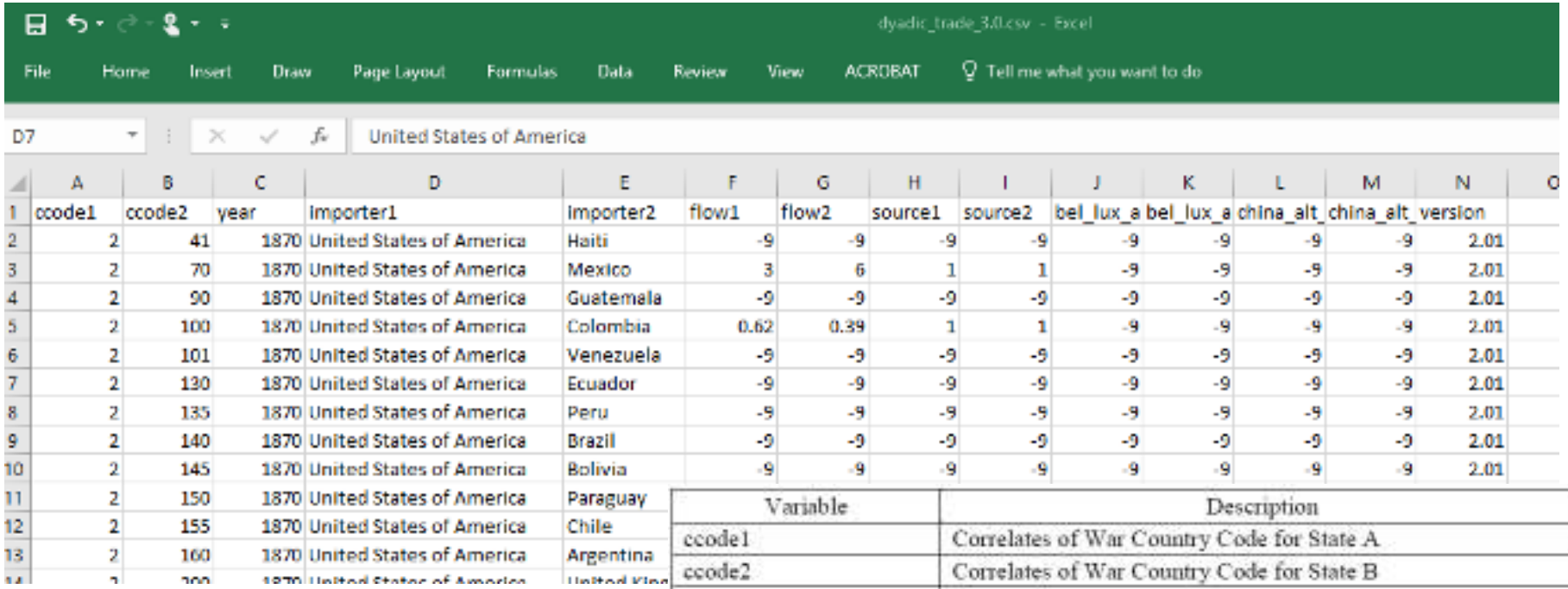
http://correlatesofwar.org/

Barbieri, Katherine, Omar M. G. Keshk, and Brian Pollins. 2009. "TRADING DATA: Evaluating our Assumptions and Coding Rules." Conflict Management and Peace Science. 26(5): 471-491.

International bilateral trade data: 1870 to 2009

In 2009 US dollars for pairs of 205 sovereign states. Based on IMF data and other state reports when necessary. In case of country name changes, record the data based on state list with the COW state membership list.

Barbieri, Katherine and Omar Keshk. 2012. Correlates of War Project Trade Data Set Codebook, Version 3.0. Online: http://correlatesofwar.org.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	ccode1	ccode2	year	importer1	importer2	flow1	flow2	source1	source2	bel_lux_a	bel_lux_a	china_alt	china_alt	version	
2	2	41	1870	United States of America	Haiti	-9	-9	-9	-9	-9	-9	-9	-9	2.01	
3	2	70	1870	United States of America	Mexico	3	6	1	1	-9	-9	-9	-9	2.01	
4	2	90	1870	United States of America	Guatemala	-9	-9	-9	-9	-9	-9	-9	-9	2.01	
5	2	100	1870	United States of America	Colombia	0.62	0.39	1	1	-9	-9	-9	-9	2.01	
6	2	101	1870	United States of America	Venezuela	-9	-9	-9	-9	-9	-9	-9	-9	2.01	
7	2	130	1870	United States of America	Ecuador	-9	-9	-9	-9	-9	-9	-9	-9	2.01	
8	2	135	1870	United States of America	Peru	-9	-9	-9	-9	-9	-9	-9	-9	2.01	
9	2	140	1870	United States of America	Brazil	-9	-9	-9	-9	-9	-9	-9	-9	2.01	
10	2	145	1870	United States of America	Bolivia	-9	-9	-9	-9	-9	-9	-9	-9	2.01	
11	2	150	1870	United States of America	Paraguay										
12	2	155	1870	United States of America	Chile										
13	2	160	1870	United States of America	Argentina										

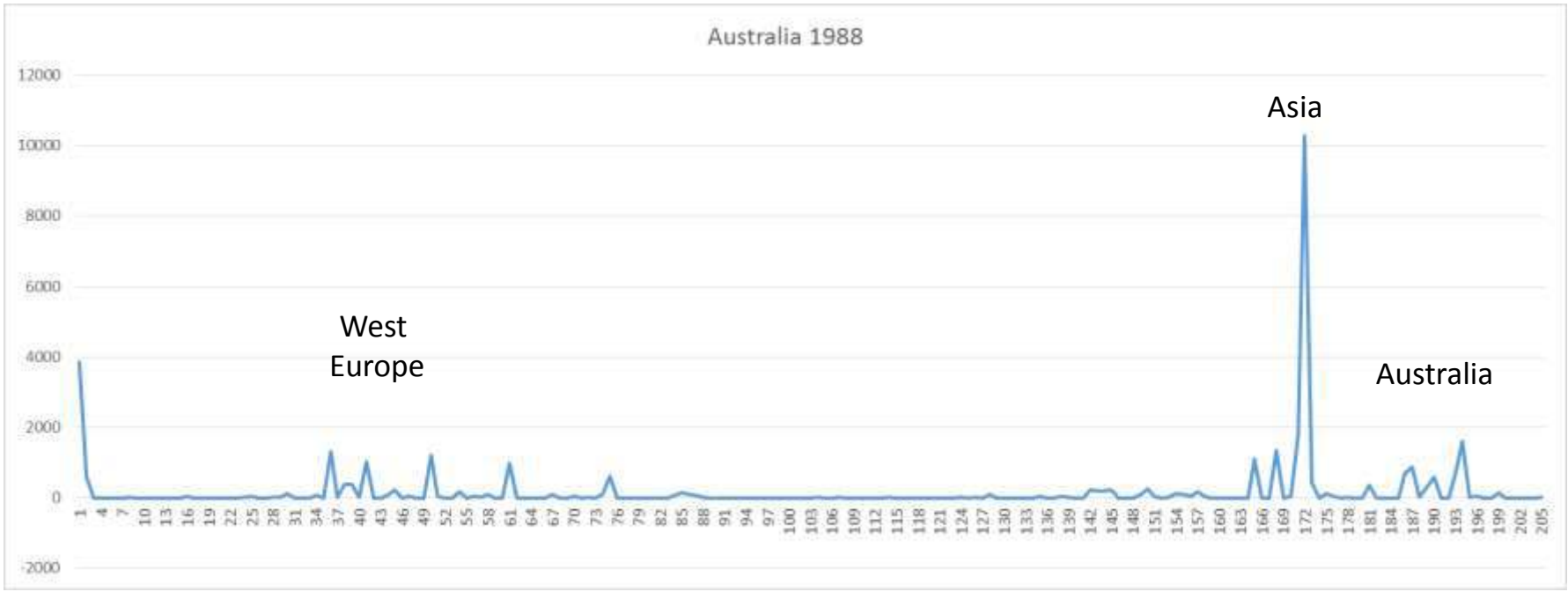
Variable	Description
ccode1	Correlates of War Country Code for State A
ccode2	Correlates of War Country Code for State B
year	Observation year
importer1	Name of country A
importer2	Name of country B
flow1	Imports of Country A from Country B in current US millions of dollars
flow2	Imports of Country B from Country A in current US millions of dollars
source1	Source of data for flow1 variable (see table below)
source2	Source of data for flow2 variable (see table below)
China_alt_flow1	Original The People's Republic of China trade values (see notes below)
China_alt_flow2	Original The People's Republic of China trade values (see notes below)
Bel_Lux_alt_flow1	Original Belgium and Luxembourg trade values (see notes below)
Bel_Lux_alt_flow2	Original Belgium and Luxembourg trade values (see notes below)
version	Data version = 3.0

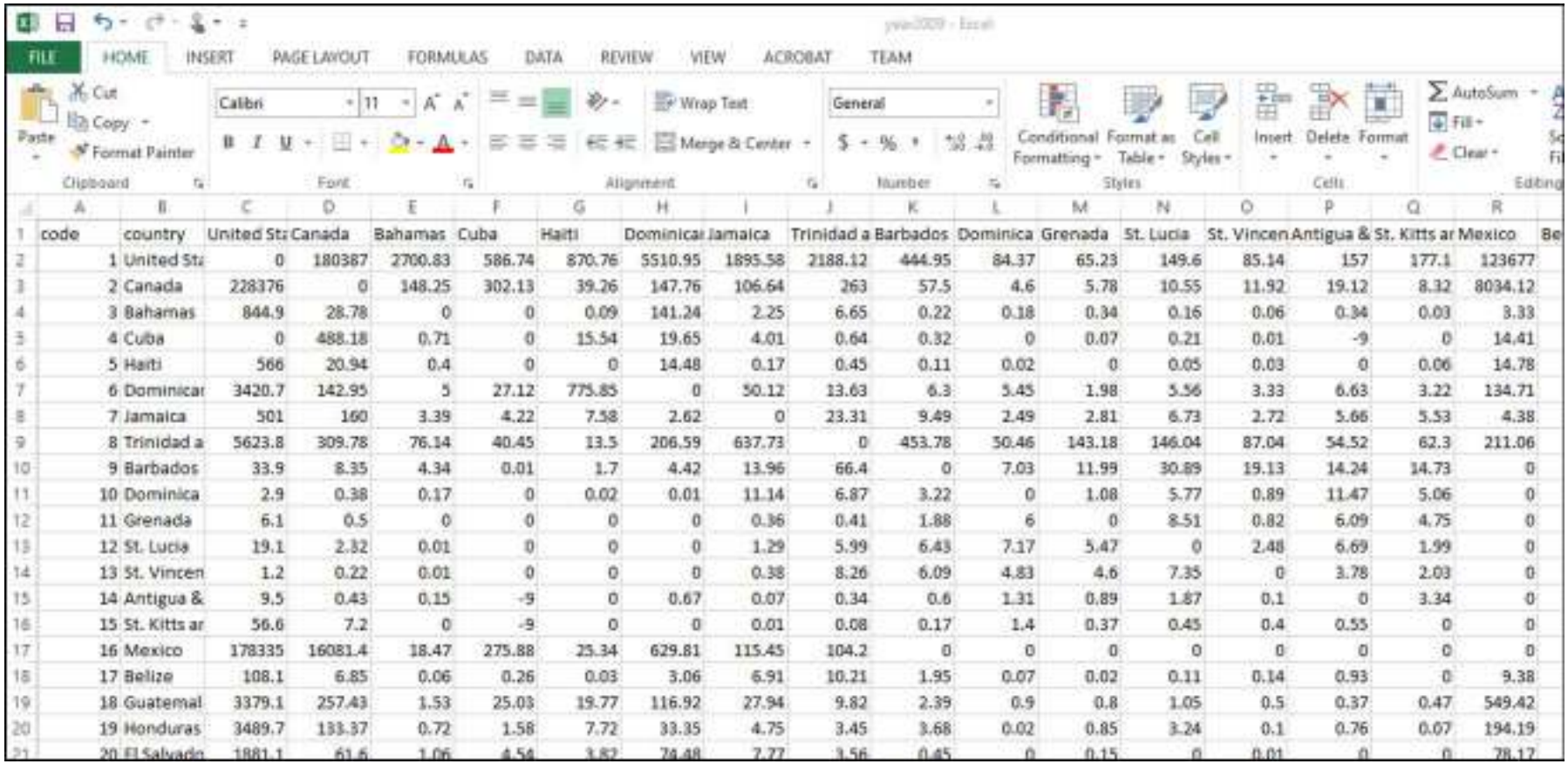
Instead of modeling spatial interactions of state pairs, can we seek how a state develops international trade patterns over the years and how each state compares to the others?

With Wei Luo at UC Santa Barbara

205 countries

North America | Central America | South America | West Europe | East Europe | North Europe | Africa | Middle East | Euroasia | Asia | Australia | Pacific Islands





FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW ACROBAT TEAM

Cut Copy Format Painter Paste — Clipboard

Calibri 11 — Font

Wrap Text Merge & Center — Alignment

General — Number

Conditional Formatting Format as Table Cell Styles — Styles

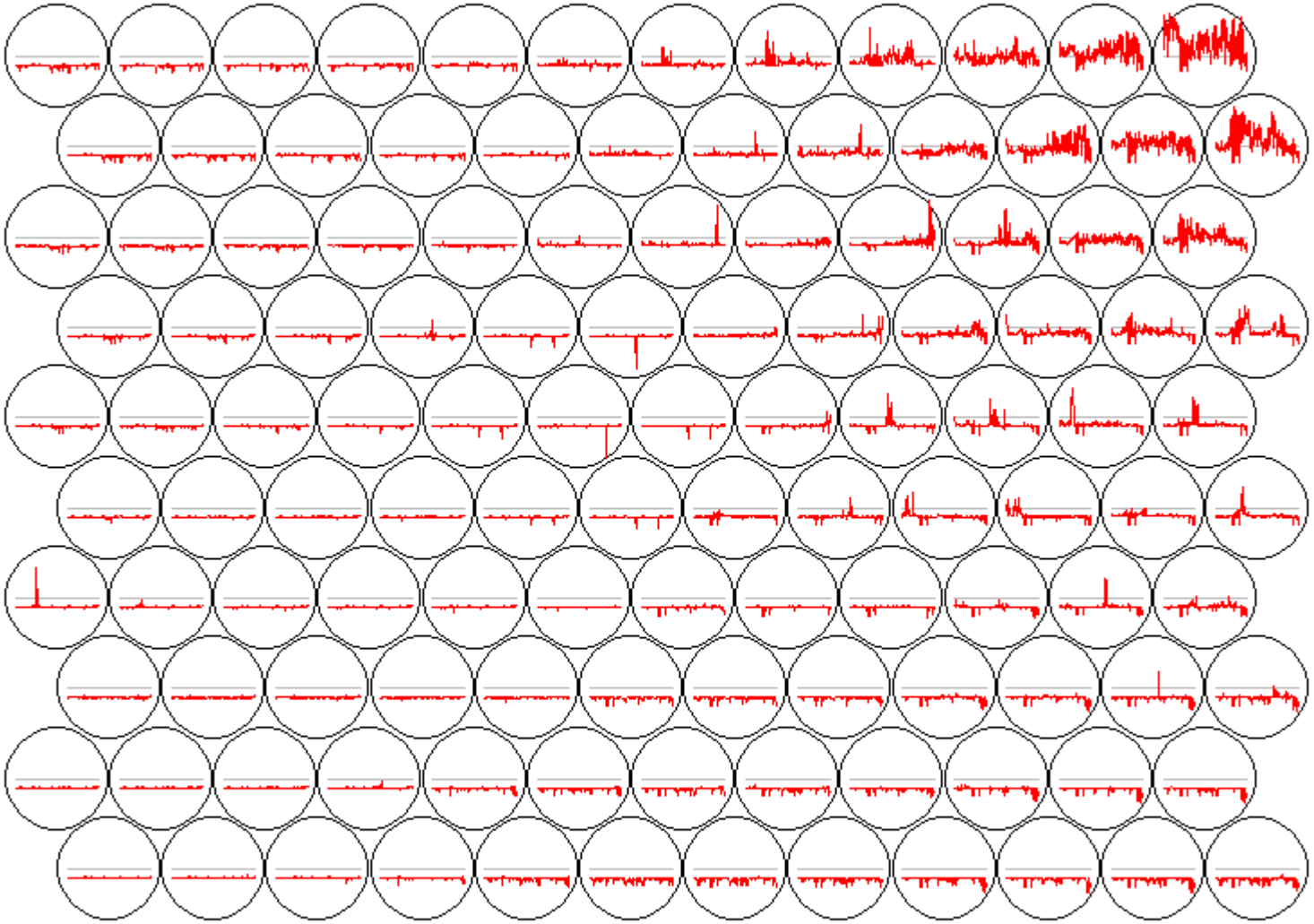
Insert Delete Format — Cells

AutoSum Fill Clear — Editing

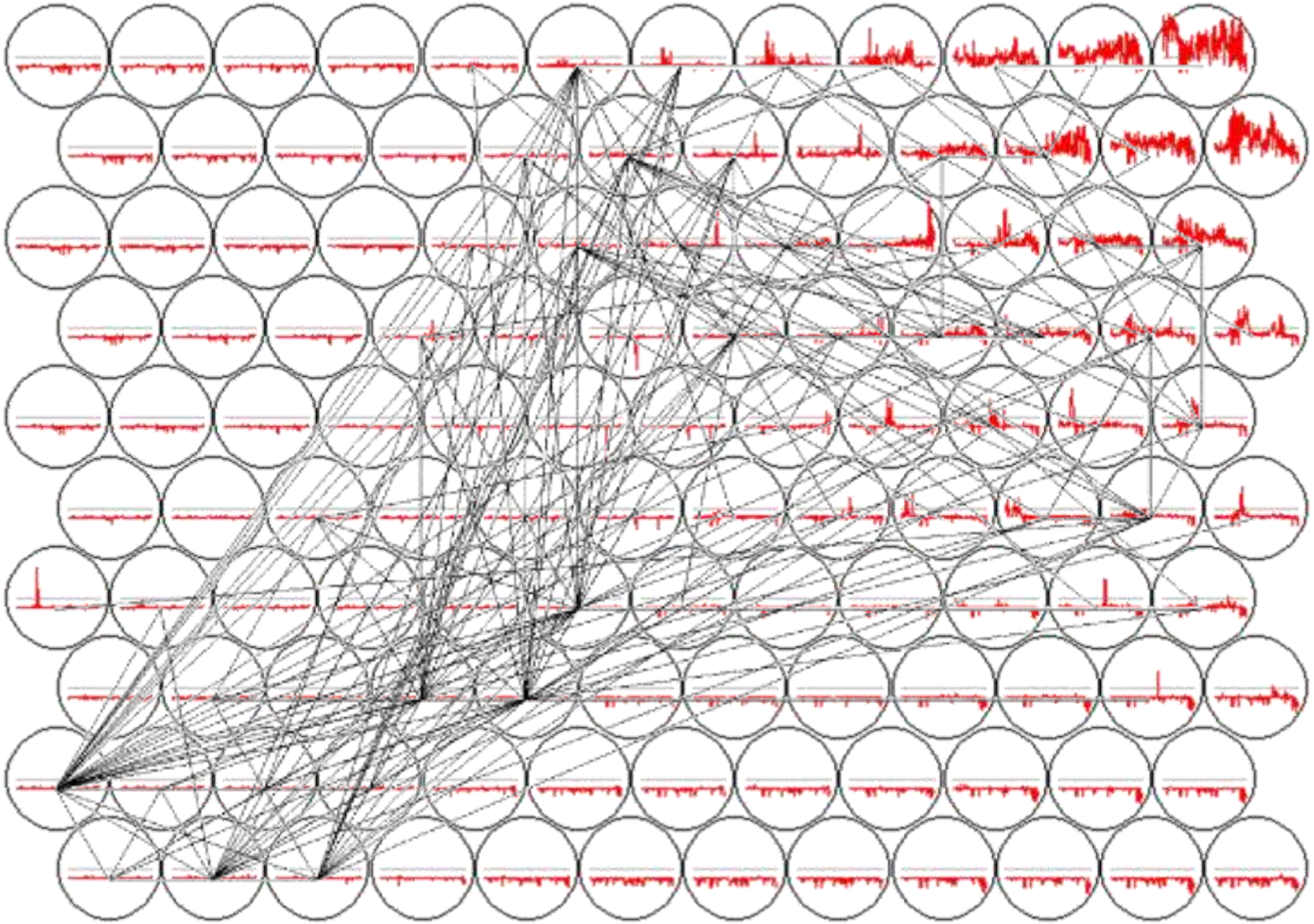
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	code	country	United St	Canada	Bahamas	Cuba	Haiti	Dominica	Jamaica	Trinidad a	Barbados	Dominica	Grenada	St. Lucia	St. Vincen	Antigua &	St. Kitts ar	Mexico
2	1	United St	0	180387	2700.83	586.74	870.76	5510.95	1895.58	2188.12	444.95	84.37	65.23	149.6	85.14	157	177.1	123677
3	2	Canada	228376	0	148.25	302.13	39.26	147.76	106.64	263	57.5	4.6	5.78	10.55	11.92	19.12	8.32	8034.12
4	3	Bahamas	844.9	28.78	0	0	0.09	141.24	2.25	6.65	0.22	0.18	0.34	0.16	0.06	0.34	0.03	3.33
5	4	Cuba	0	488.18	0.71	0	15.54	19.65	4.01	0.64	0.32	0	0.07	0.21	0.01	-9	0	14.41
6	5	Haiti	566	20.94	0.4	0	0	14.48	0.17	0.45	0.11	0.02	0	0.05	0.03	0	0.06	14.78
7	6	Dominicar	3420.7	142.95	5	27.12	775.85	0	50.12	13.63	6.3	5.45	1.98	5.56	3.33	6.63	3.22	134.71
8	7	Jamaica	501	160	3.39	4.22	7.58	2.62	0	23.31	9.49	2.49	2.81	6.73	2.72	5.66	5.53	4.38
9	8	Trinidad a	5623.8	309.78	76.14	40.45	13.5	206.59	637.73	0	453.78	50.46	143.18	146.04	87.04	54.52	62.3	211.06
10	9	Barbados	33.9	8.35	4.34	0.01	1.7	4.42	13.96	66.4	0	7.03	11.99	30.89	19.13	14.24	14.73	0
11	10	Dominica	2.9	0.38	0.17	0	0.02	0.01	11.14	6.87	3.22	0	1.08	5.77	0.89	11.47	5.06	0
12	11	Grenada	6.1	0.5	0	0	0	0	0.36	0.41	1.88	6	0	8.51	0.82	6.09	4.75	0
13	12	St. Lucia	19.1	2.32	0.01	0	0	0	1.29	5.99	6.43	7.17	5.47	0	2.48	6.69	1.99	0
14	13	St. Vincen	1.2	0.22	0.01	0	0	0	0.38	8.26	6.09	4.83	4.6	7.35	0	3.78	2.03	0
15	14	Antigua &	9.5	0.43	0.15	-9	0	0.67	0.07	0.34	0.6	1.31	0.89	1.87	0.1	0	3.34	0
16	15	St. Kitts ar	56.6	7.2	0	-9	0	0	0.01	0.08	0.17	1.4	0.37	0.45	0.4	0.55	0	0
17	16	Mexico	178335	16081.4	18.47	275.88	25.34	629.81	115.45	104.2	0	0	0	0	0	0	0	0
18	17	Belize	108.1	6.85	0.06	0.26	0.03	3.06	6.91	10.21	1.95	0.07	0.02	0.11	0.14	0.93	0	9.38
19	18	Guatemal	3379.1	257.43	1.53	25.03	19.77	116.92	27.94	9.82	2.39	0.9	0.8	1.05	0.5	0.37	0.47	549.42
20	19	Honduras	3489.7	133.37	0.72	1.58	7.72	33.35	4.75	3.45	3.68	0.02	0.85	3.24	0.1	0.76	0.07	194.19
21	20	El Salvado	1881.1	61.6	1.06	4.54	3.82	74.48	7.27	3.56	0.45	0	0.15	0	0.01	0	0	78.17

Kohonen SOM
Rbind: 1900-2009
Alpha 0.00005 to 0.000001

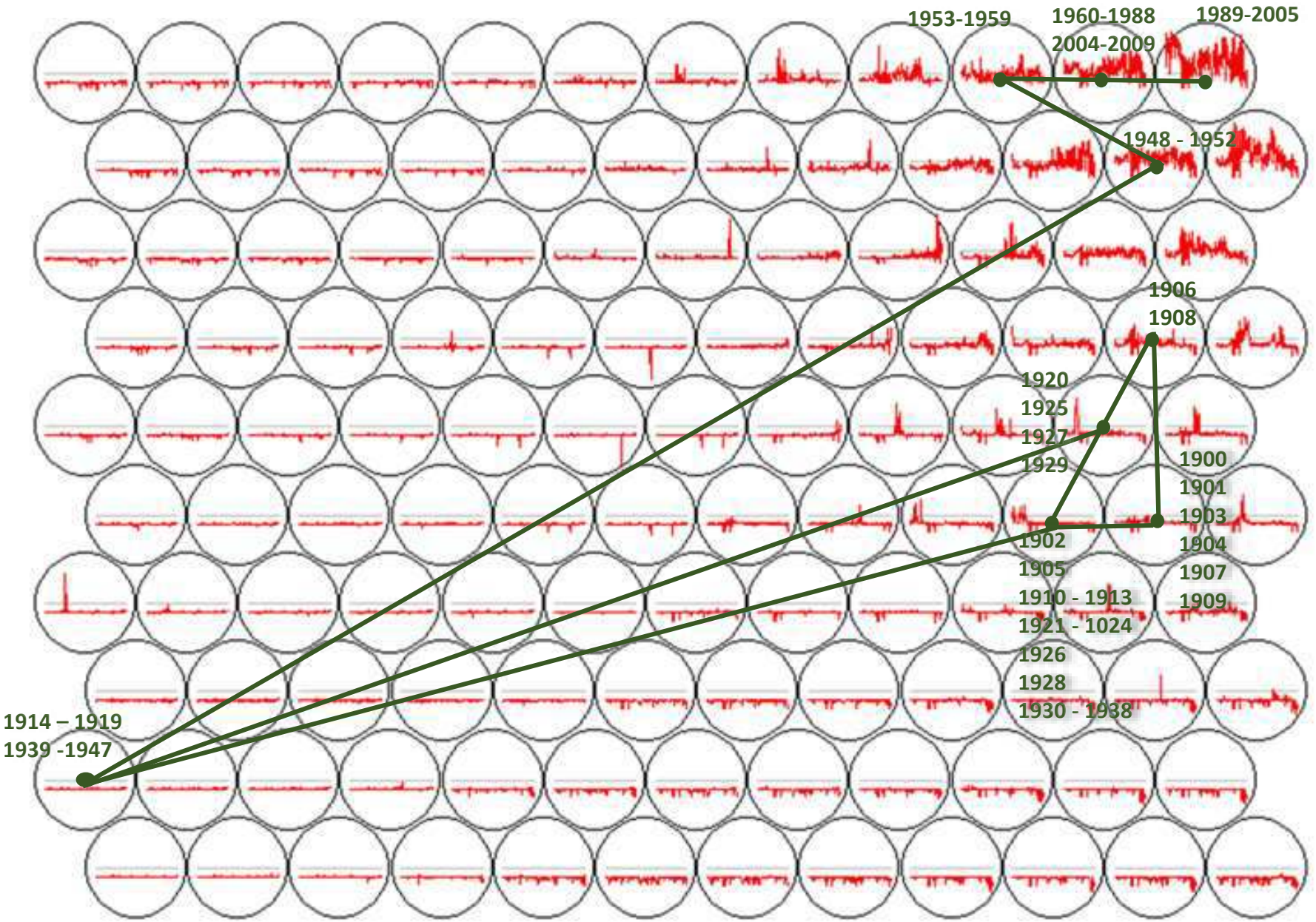
Use Self Organizing Map to classify imports patterns across all countries at a given year

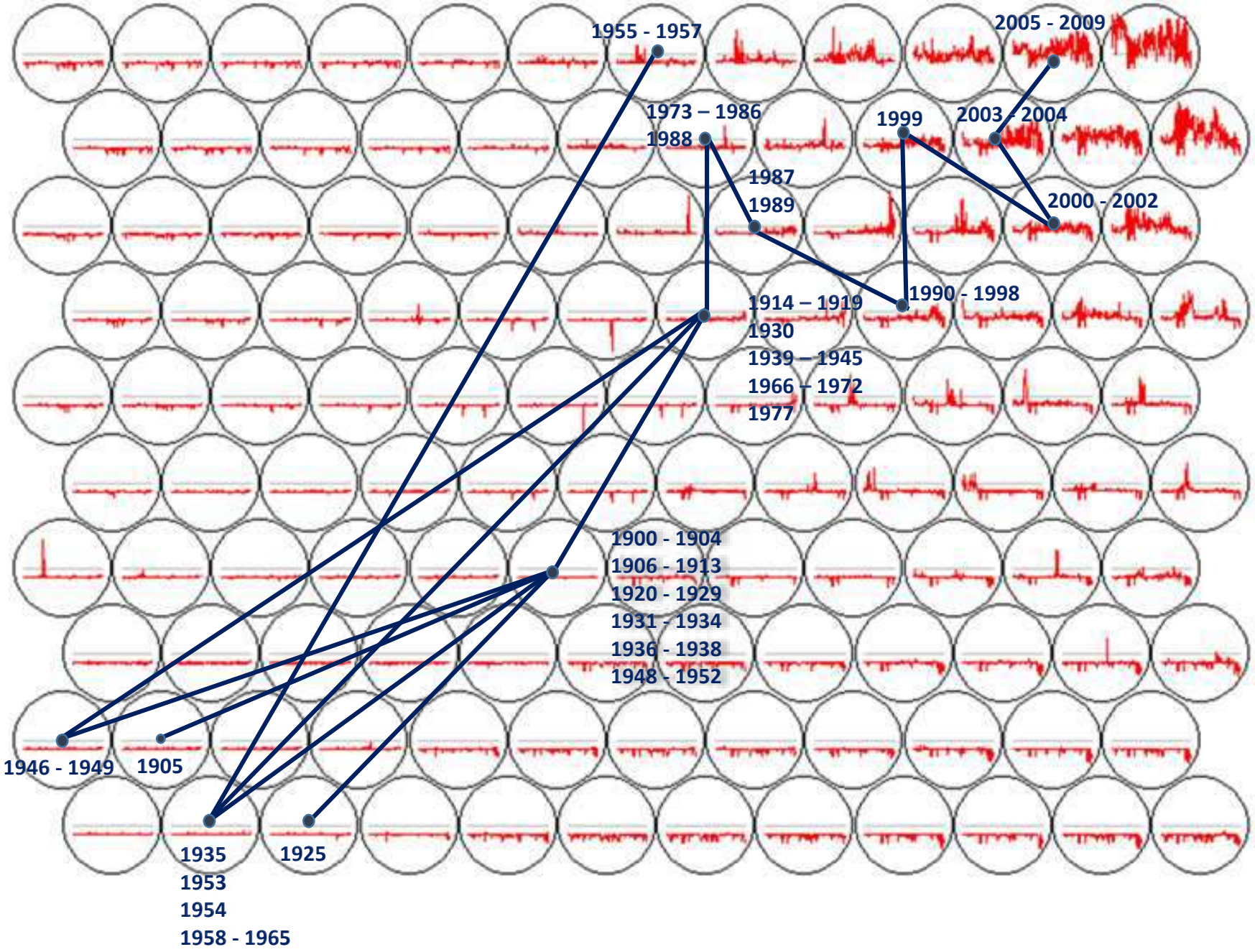


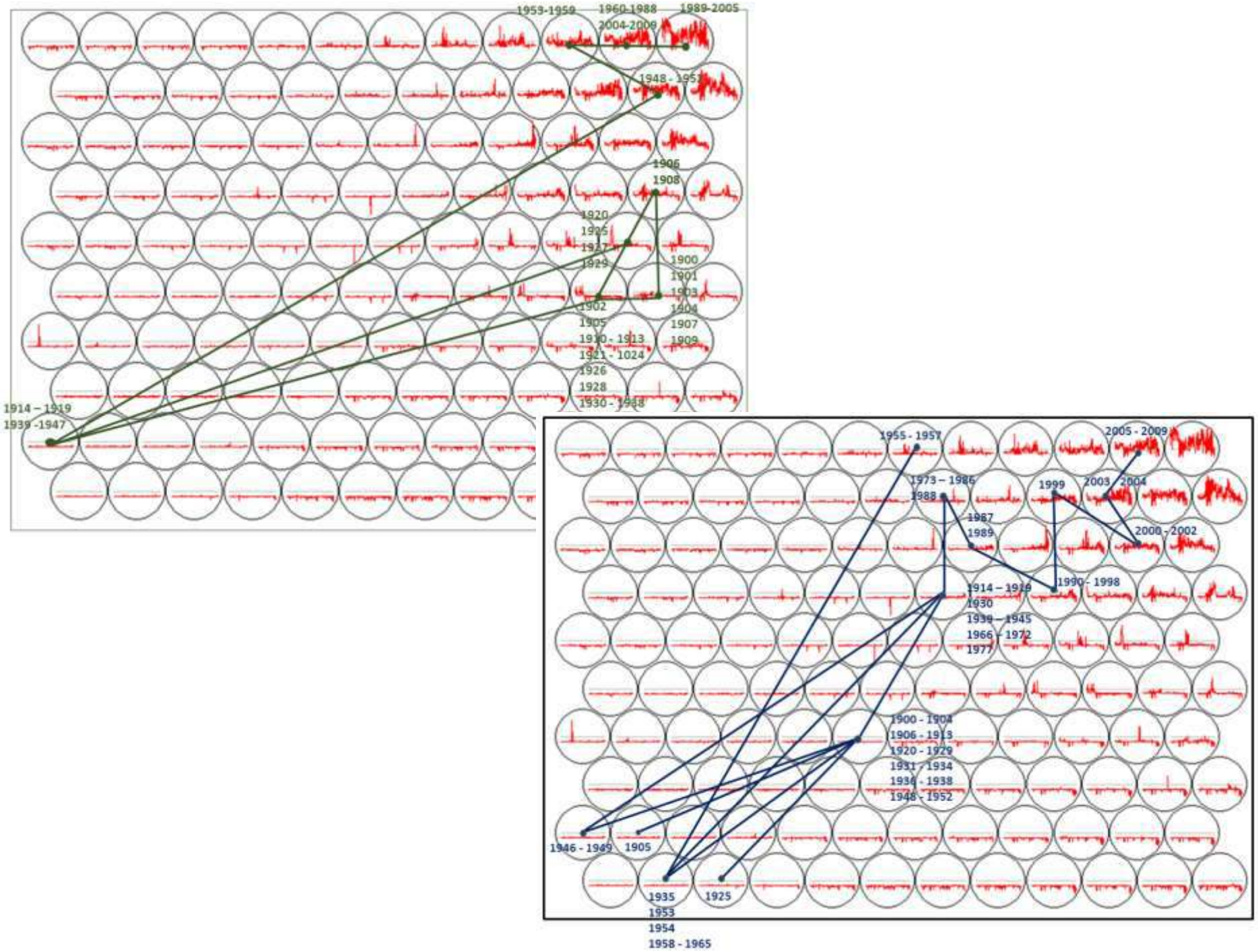
For each country, plot its trajectory of imports patterns from 1900 to 2009



The trajectory of a country




1955 - 1957
2005 - 2009
1973 – 1986
1988
1999
2003 - 2004
1987
1989
2000 - 2002
1990 - 1998
1914 – 1919
1930
1939 – 1945
1966 – 1972
1977
1900 - 1904
1906 - 1913
1920 - 1929
1931 - 1934
1936 - 1938
1948 - 1952
1946 - 1949
1905
1935
1953
1954
1958 - 1965
1925


1953-1959
1960-1988
2004-2009
1989-2005
1948 - 1952
1906
1908
1920
1924
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1910 - 1913
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1921 - 1024
1926
1928
1930 - 1938
1914 – 1919
1939 -1947
1955 - 1957
2005 - 2009
1973 – 1986
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1990 - 1998
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1939 – 1945
1966 - 1972
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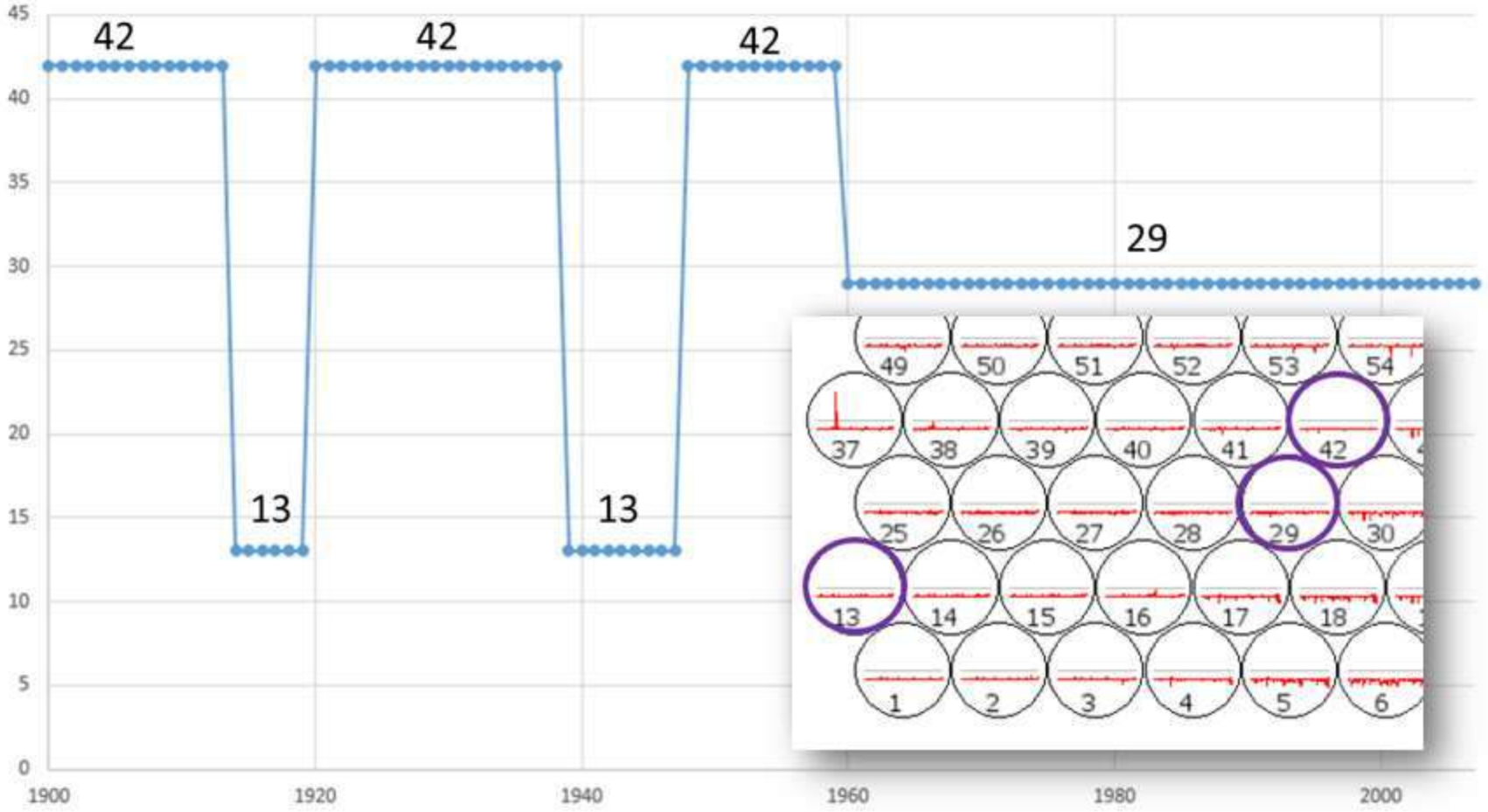
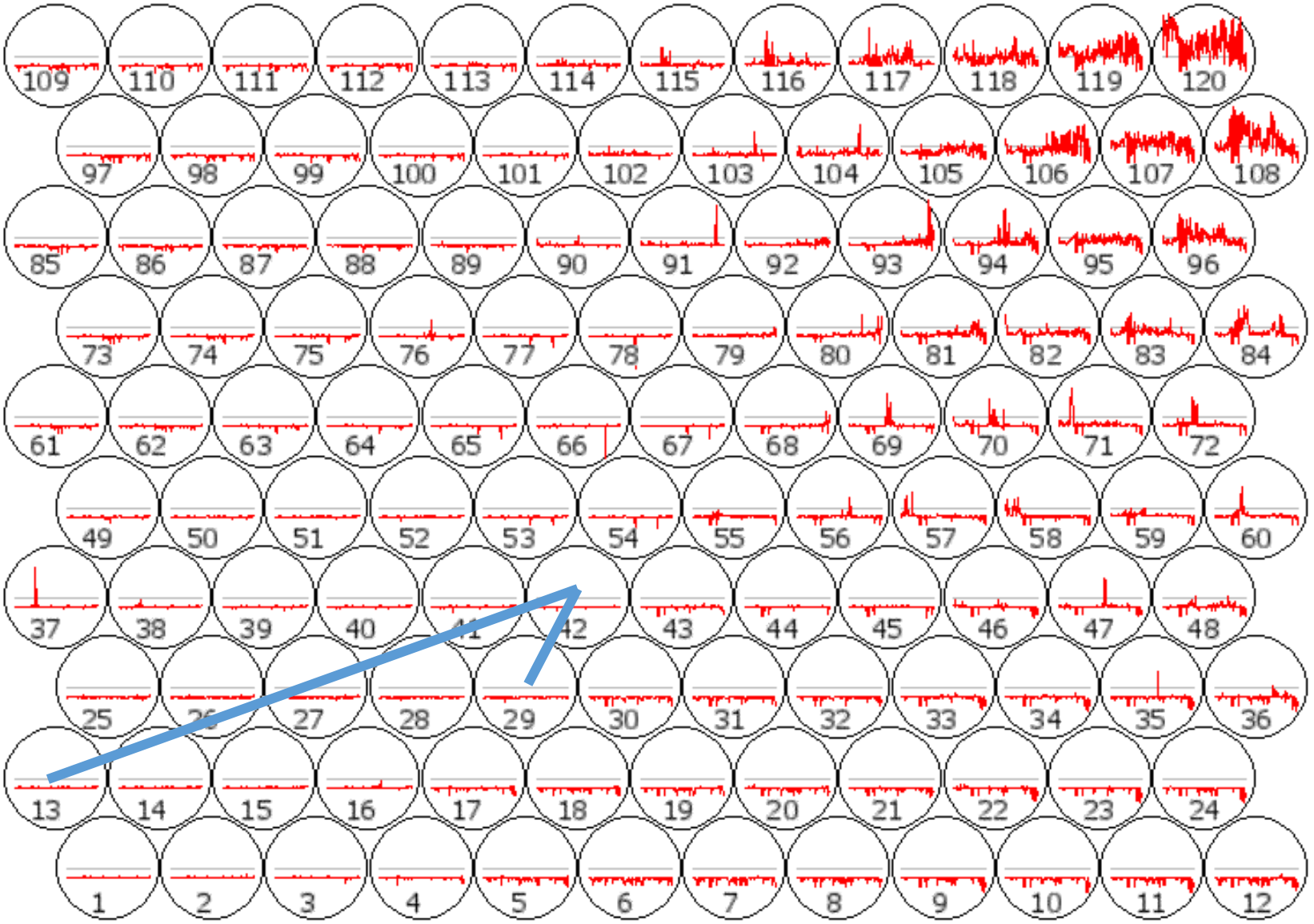
1900 - 1904
1906 - 1913
1920 - 1929
1931 - 1934
1936 - 1938
1948 - 1952
1946 - 1949
1905
1935
1953
1954
1925
1958 - 1965

Mode of trade patterns from 1900 to 2009

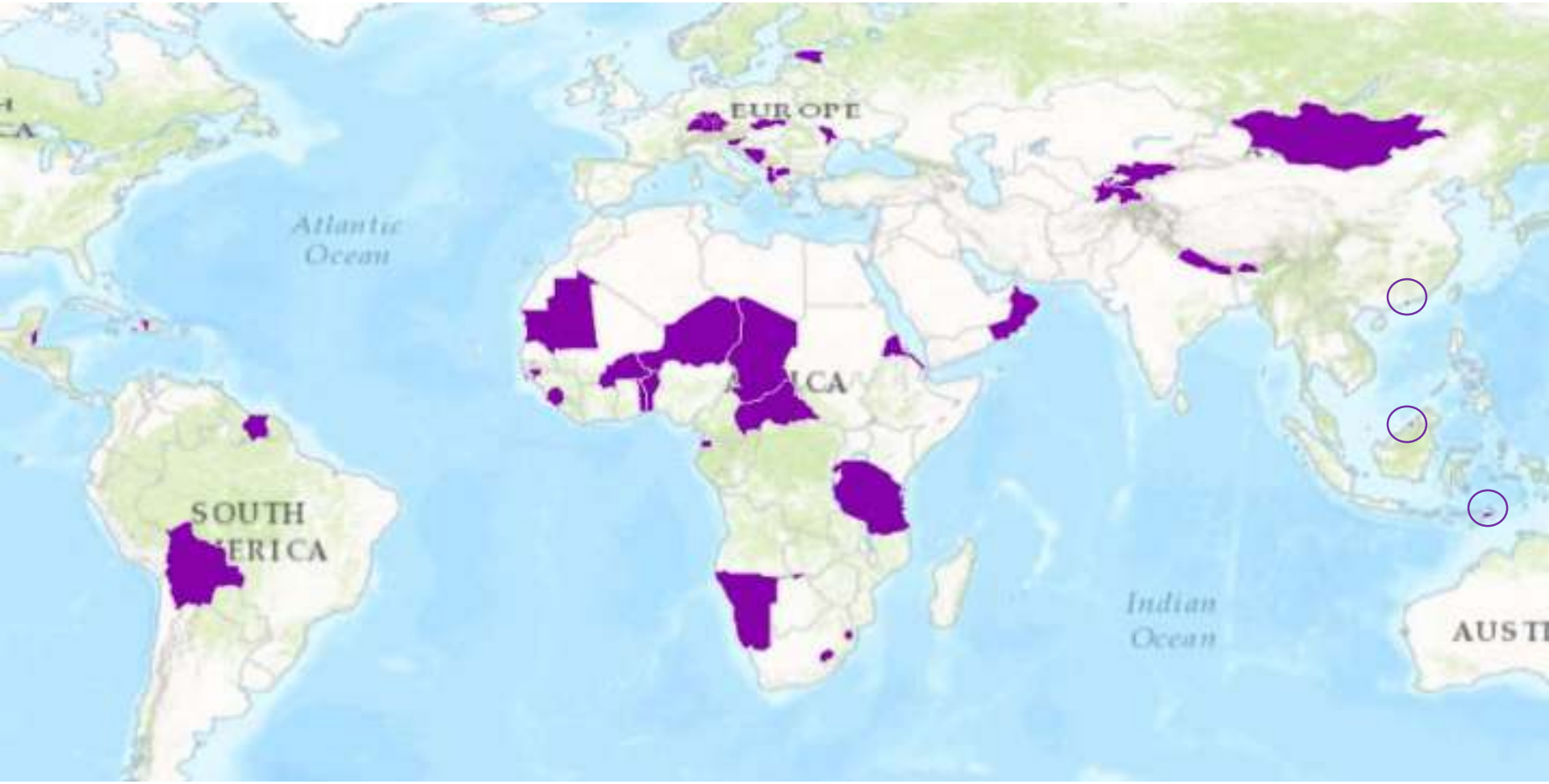


Variety of International Trade Patterns
45
40
35
30
25
20
15
10
5
0
1900
1920
1940
1960
1980
2000

The most common trajectory of trend patterns
65 out of 205 countries

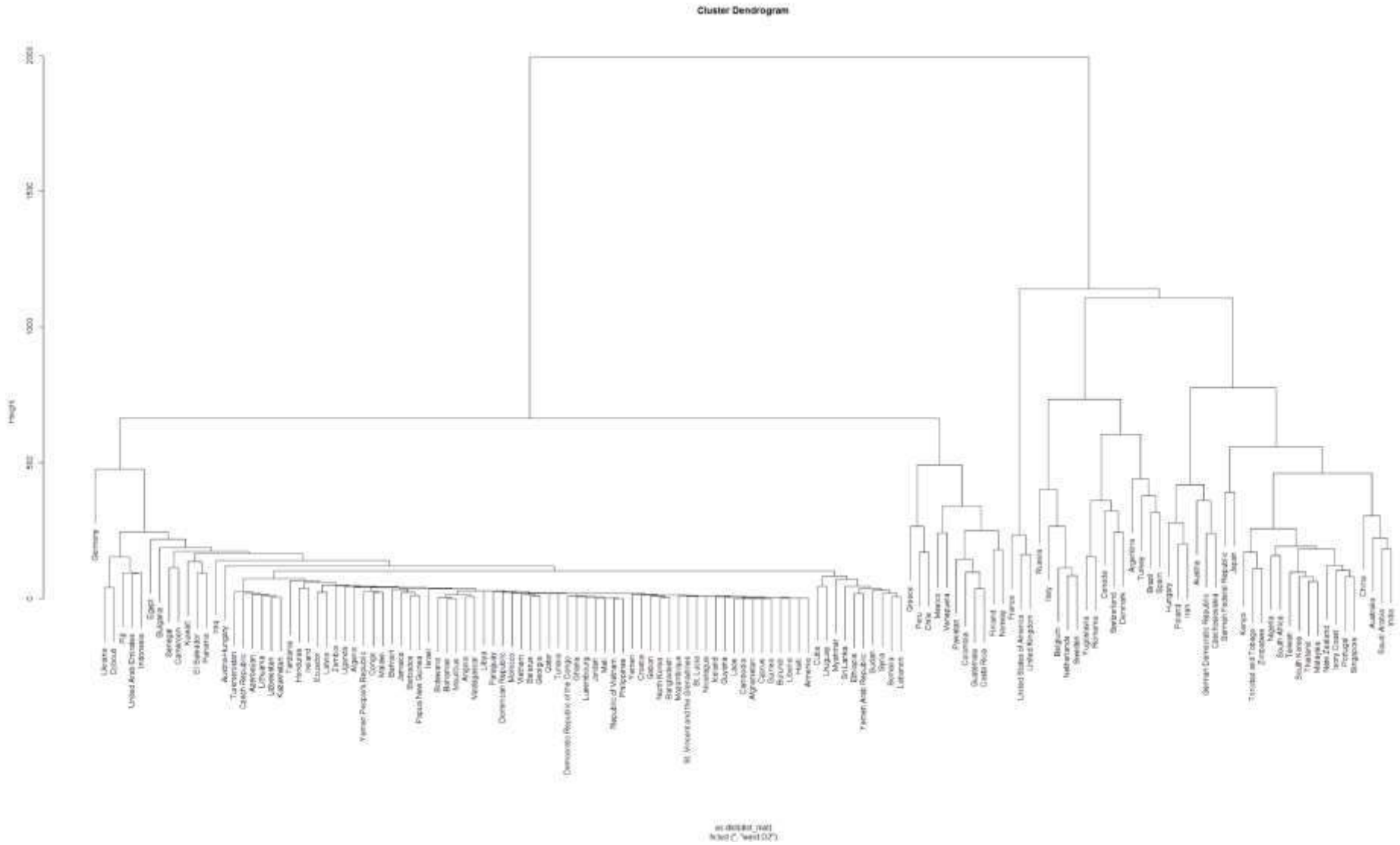


65 countries with minimal imports from all other countries from 1900 to 2009

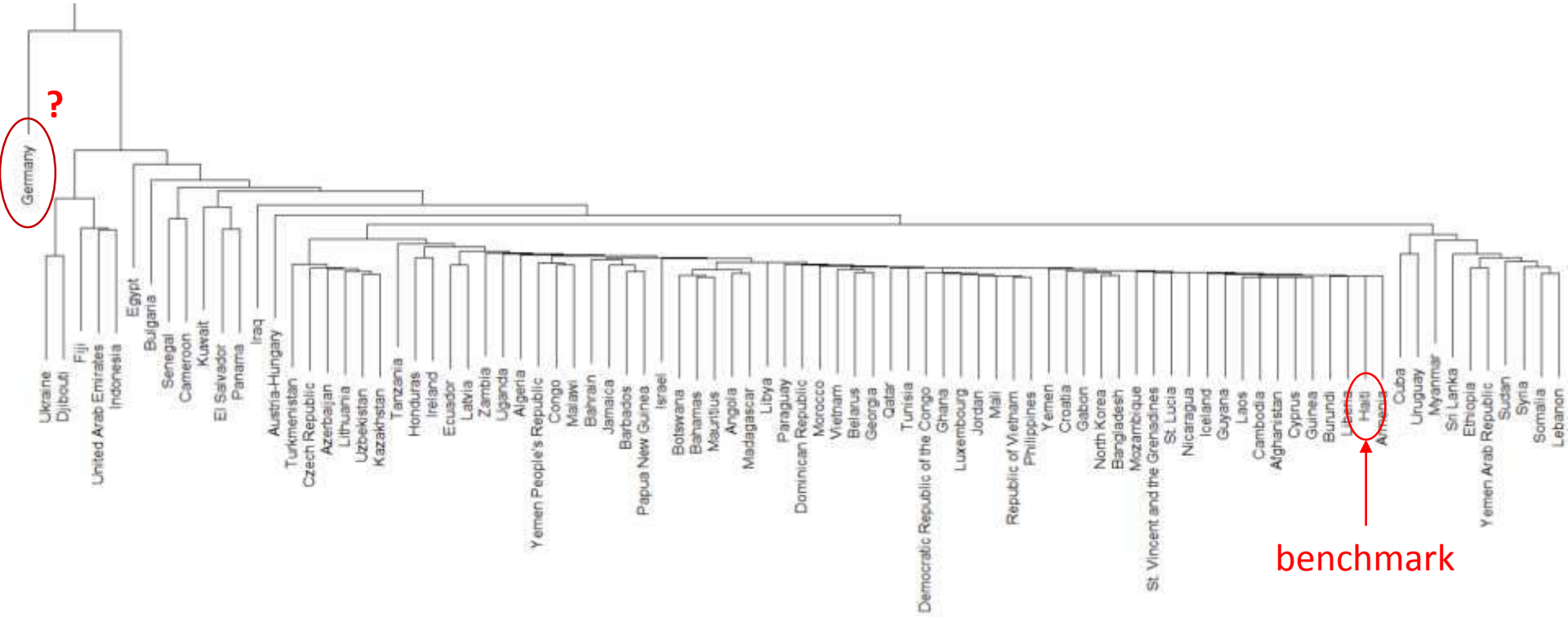


Clusters of remaining 140 countries

hclust(dist(x), method="ward.D2") in R

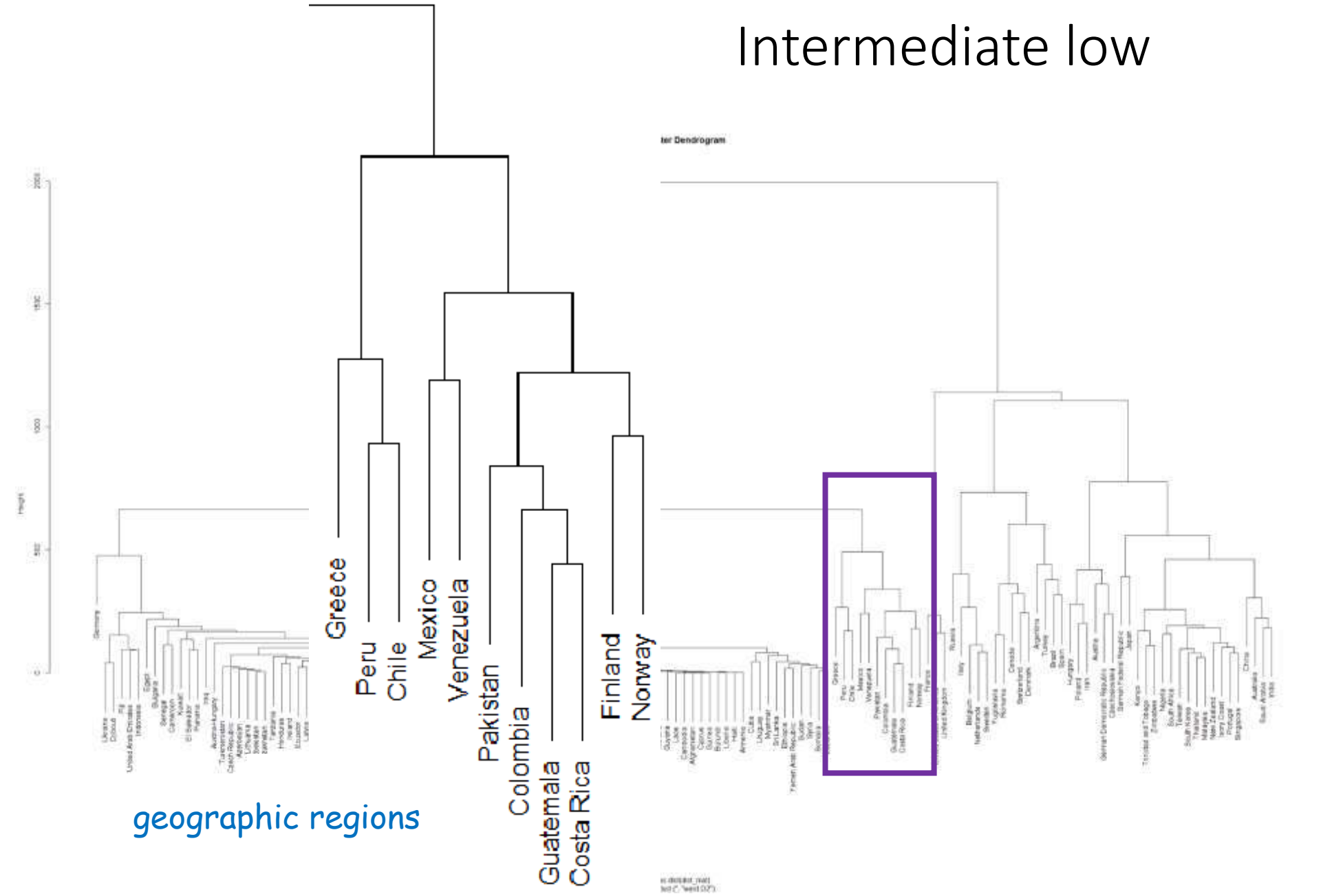


Countries with extreme low imports

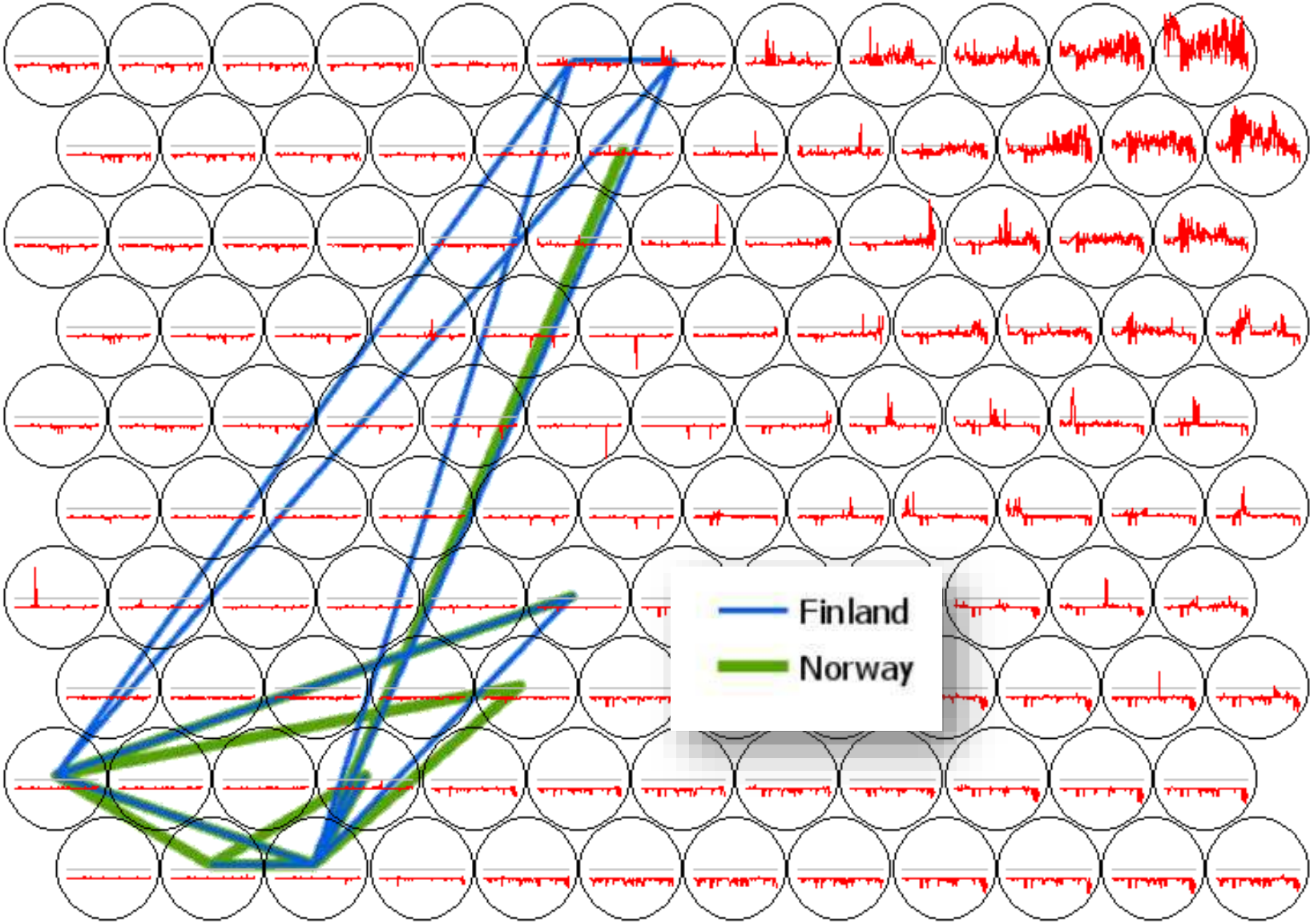


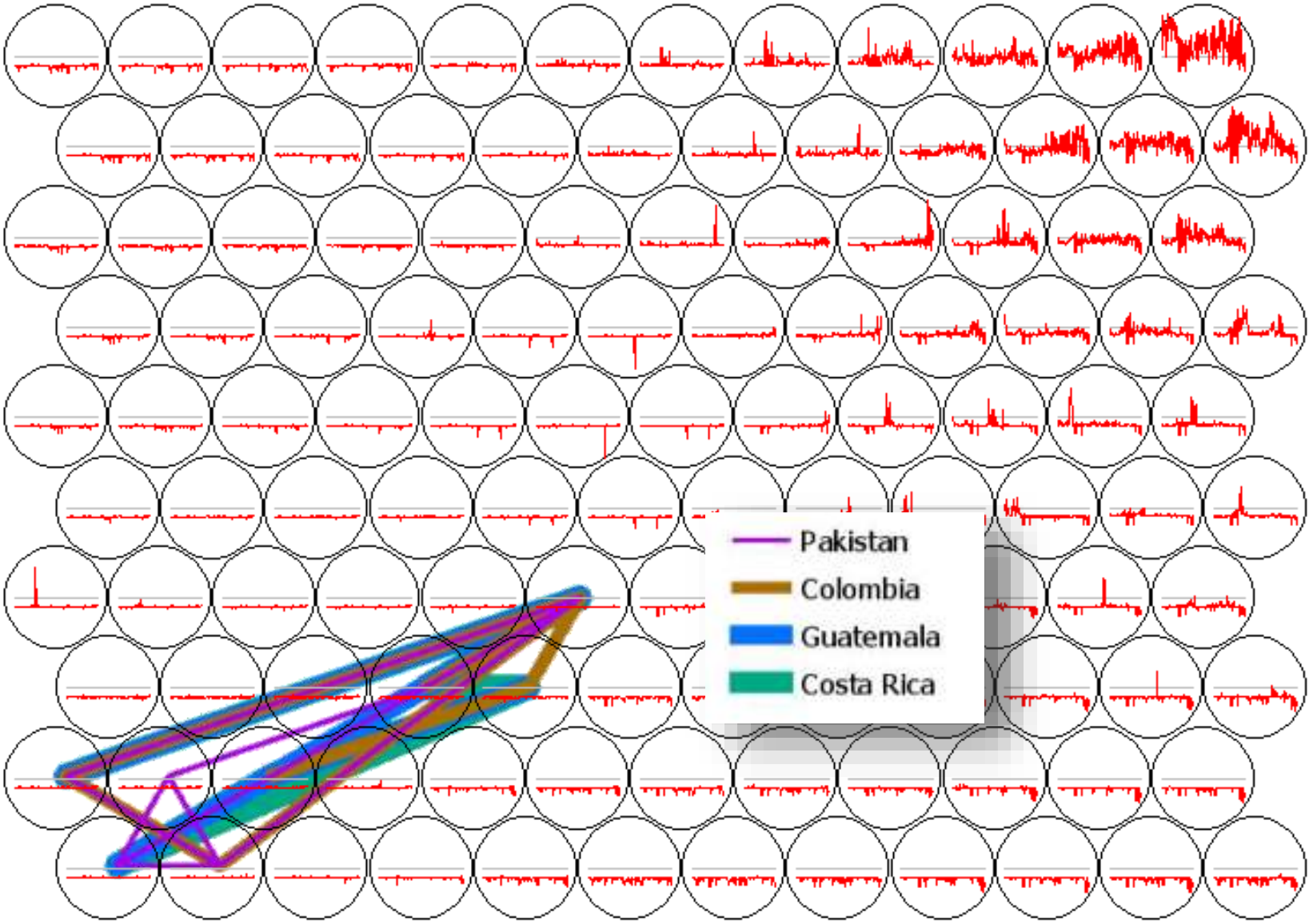
geographic regions

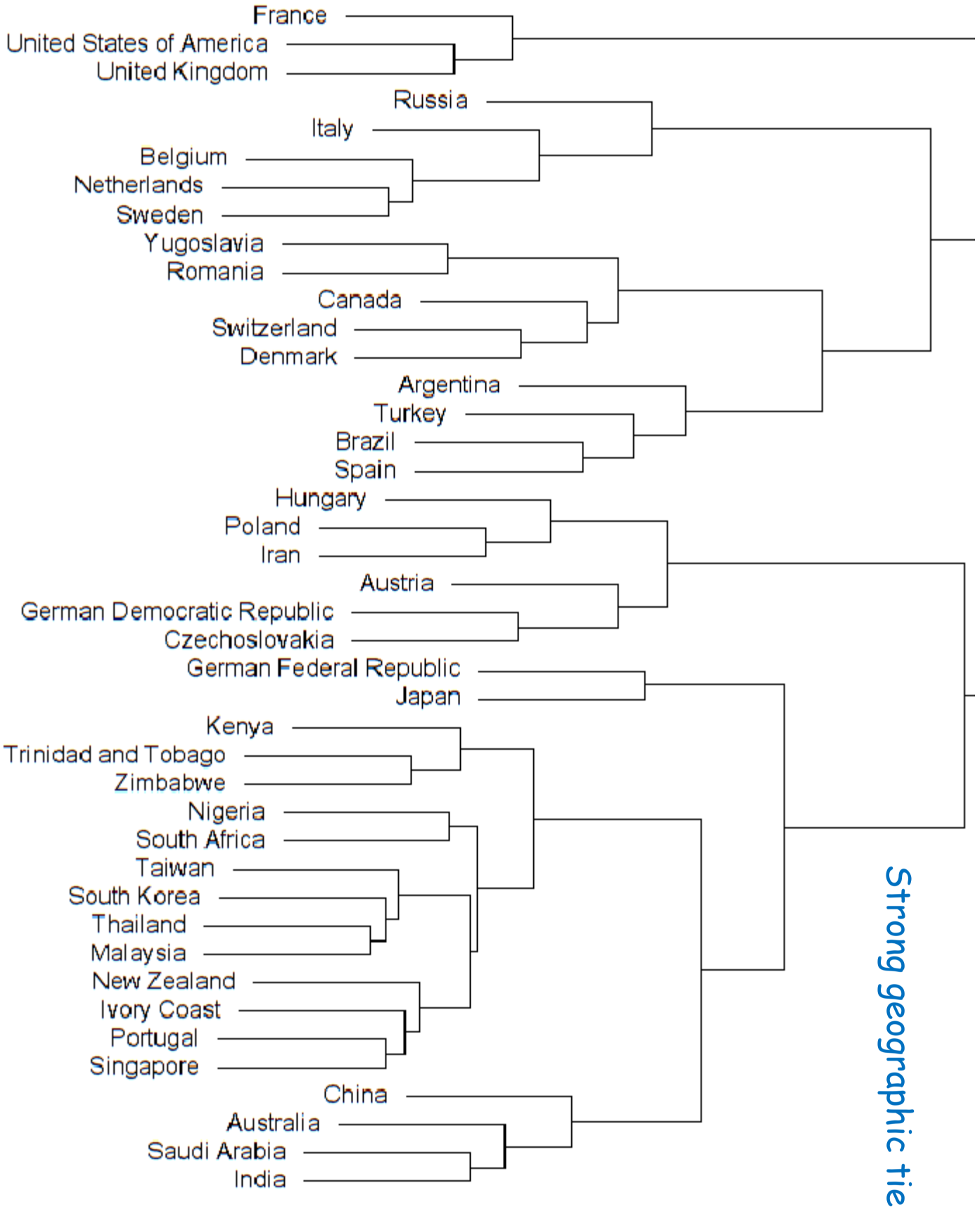
Intermediate low



geographic regions


Finland
Norway


Pakistan
Colombia
Guatemala
Costa Rica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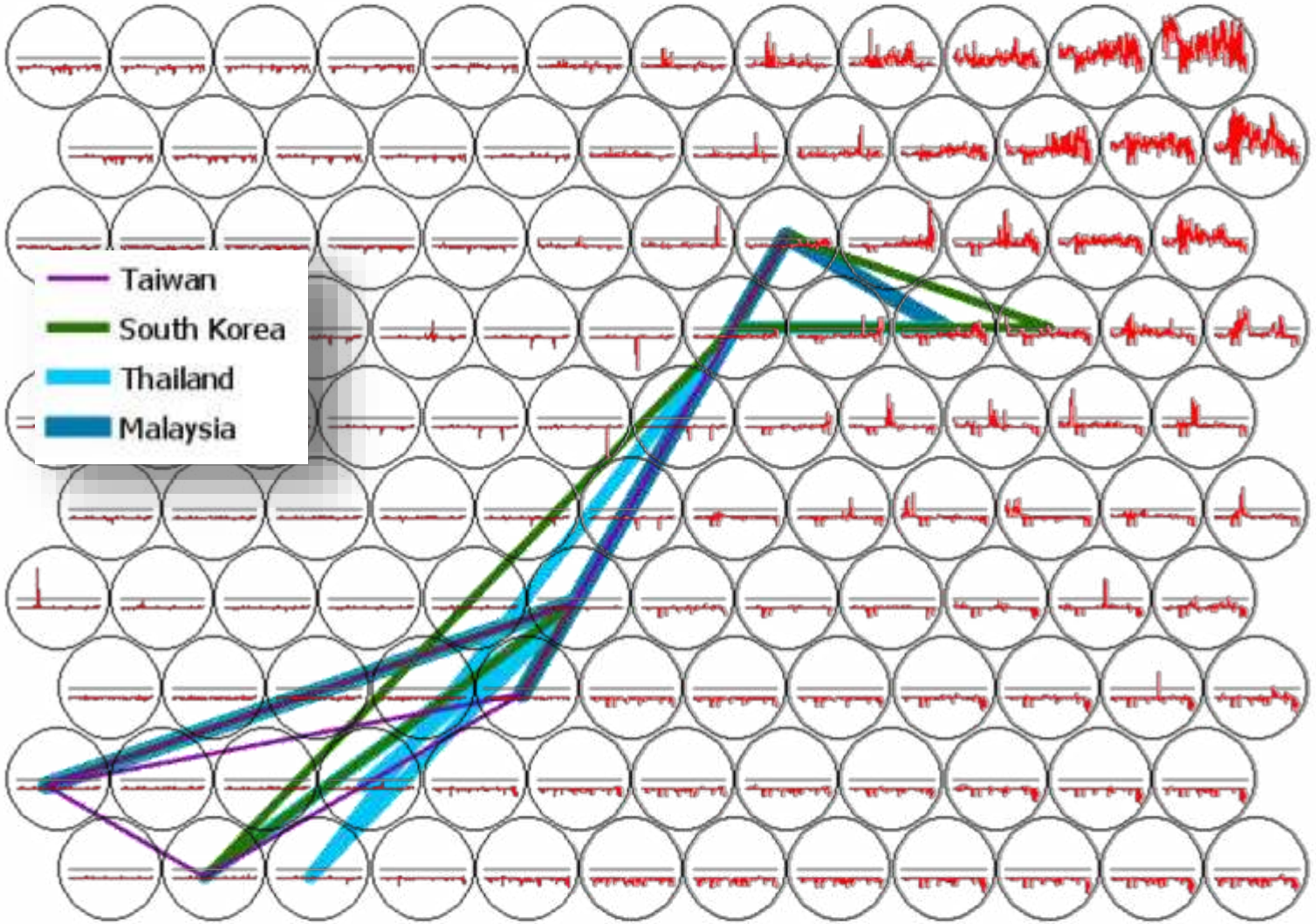
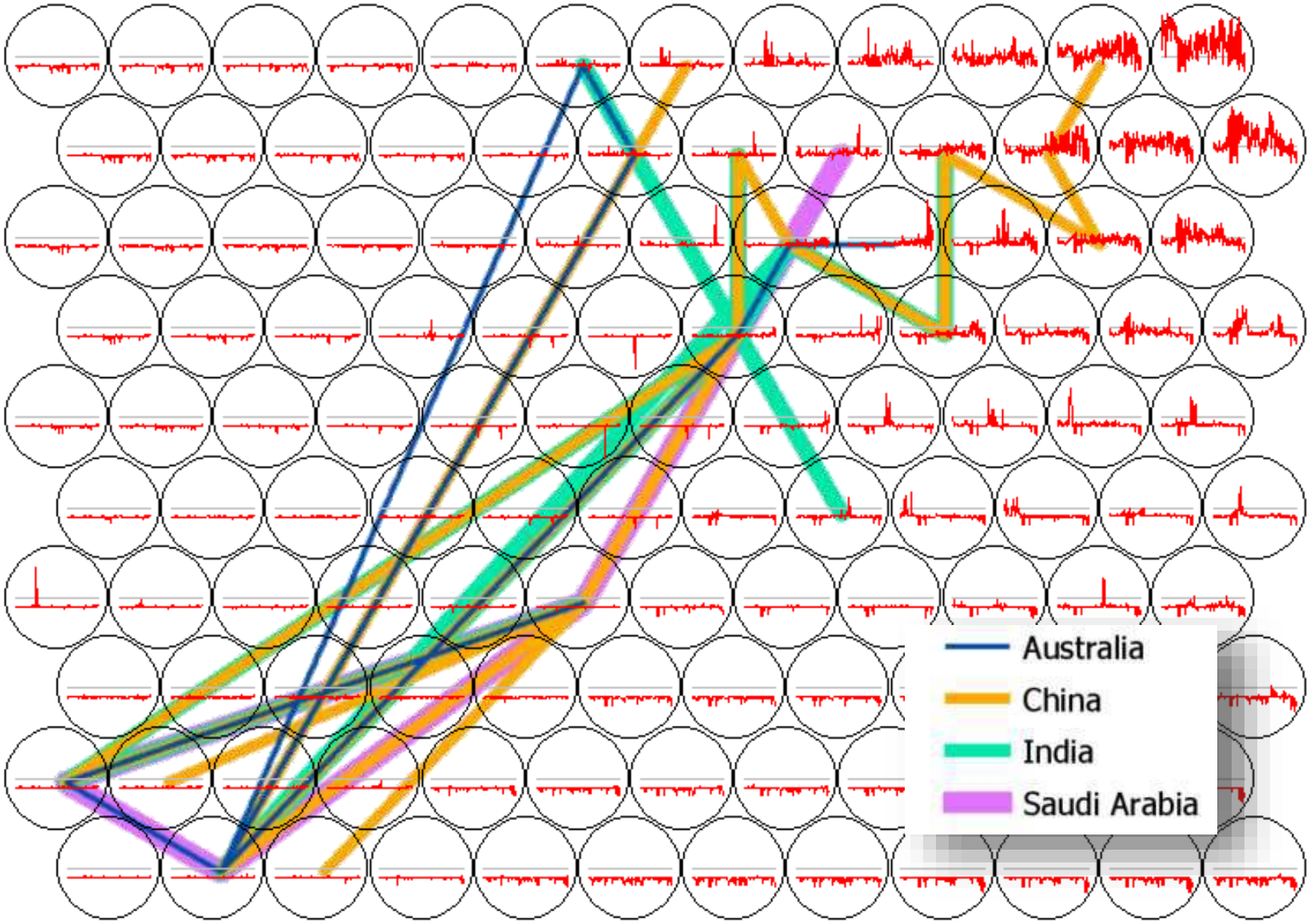
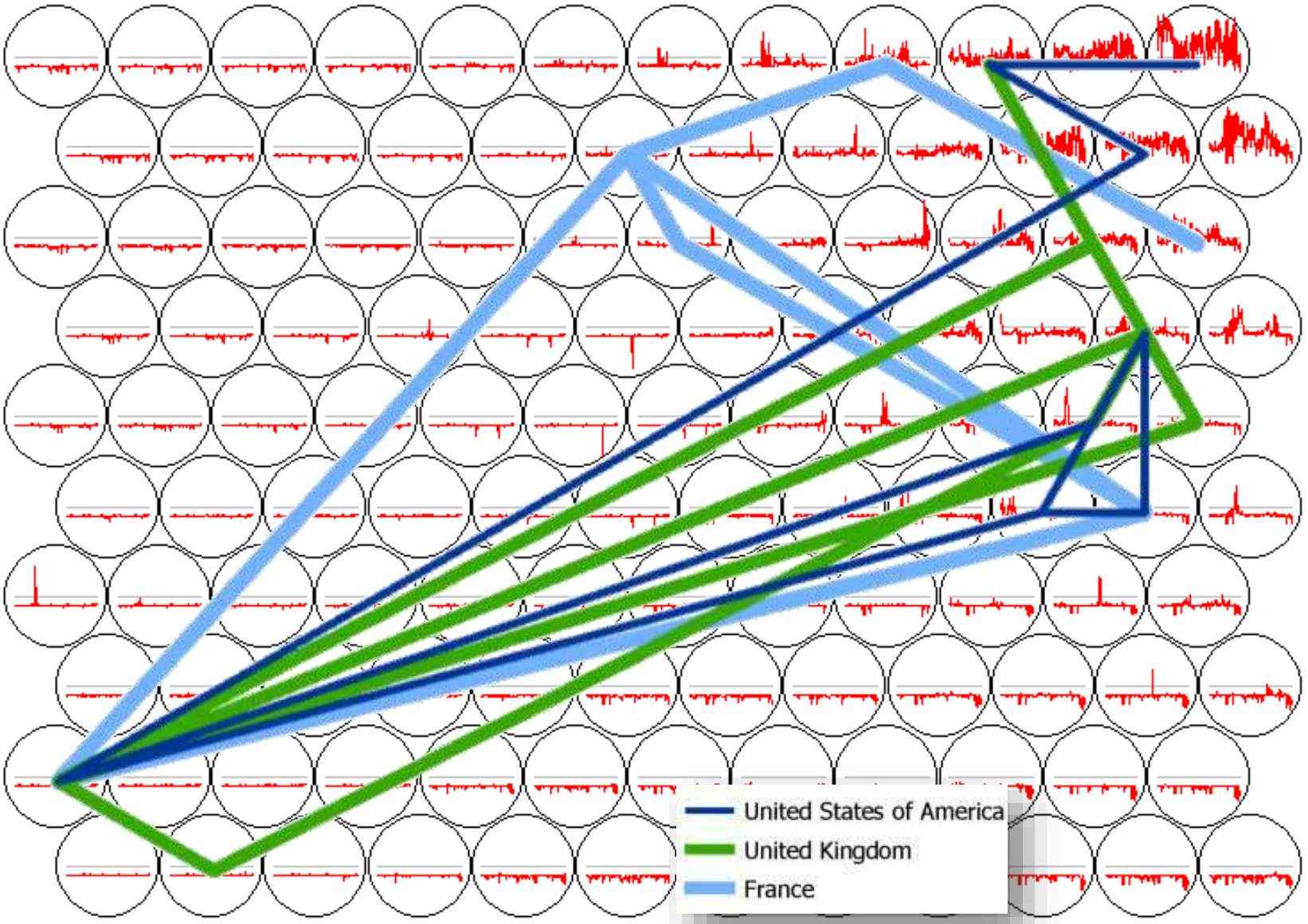
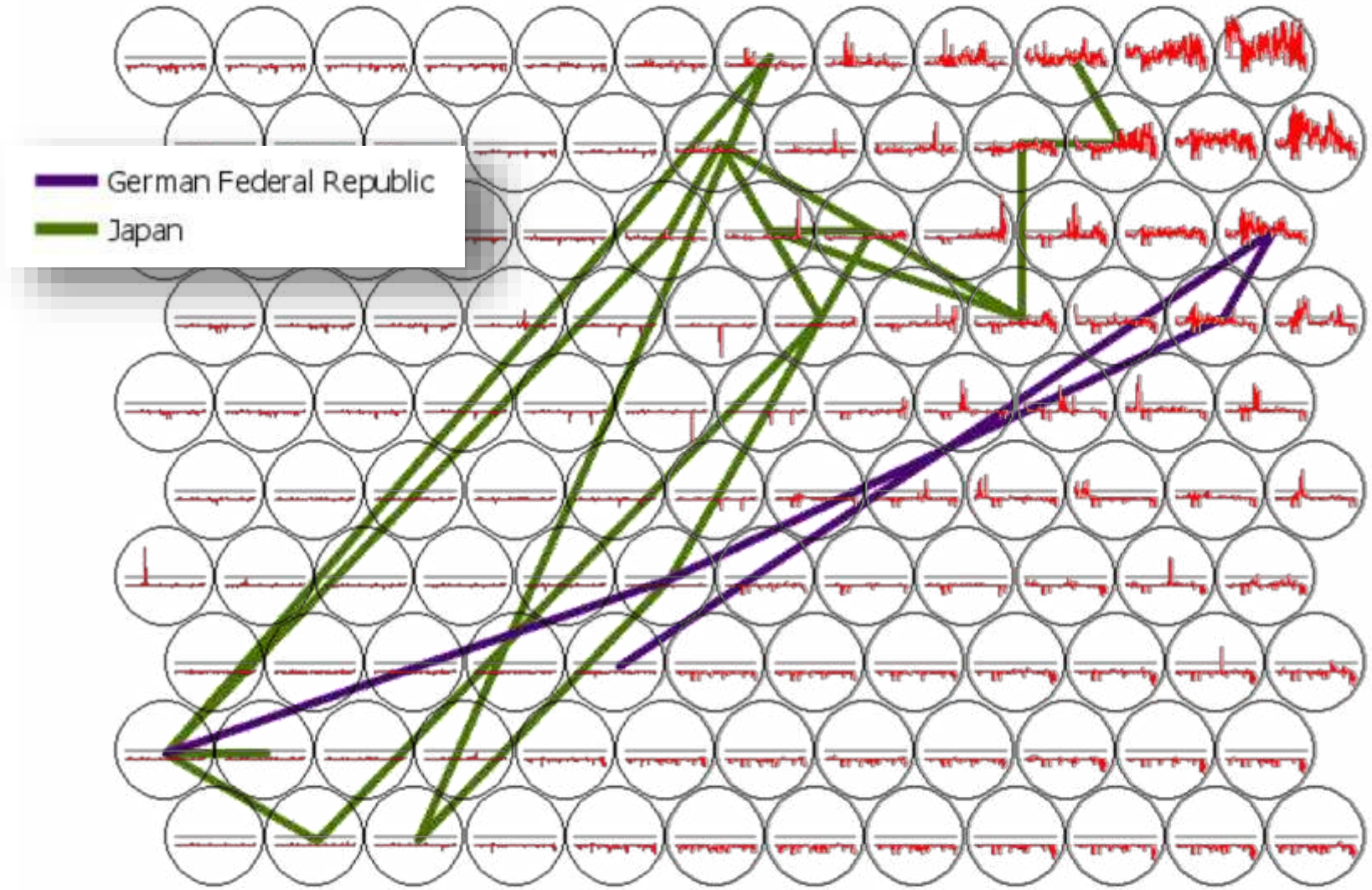
United Kingdom
Russia
Italy
Belgium
Netherlands
Sweden
Yugoslavia
Romania
Canada
Switzerland
Denmark
Argentina
Turkey
Brazil
Spain
Hungary
Poland
Iran
Austria
German Democratic Republic
Czechoslovakia
German Federal Republic
Japan
Kenya
Trinidad and Tobago
Zimbabwe
Nigeria
South Africa
Taiwan
South Korea
Thailand
Malaysia
New Zealand
Ivory Coast
Portugal
Singapore
China
Australia
Saudi Arabia
India
Strong geographic tie


Taiwan
South Korea
Thailand
Malaysia


Australia
China
India
Saudi Arabia


United States of America
United Kingdom
France


German Federal Republic
Japan

Concluding Remarks

- This presentation highlights the alternative two approaches to mapping of human dynamics
  - Mapping in a cartographic framework – a geographic space
  - Mapping in a semantical framework – a non-geographic space
- Use the example of international trades (imports) in 1900 to 2009.
- 65 out of 205 countries remained extremely low imports from all other countries during this period. These countries are small in terms of size or population, or are located in marginal lands (boundaries between major geographic regions).
- The rest 140 countries suggest four tendency in on their trajectories of import patterns over time.
  1. More than 50% countries stay in low imports throughout the period.
  2. Countries moved to active imports in ways that show geographic and historical effects on their trajectories.
  3. Geographical: more similar trajectories among countries in geographical regions
  4. Historical: USA/UK/France, Japan/West Germany
- A non-geographic space may provide a richer framework to elicit latent space-time patterns and semantics.

Thank You

We welcome your questions and comments.

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