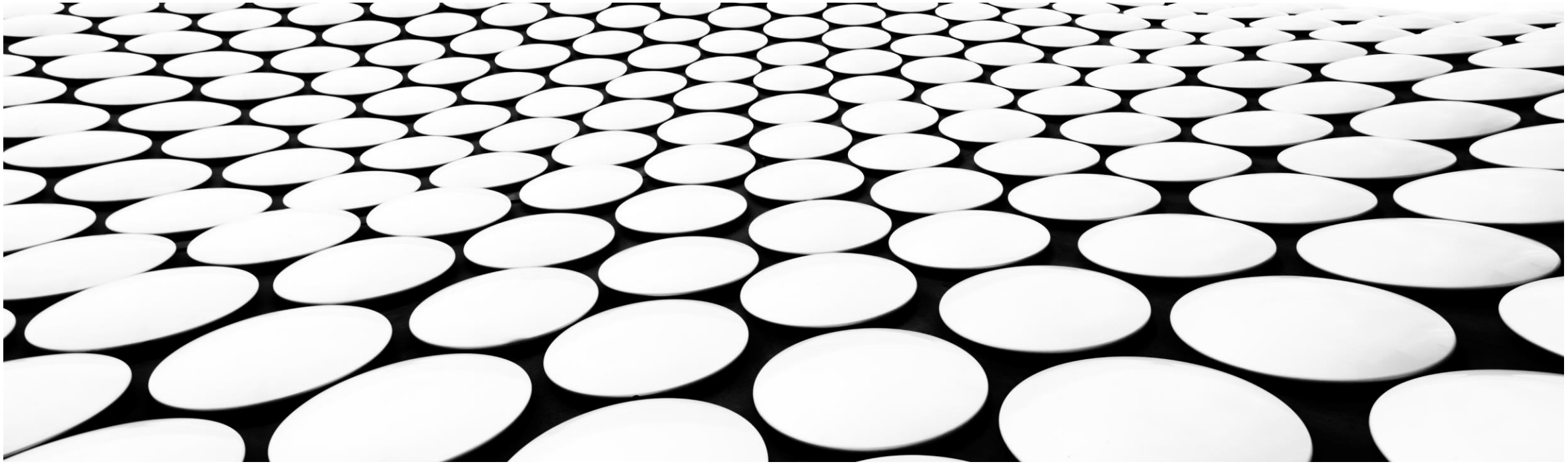
ASSIGNMENT 3: NETWORK ANALYSIS AND GLOBAL SUPPLY CHAIN

EE406: CONTEMPORARY ECONOMIC ISSUES (SEMESTER 1/2021)



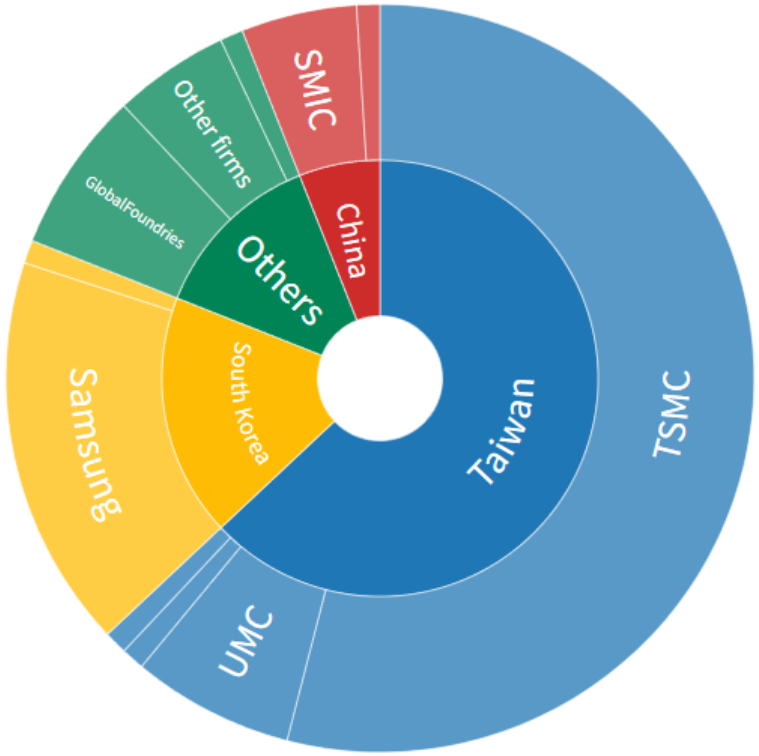
BACKGROUND AND MOTIVATION

- Taiwan's outsized role in chipmaking has come under the spotlight as a global shortage of semiconductors forced several automakers to halt production.
- Countries including the U.S. and Germany reached out to Taiwan to help alleviate bottlenecks in the production of chips.
- Taiwan dominates the foundry market, or the outsourcing of semiconductor manufacturing.
- Its contract manufacturers together accounted for more than 60% of total global foundry revenue last year, according to data by Taipei-based research firm TrendForce.
- Much of Taiwan's dominance can be attributed to Taiwan Semiconductor Manufacturing Co or TSMC, the world's largest foundry that counts major technology firms such as Apple, Qualcomm and Nvidia as its clients.
- TSMC accounted for 54% of total foundry revenue globally last year, TrendForce data showed.

Source: https://www.cnbc.com/2021/03/16/2-charts-show-how-much-the-world-depends-on-taiwan-for-semiconductors.html

Semiconductor contract manufacturers by market share

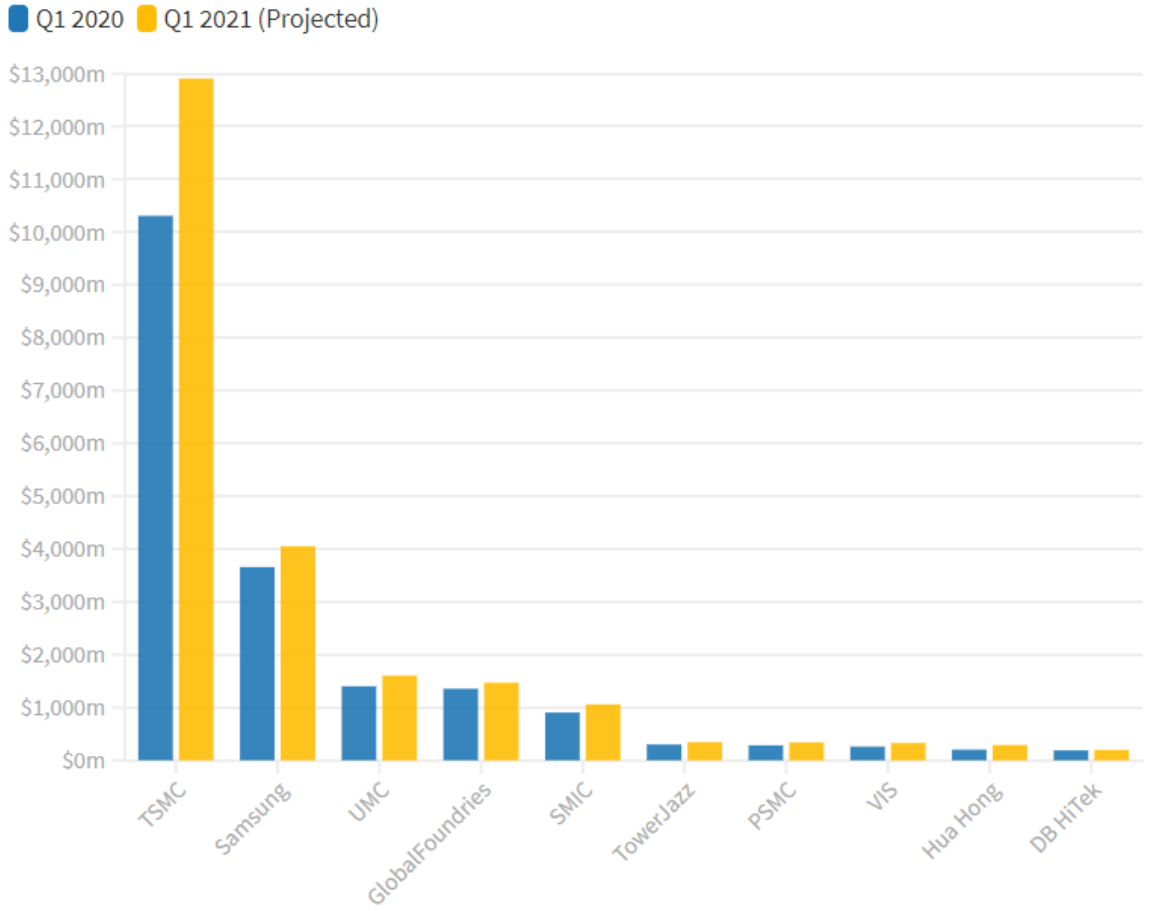
Total foundry revenue stood at $85.13 billion in 2020



SOURCE: TrendForce (March 2021)

CNBC

Top semiconductor foundries by revenue



SOURCE: TrendForce (February 2021)

CNBC

Source: https://www.cnbc.com/2021/03/16/2-charts-show-how-much-the-world-depends-on-taiwan-for-semiconductors.html

BACKGROUND AND MOTIVATION (CONT'D)

- Semiconductor designers and manufacturers are on a quest to make chips smaller and better.
- Currently, TSMC and its South Korean rival Samsung are the only foundries capable of manufacturing the most advanced 5-nanometer chips.

China playing catch up

- Some countries are planning to boost their own semiconductor production — and one of them is China, which is aiming to be more self-reliant.
- But China's tech fight with the previous U.S. administration is holding back its largest chipmaker Semiconductor Manufacturing International Corporation, or SMIC, said Paul Triolo, geo-technology practice head at risk consultancy Eurasia Group.
- In 2020, the Trump administration placed SMIC on a blacklist known as the entity list, which limits the company's access to technology and machinery that it needs.
- SMIC was the fifth largest semiconductor foundry globally by revenue in 2020 — behind Taiwan's TSMC and UMC, South Korea's Samsung, and GlobalFoundries in the U.S., TrendForce data showed.
- "The target right now is being able to compete at the cutting edge with companies like TSMC, Samsung and Intel," Triolo told CNBC's "Squawk Box Asia."

Source: https://www.cnbc.com/2021/03/16/2-charts-show-how-much-the-world-depends-on-taiwan-for-semiconductors.html

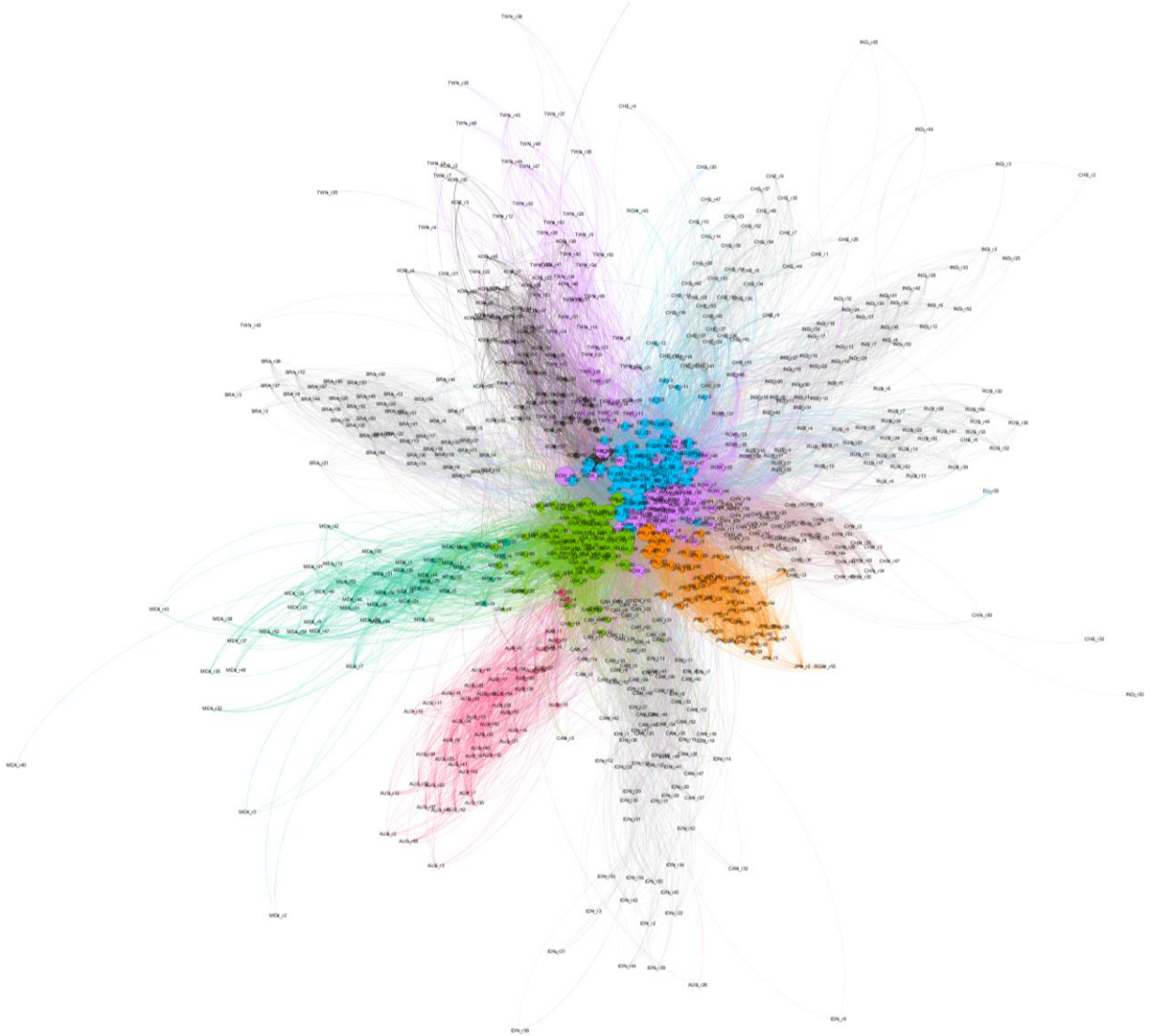
WORLD INPUT-OUTPUT TABLE AND NETWORK ANALYSIS

- The technique of Network Analysis can be applied to World Input-Output table, enabling the comprehensive insight on the structure of international trade.
- Specifically, this quantitative analysis yields four sets of outcomes.
  - (1) Network diagram (i.e. network graph)
    - A diagram showing a complete set of connectivity of global trade and global supply chains
  - (2) Network indicators (overall characteristics of a particular network)
    - Average Degree
    - Average Weighted Degree
    - Network Diameter
    - Graph Density
    - Modularity
    - Avg. Clustering Coefficient
    - Avg. Path Length
  - (3) Centrality indices
    - Closeness centrality
    - Eigen-vector centrality
  - (4) Subnetworks (i.e. modularity)
- In this assignment, World Input-Output tables (2000 – 2014) have been obtained from www.wiod.org .

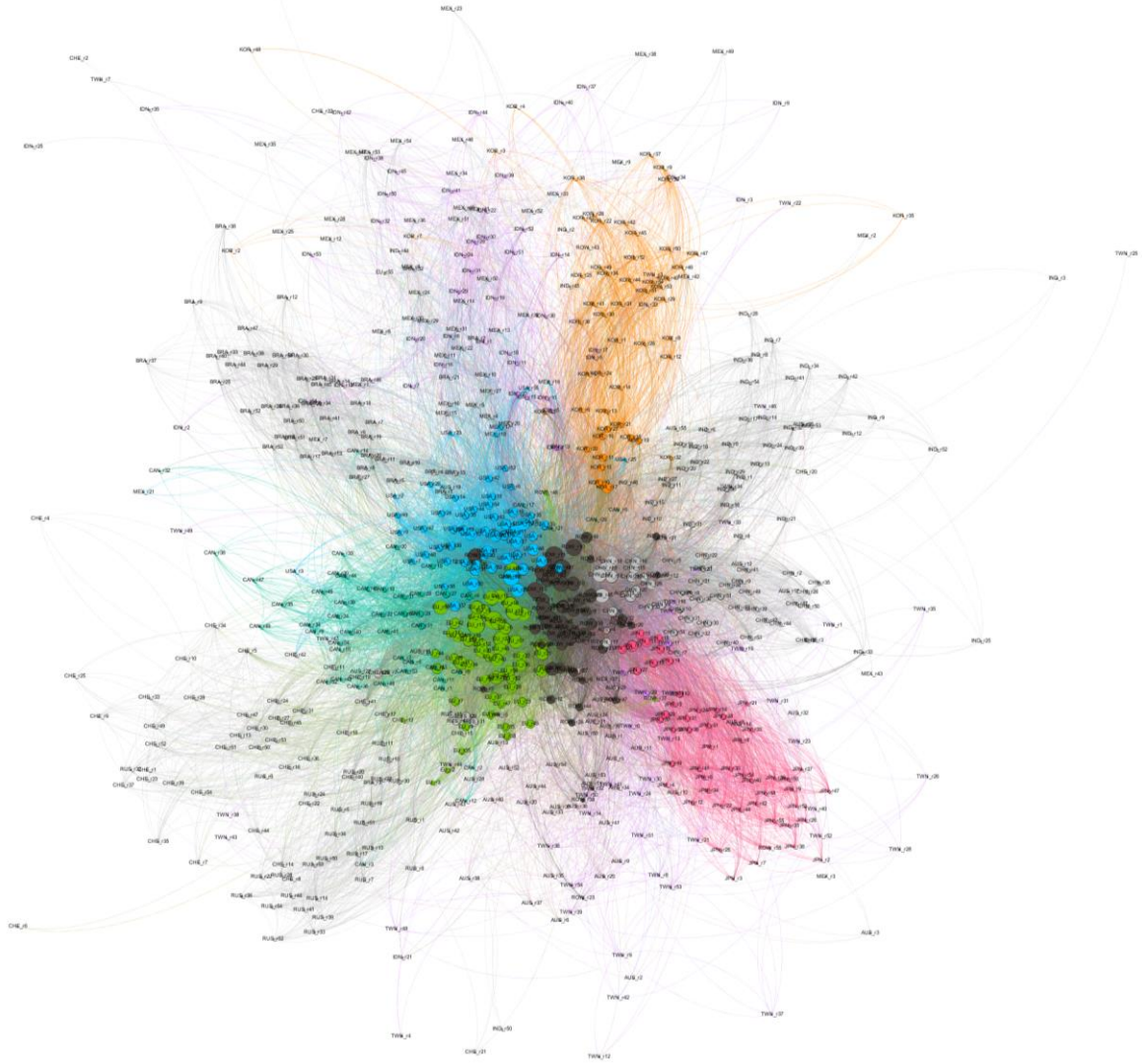
1	A01	Crop and animal production, hunting and related service activities
2	A02	Forestry and logging
3	A03	Fishing and aquaculture
4	B	Mining and quarrying
5	C10-C12	Manufacture of food products, beverages and tobacco products
6	C13-C15	Manufacture of textiles, wearing apparel and leather products
7	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
8	C17	Manufacture of paper and paper products
9	C18	Printing and reproduction of recorded media
10	C19	Manufacture of coke and refined petroleum products
11	C20	Manufacture of chemicals and chemical products
12	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
13	C22	Manufacture of rubber and plastic products
14	C23	Manufacture of other non-metallic mineral products
15	C24	Manufacture of basic metals
16	C25	Manufacture of fabricated metal products, except machinery and equipment
17	**C26**	**Manufacture of computer, electronic and optical products**
18	C27	Manufacture of electrical equipment
19	C28	Manufacture of machinery and equipment n.e.c.
20	**C29**	**Manufacture of motor vehicles, trailers and semi-trailers**
21	C30	Manufacture of other transport equipment
22	C31_C32	Manufacture of furniture; other manufacturing
23	C33	Repair and installation of machinery and equipment
24	D35	Electricity, gas, steam and air conditioning supply
25	E36	Water collection, treatment and supply
26	E37-E39	Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services
27	F	Construction
28	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles

29	G46	Wholesale trade, except of motor vehicles and motorcycles
30	G47	Retail trade, except of motor vehicles and motorcycles
31	H49	Land transport and transport via pipelines
32	H50	Water transport
33	H51	Air transport
34	H52	Warehousing and support activities for transportation
35	H53	Postal and courier activities
36	I	Accommodation and food service activities
37	J58	Publishing activities
38	J59_J60	Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities
39	J61	Telecommunications
40	J62_J63	Computer programming, consultancy and related activities; information service activities
41	K64	Financial service activities, except insurance and pension funding
42	K65	Insurance, reinsurance and pension funding, except compulsory social security
43	K66	Activities auxiliary to financial services and insurance activities
44	L68	Real estate activities
45	M69_M70	Legal and accounting activities; activities of head offices; management consultancy activities
46	M71	Architectural and engineering activities; technical testing and analysis
47	M72	Scientific research and development
48	M73	Advertising and market research
49	M74_M75	Other professional, scientific and technical activities; veterinary activities
50	N	Administrative and support service activities
51	O84	Public administration and defence; compulsory social security
52	P85	Education
53	Q	Human health and social work activities
54	R_S	Other service activities
55	T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
56	U	Activities of extraterritorial organizations and bodies

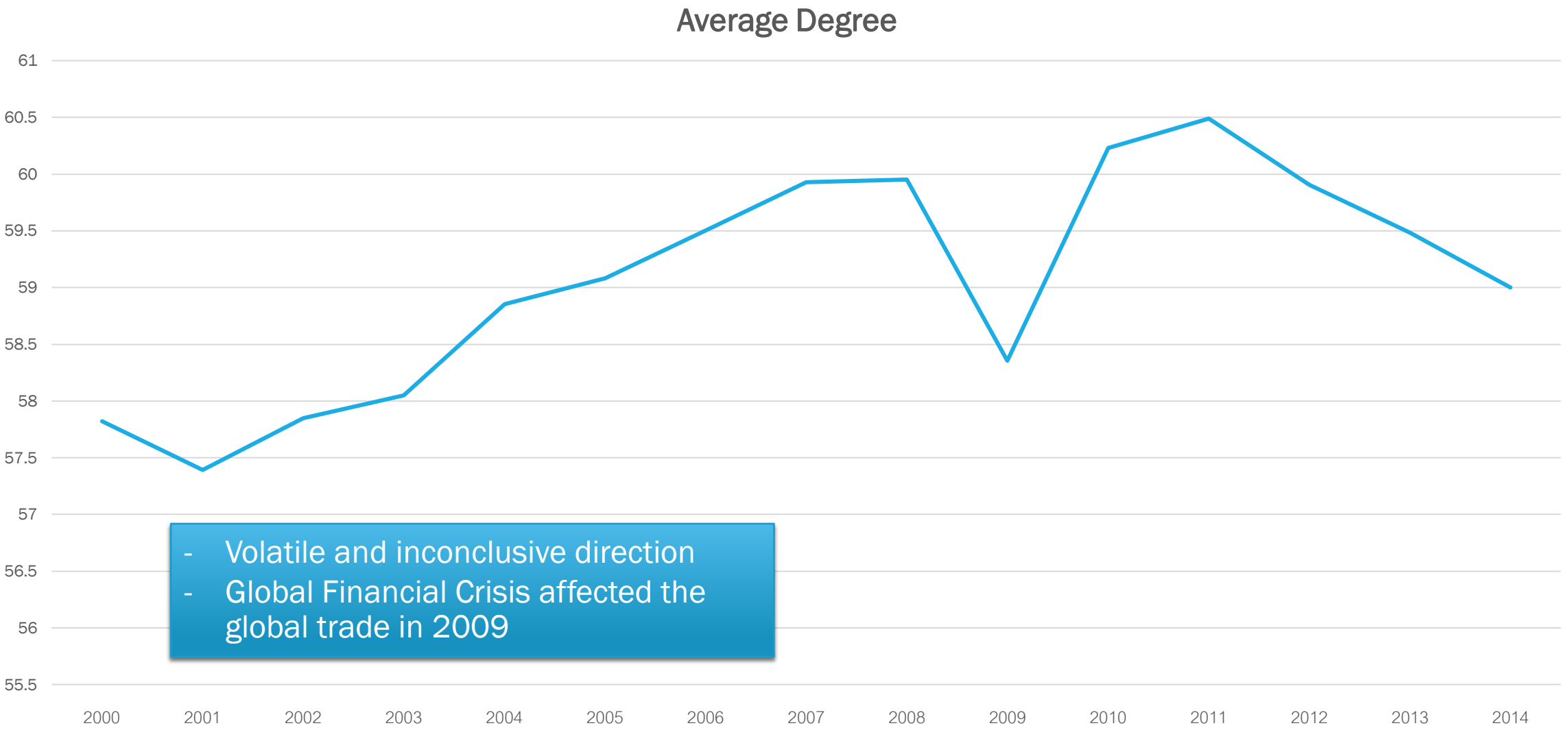
Network Diagram: 2000



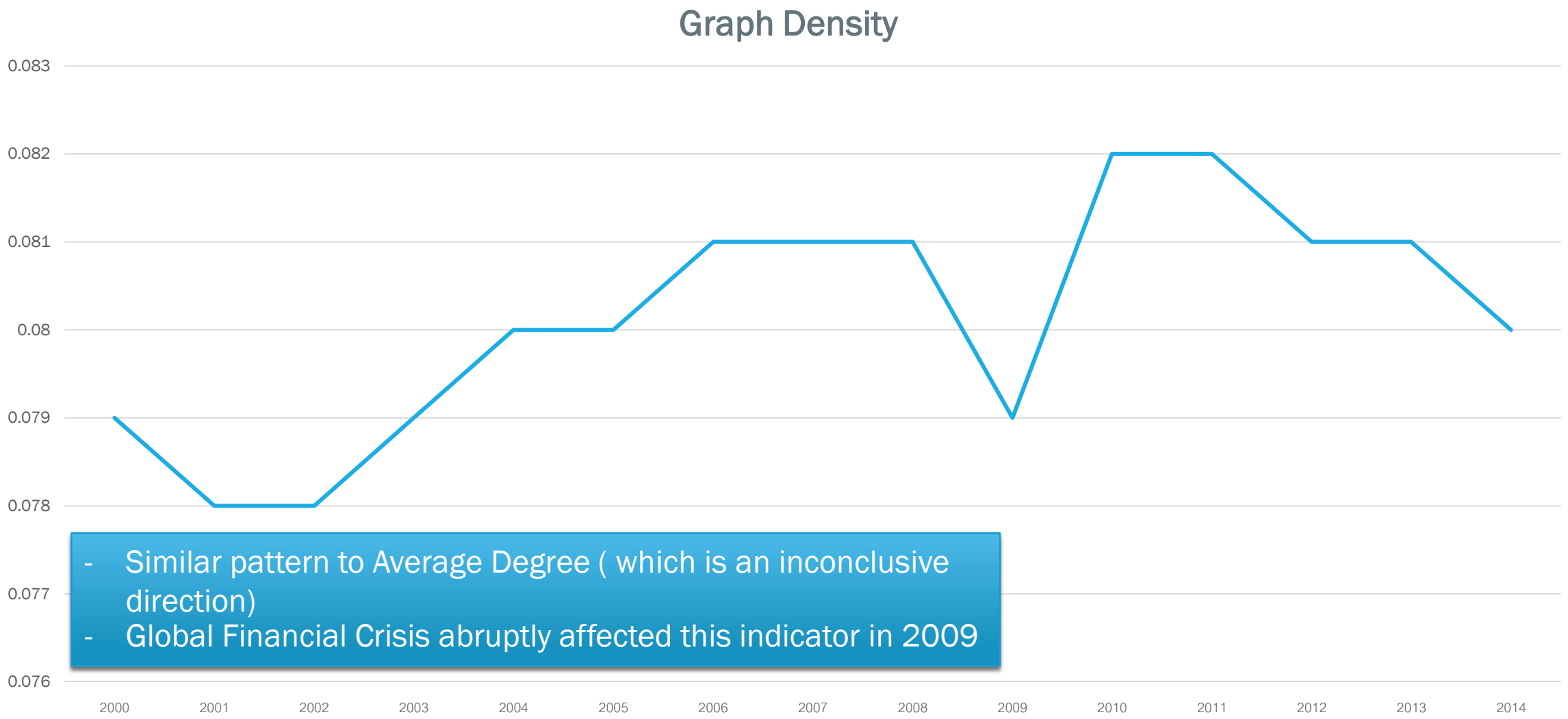
Network Diagram: 2009



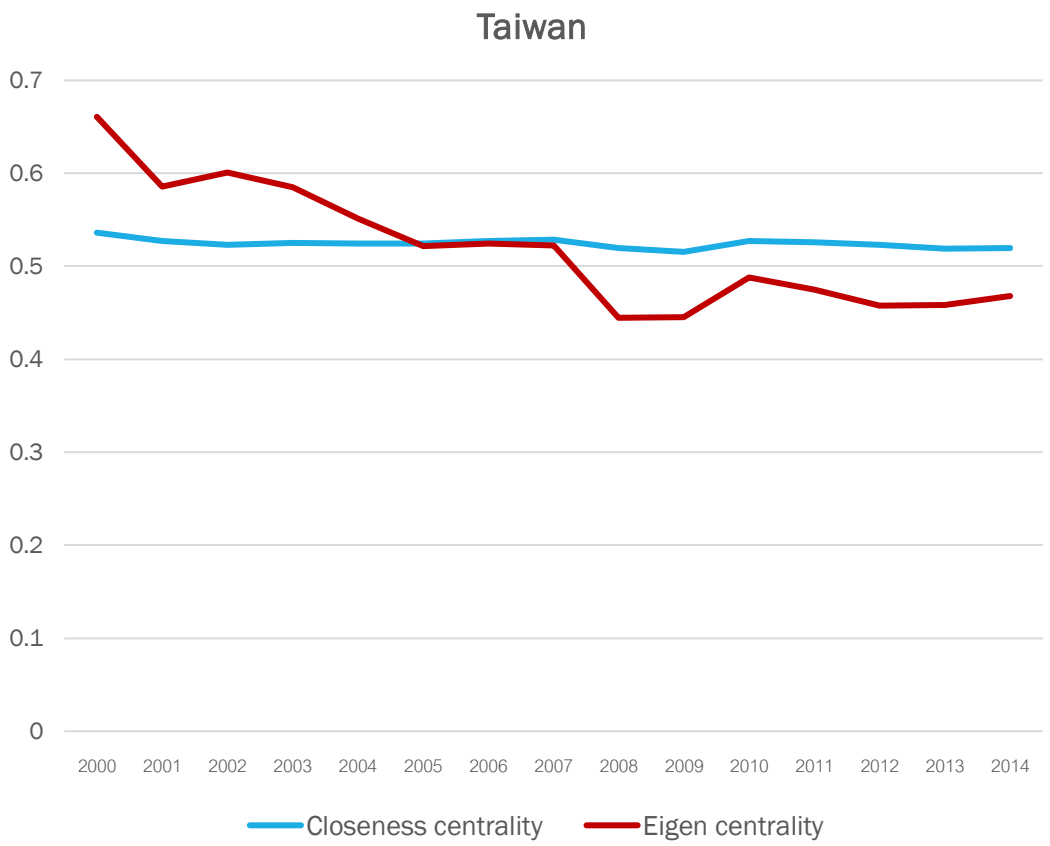
NETWORK INDICATORS

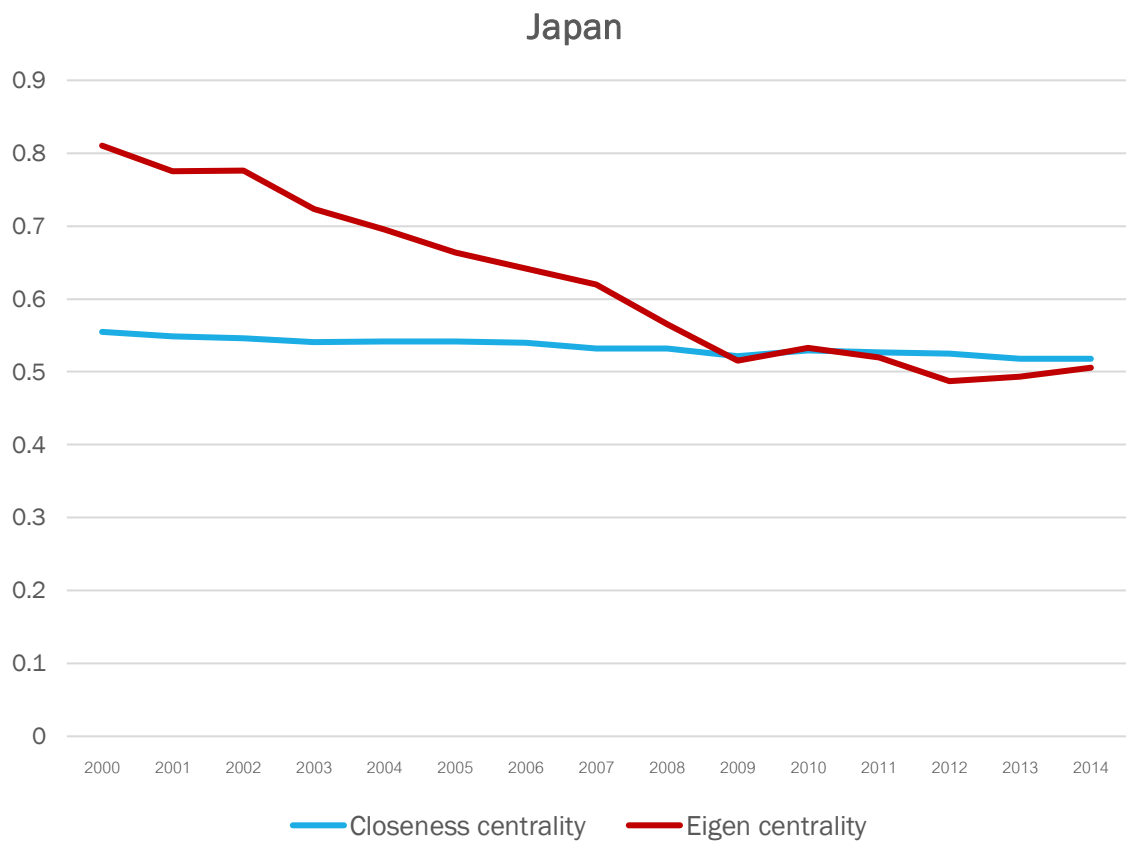


NETWORK INDICATORS



CENTRALITY INDICATORS (ELECTRONIC INDUSTRY)





MAIN TASKS

TASK #1: Comparison of main network indicators

- By applying World IO table of 2000-2014 to Gephi, please analyze the evolution of the following network indicators
  - Average Degree
  - Average Weighted Degree
  - Network Diameter
  - Graph Density
  - Modularity
  - Avg. Clustering Coefficient
  - Avg. Path Length

TASK #2: Comparison of centrality indices of electronic industry (sector no.17)

- By applying World IO table of 2000-2014 to Gephi, please compare the trends of **Closeness centrality** and **Eigen-vector centrality** indices of
  - China
  - Korea
  - Japan
  - Taiwan
- For both countries, are both indicators moving in the same direction? What is the policy implication of this result?

MAIN TASKS (CONT'D)

TASK #3: Comparison of centrality indices of automotive industry (sector no.20)

- By applying World IO table of 2000-2014 to Gephi, please compare the trends of **Closeness centrality** and **Eigen-vector centrality** indices of
  - EU
  - USA
  - Japan
  - Korea
- For each country, are both indicators moving in the same direction? What is the policy implication of this result?

- Additional analyses using other indicators and methods are very welcome.

Presentation Dates: October 27 & 29, 2021

- PowerPoint: the format of consulting company (PowerPoint with texts and graphs/diagrams)
- Submit the presentation file in the submission box on Moodle (by October 26, 2021 (11.00pm)).
- Presentation session : 12 minutes
- Q & A session : 3-5 minutes
- Sequence of presentation : from draw

- Length of presentation: 12-15 pages
- Structure of presentation

Part 1 – Introduction and project's background

Part 2 – Sources of data

Part 3 – Briefs of analytical methodologies

Part 4 – Results

- Task #1 (comparison of network diagrams of 2000, 2009, 2014 and main network indicators)
- Task #2 (comparative analysis of main electronic exporters using centrality indices)
- Task #3 (comparative analysis of main automotive exporters using centrality indices)
- Other related tools and data are welcome

Part 5 – Policy recommendations (for example, future expansion, strategic adjustment, etc.)

GRADING CRITERIA

- **Quality of report (60%)**

  - appropriate methodologies (20%)

  - critical reasoning in result analysis and policy recommendation (20%)

  - format of PowerPoint (comprehensive graphical communication and concise text explanation) (10%)

  - on-time submission (10%)

- **Quality of presentation (40%)**

  - convincing verbal explanation (20%)

  - comprehensive Q&A (20%)