

Page Rank analysis under trade war

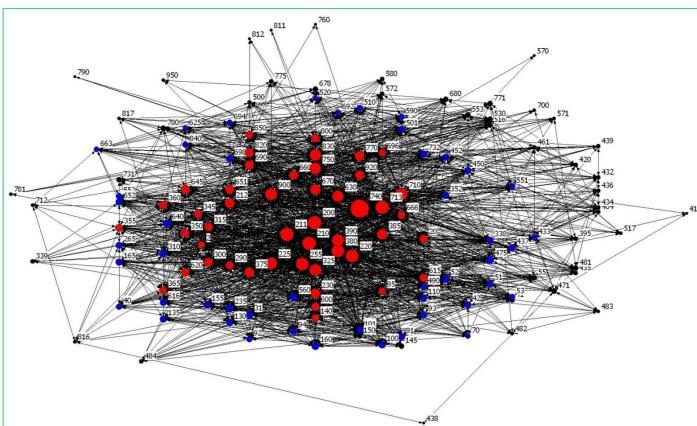
International Trade with Network PageRank and choice

2019.06.03

Current Trade Analysis

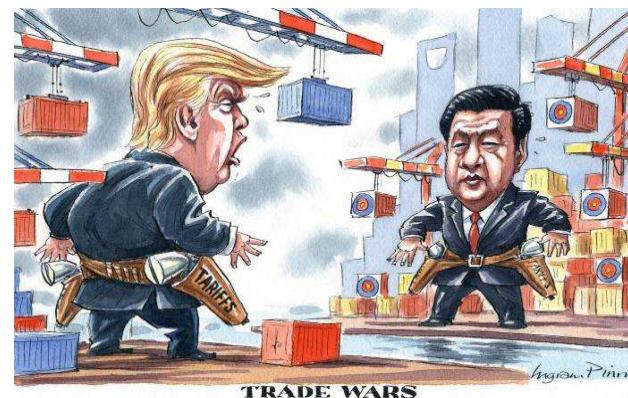
International trade today shows complex structure, shifting dynamics and unexpected external factors

Complex Trade network's characteristics
Trade dynamics are changing rapidly.



Arrows represent trade at level of 0.0001 of the focal (row) state's GDP
Color of circles represent degree centrality level:

Also external factors such as trade war adds more complexity to current situation.



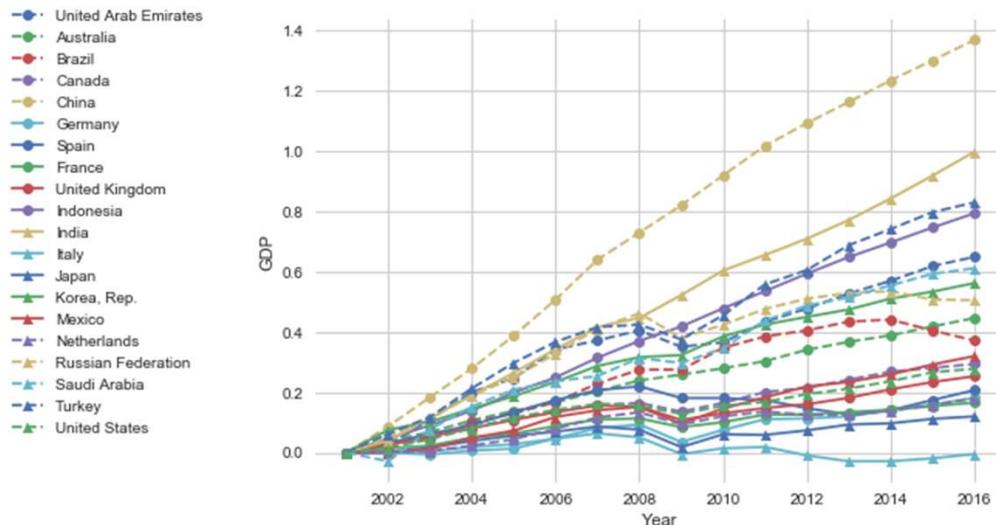
We want to measure quantitative impacts of such movements, with given weighted network

Right) Maoz, Zeev. (2012). Preferential Attachment, Homophily, and the Structure of International Networks, 1816–2003. Conflict Management and Peace Science
Left) Financial Times

Follow up research topic

Service also consists of huge portion of GDP, but not explicit relationship with economic growth as manufacturing

$$\text{GDP} = \text{Manufacturing} + \text{Service}$$



- Most of countries which shows strong service industry have developed economic structure such as US, UK, France. But some countries such as Japan shows strong manufacturing industry back ground.
- Service industry employment induction coefficient differ from Manufacturing's one.
- Need to adjust parameter in our manufacturing industry-based trade network to derive relationship.

Methodology(Page Rank and Similarity)

Change of each countries' Page Rank can give insight of global trade power movements along time.

Page Rank definition

$$PR(p_i) = \frac{1-d}{N} + d \sum_{p_j \in M(p_i)} \frac{PR(p_j)}{L(p_j)}$$

$$\mathbf{R}(t+1) = d\mathcal{M}\mathbf{R}(t) + \frac{1-d}{N} \mathbf{1}, (*)$$

$$\mathcal{M}_{ij} = \begin{cases} 1/L(p_j), & \text{if } j \text{ links to } i \\ 0, & \text{otherwise} \end{cases}$$

Data Source

Data :

GDP top 20 countries
trade inflow and outflow.

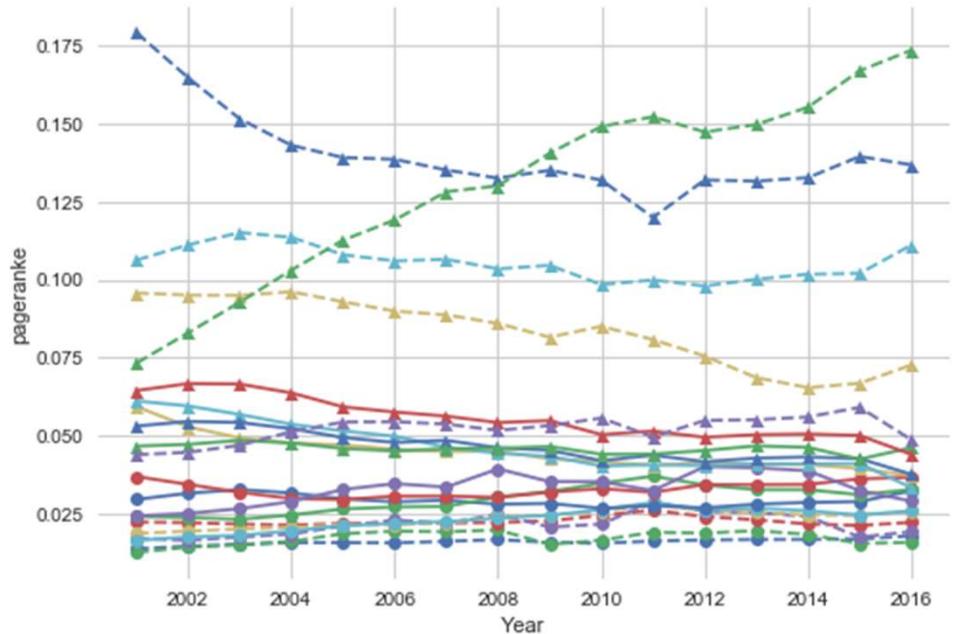
Source :

UN Comtrade Database

Time range :

2001 to 2016 annual data

- Turkey
- United Arab Emirates
- Indonesia
- Saudi Arabia
- Brazil
- India
- Spain
- Australia
- Mexico
- Russian Federation
- Canada
- United Kingdom
- Italy
- Netherlands
- France
- Rep. of Korea
- Japan
- Germany
- USA
- China



Connection with exchange rate

Marshall–Lerner condition shows traditional relationship btw balance of trade & exchange rate. Page rank can be applied

Price elasticity of demand

% change in qty % change in price > 1	elastic
% change in qty % change in price $= 1$	unit
% change in qty % change in price < 1	inelastic

Marshall Lerner Condition

The marshall Lerner condition states that devaluation of the exchange rate will eventually lead to net improvement in trade balance if **sum of price elasticity of export and import > 1**

Price elasticity
=
Influence

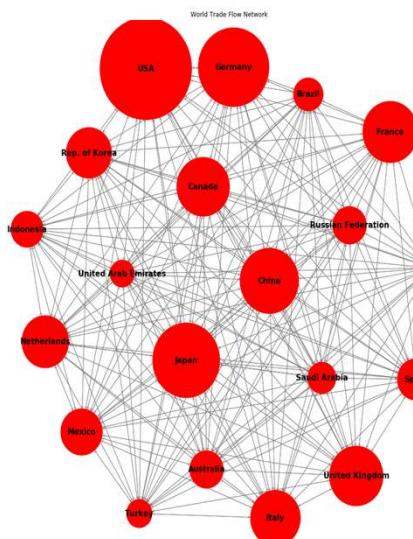
Exchange rate $\uparrow \rightarrow$ devaluation of local currency \rightarrow higher price for import \rightarrow lower price for export
Exchange rate $\downarrow \rightarrow$ devaluation of local currency \rightarrow higher price for import \rightarrow lower price for export

Import & export elasticity difference can be replace with page rank index

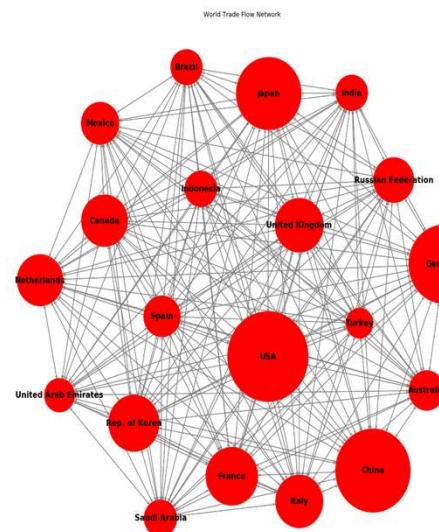
International Trade Network

World trade network shows great change along 2001 to 2016

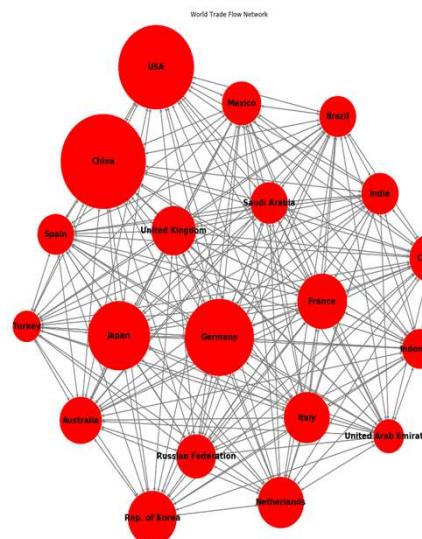
2001



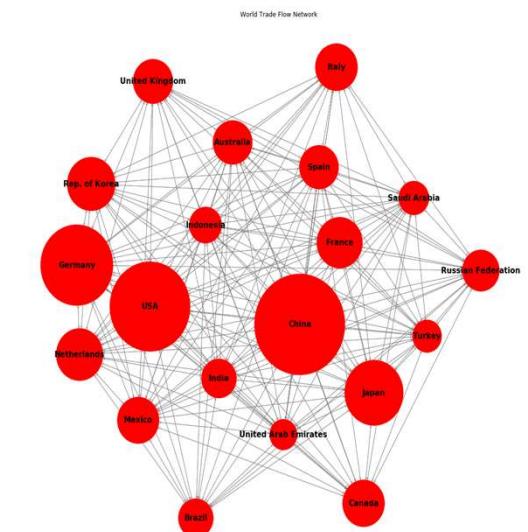
2006



2011



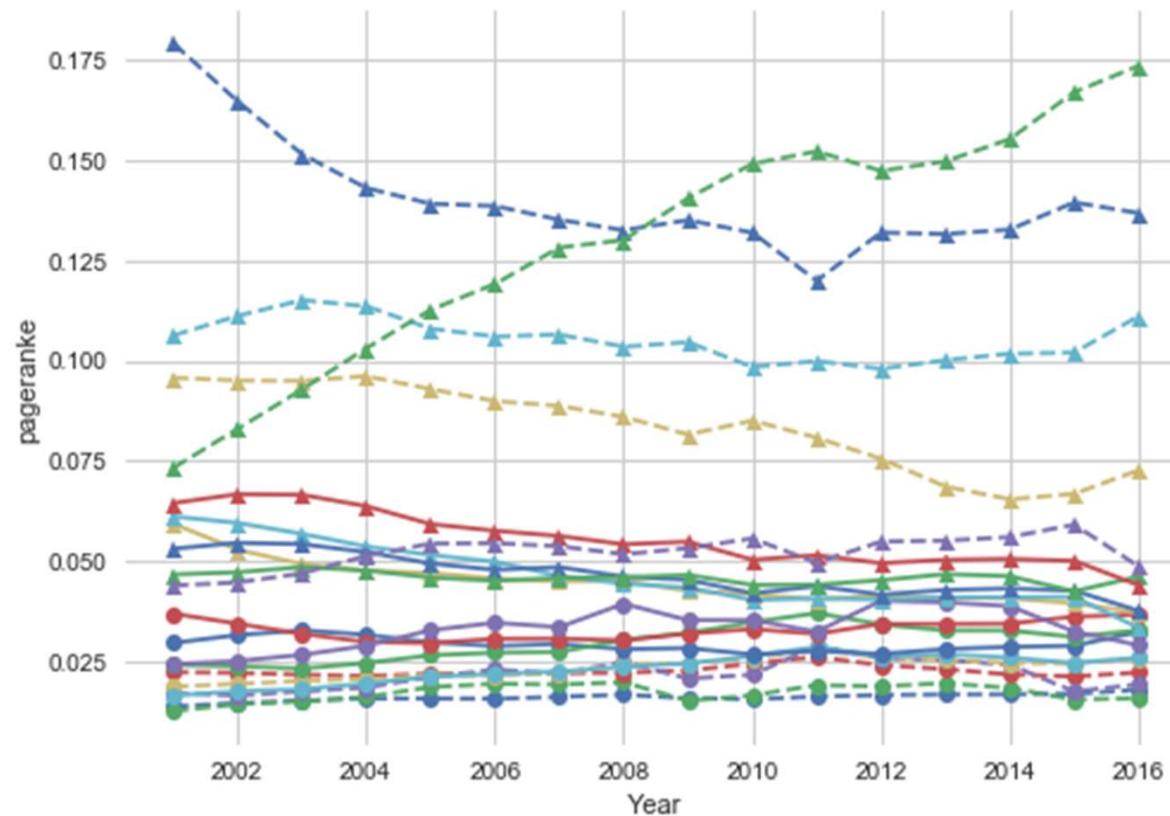
2016



Page Rank Analysis

Page rank of trade network can be shown as time series. And it gives comparison btw countries and time

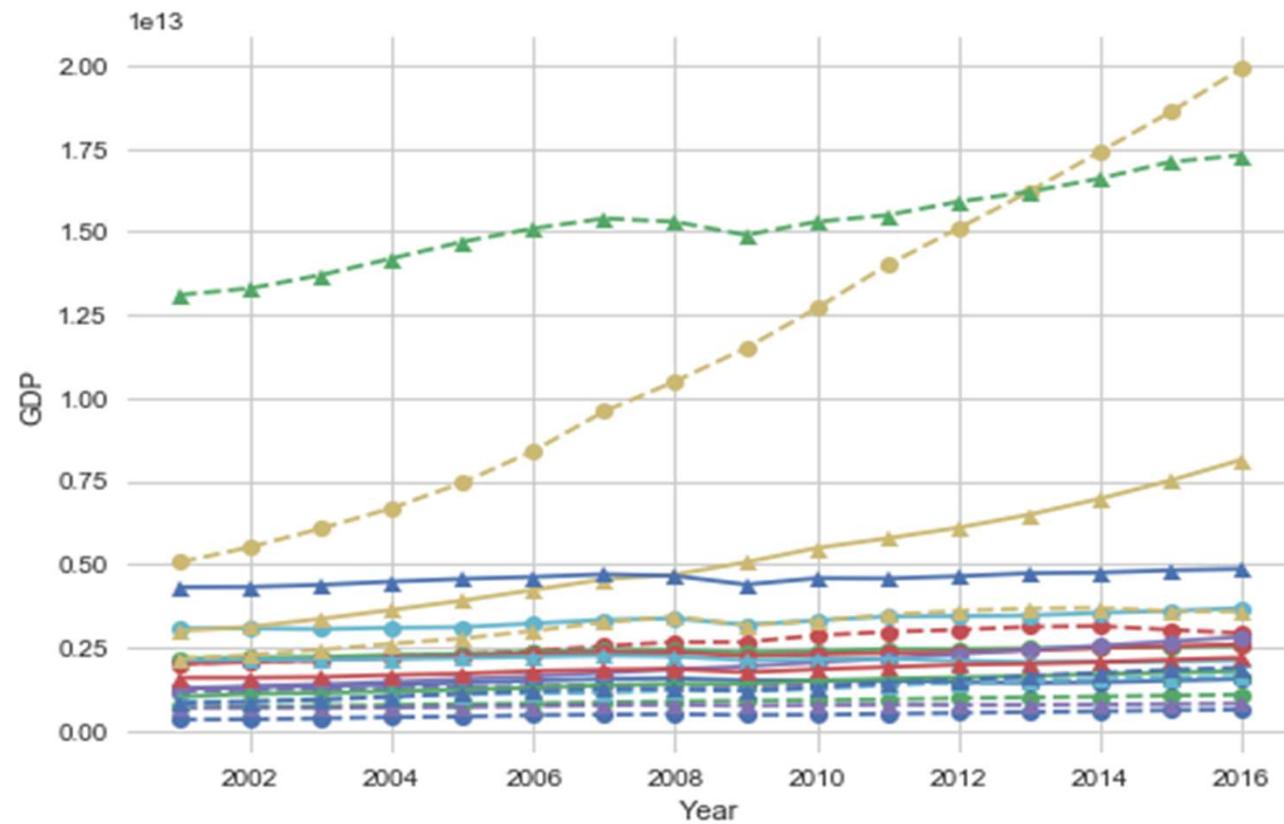
- Turkey
- United Arab Emirates
- Indonesia
- Saudi Arabia
- Brazil
- India
- Spain
- Australia
- Mexico
- Russian Federation
- Canada
- United Kingdom
- Italy
- Netherlands
- France
- Rep. of Korea
- Japan
- Germany
- USA
- China



GDP Analysis

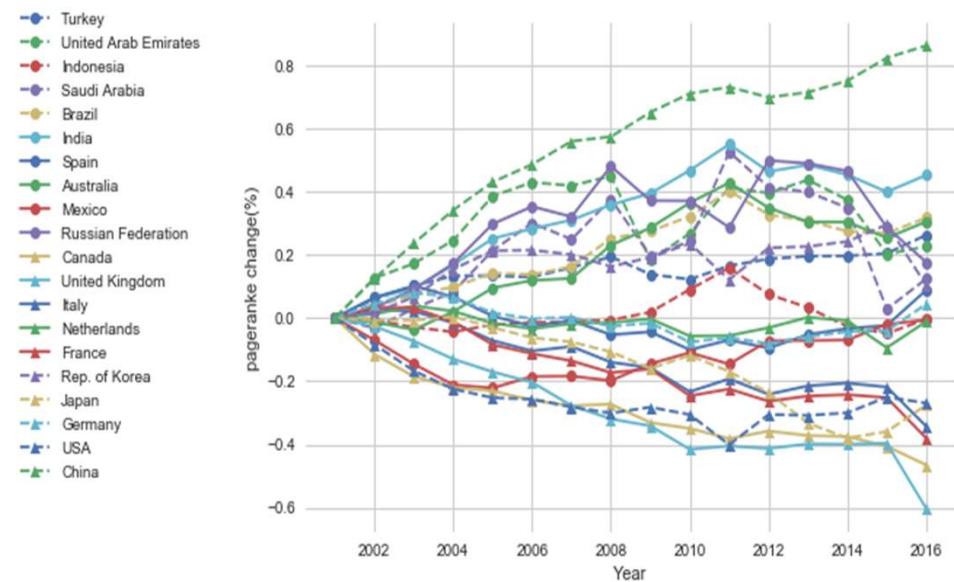
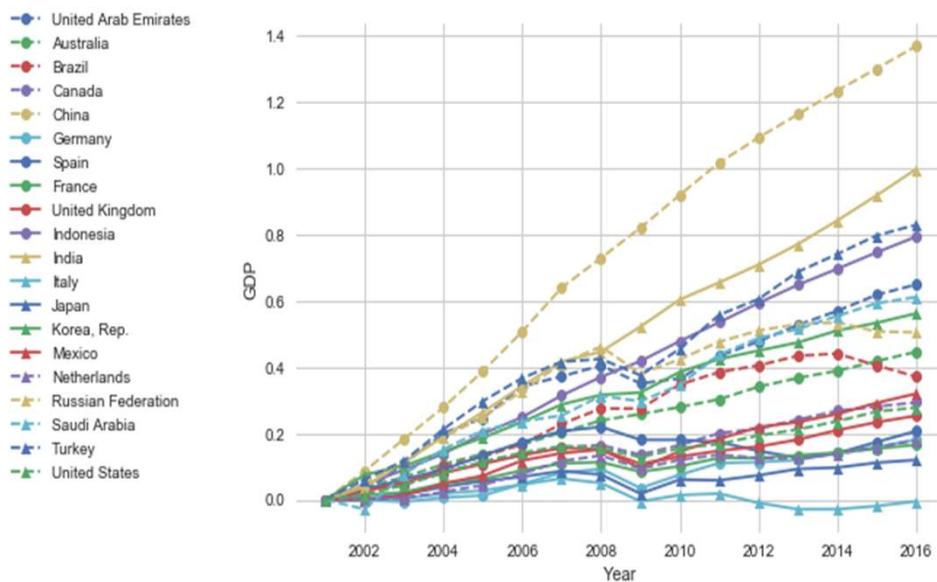
Page rank might give insight to GDP(economic size)

- United Arab Emirates
- Australia
- Brazil
- Canada
- China
- Germany
- Spain
- France
- United Kingdom
- Indonesia
- India
- Italy
- Japan
- Korea, Rep.
- Mexico
- Netherlands
- Russian Federation
- Saudi Arabia
- Turkey
- United States



Page rank Economic growth

GDP growth speed decrease can be found as decreasing or stunned page rank growth graph



Concave GDP growth graph case have negative(or decreasing) page rank change movements

Convex GDP growth graph case have positive(or increasing) page rank change movements

PageRank Correlation

Page rank change correlation indicate which country Korea's Economy is sharing and competing with at international trade

	TUR	USE	INDON	SAU	BRZ	IND	SPA	AUS	MEX	RUS	CAN	UK	Italy	NET	France	KOR	JAP	GER	USA	CHN
TUR	1.000	0.590	0.054	0.489	0.765	0.798	-0.180	0.674	0.051	0.629	-0.915	-0.876	-0.814	-0.345	-0.837	0.599	-0.754	-0.301	-0.768	0.894
USE	0.590	1.000	0.264	0.855	0.527	0.627	-0.495	0.477	-0.507	0.802	-0.517	-0.449	-0.384	-0.259	-0.432	0.608	-0.300	-0.451	-0.797	0.543
INDON	0.054	0.264	1.000	0.632	0.620	0.547	-0.619	0.661	0.050	0.271	-0.301	-0.384	-0.394	-0.361	-0.377	-0.001	-0.123	-0.632	-0.482	0.319
SAU	0.489	0.855	0.632	1.000	0.720	0.759	-0.723	0.724	-0.283	0.809	-0.535	-0.551	-0.517	-0.305	-0.544	0.463	-0.395	-0.701	-0.818	0.581
BRZ	0.765	0.527	0.620	0.720	1.000	0.981	-0.626	0.980	0.131	0.708	-0.907	-0.928	-0.901	-0.569	-0.900	0.569	-0.741	-0.722	-0.874	0.926
IND	0.798	0.627	0.547	0.759	0.981	1.000	-0.646	0.966	0.074	0.781	-0.929	-0.933	-0.904	-0.582	-0.912	0.672	-0.766	-0.734	-0.910	0.955
SPA	-0.180	-0.495	-0.619	-0.723	-0.626	-0.646	1.000	-0.716	0.026	-0.756	0.365	0.437	0.479	0.621	0.486	-0.584	0.384	0.957	0.556	-0.487
AUS	0.674	0.477	0.661	0.724	0.980	0.966	-0.716	1.000	0.209	0.707	-0.847	-0.905	-0.903	-0.613	-0.901	0.553	-0.742	-0.809	-0.811	0.890
MEX	0.051	-0.507	0.050	-0.283	0.131	0.074	0.026	0.209	1.000	-0.222	-0.122	-0.260	-0.374	-0.183	-0.355	-0.184	-0.521	-0.209	0.325	0.130
RUS	0.629	0.802	0.271	0.809	0.708	0.781	-0.756	0.707	-0.222	1.000	-0.650	-0.635	-0.612	-0.369	-0.632	0.806	-0.584	-0.732	-0.792	0.718
CAN	-0.915	-0.517	-0.301	-0.535	-0.907	-0.929	0.365	-0.847	-0.122	-0.650	1.000	0.953	0.908	0.517	0.910	-0.675	0.804	0.489	0.850	-0.984
UK	-0.876	-0.449	-0.384	-0.551	-0.928	-0.933	0.437	-0.905	-0.260	-0.635	0.953	1.000	0.980	0.523	0.983	-0.569	0.804	0.568	0.779	-0.966
Italy	-0.814	-0.384	-0.394	-0.517	-0.901	-0.904	0.479	-0.903	-0.374	-0.612	0.908	0.980	1.000	0.570	0.995	-0.557	0.821	0.622	0.694	-0.931
NET	-0.345	-0.259	-0.361	-0.305	-0.569	-0.582	0.621	-0.613	-0.183	-0.369	0.517	0.523	0.570	1.000	0.582	-0.584	0.453	0.677	0.459	-0.599
France	-0.837	-0.432	-0.377	-0.544	-0.900	-0.912	0.486	-0.901	-0.355	-0.632	0.910	0.983	0.995	0.582	1.000	-0.571	0.833	0.631	0.712	-0.940
KOR	0.599	0.608	-0.001	0.463	0.569	0.672	-0.584	0.553	-0.184	0.806	-0.675	-0.569	-0.557	-0.584	-0.571	1.000	-0.588	-0.582	-0.689	0.730
JAP	-0.754	-0.300	-0.123	-0.395	-0.741	-0.766	0.384	-0.742	-0.521	-0.584	0.804	0.804	0.821	0.453	0.833	-0.588	1.000	0.587	0.531	-0.823
GER	-0.301	-0.451	-0.632	-0.701	-0.722	-0.734	0.957	-0.809	-0.209	-0.732	0.489	0.568	0.622	0.677	0.631	-0.582	0.587	1.000	0.562	-0.597
USA	-0.768	-0.797	-0.482	-0.818	-0.874	-0.910	0.556	-0.811	0.325	-0.792	0.850	0.779	0.694	0.459	0.712	-0.689	0.531	0.562	1.000	-0.857
CHN	0.894	0.543	0.319	0.581	0.926	0.955	-0.487	0.890	0.130	0.718	-0.984	-0.966	-0.931	-0.599	-0.940	0.730	-0.823	-0.597	-0.857	1.000

Scenario Analysis

With given relationship, it is possible to infer trade war's impact to Korea with scenario analysis

Korea need to make decision

중국, 삼성·SK하이닉스 등에 경고...미중 사이에 끼어 피해볼까 우려도



무역전쟁을 벌이고 있는 미국과 중국 사이에서 한국기업이 점점 어느 한쪽을 선택해야 하는 곤란한 처지로 내몰리고 있다.

Image source : 연합뉴스(2019)

Scenario Analysis

- What if Korea need to make decision between China and United States, what would minimize impact to Korea's economy.

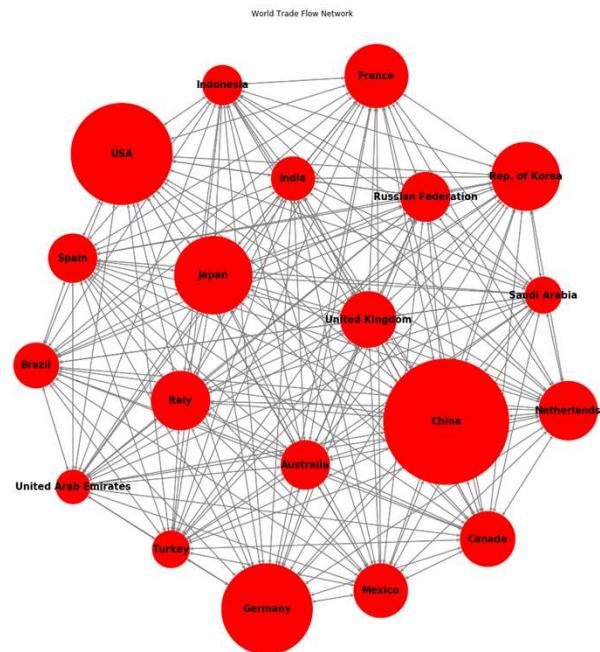
Assumptions

- Scenario include export decrease; import decrease from counterparty. And following non-chosen counterparty's significant trade decrease.
- Macro economic sanction(oil import) scenario is included

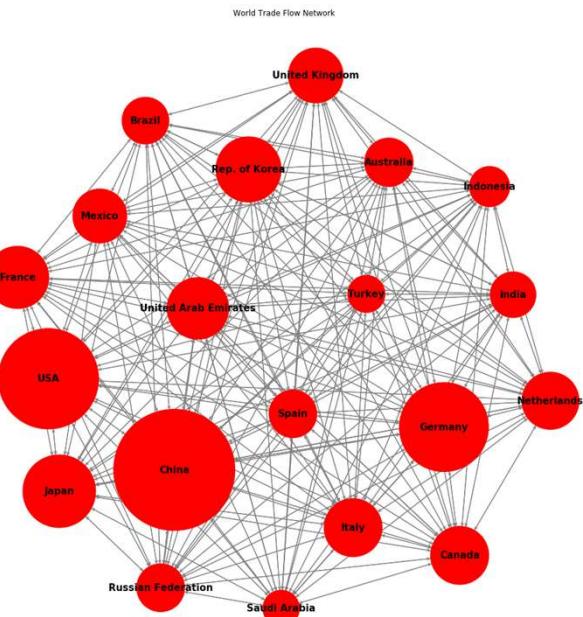
Scenario analysis result

Korea's choice result based on page rank shows China might be proper counterparty at international trade

China chosen scenario



USA chosen scenario



Scenario analysis result

Korea's choice result based on page rank shows China might be proper counterparty at international trade

2016	Original	USA	CHN
TUR	0.018	0.017	0.017
UAE	0.016	0.047	0.014
INDO	0.022	0.020	0.019
SAU	0.019	0.017	0.016
BRZ	0.026	0.027	0.025
IND	0.026	0.026	0.023
SPA	0.032	0.028	0.029
AUS	0.033	0.029	0.029
MEX	0.037	0.036	0.036
RUS	0.029	0.028	0.030
CAN	0.037	0.042	0.037
UK	0.033	0.037	0.038
ITA	0.038	0.041	0.042
NET	0.046	0.040	0.042
FRA	0.044	0.048	0.049
KOR	0.049	0.052	0.057
JAP	0.073	0.065	0.074
GER	0.111	0.097	0.101
USA	0.137	0.123	0.126
CHN	0.173	0.180	0.193

- If trade war occurs significantly, Korea's strength increase at international trade network
- China scenario shows 0.057 pagerank
- United States scenario shows 0.0052 pagerank

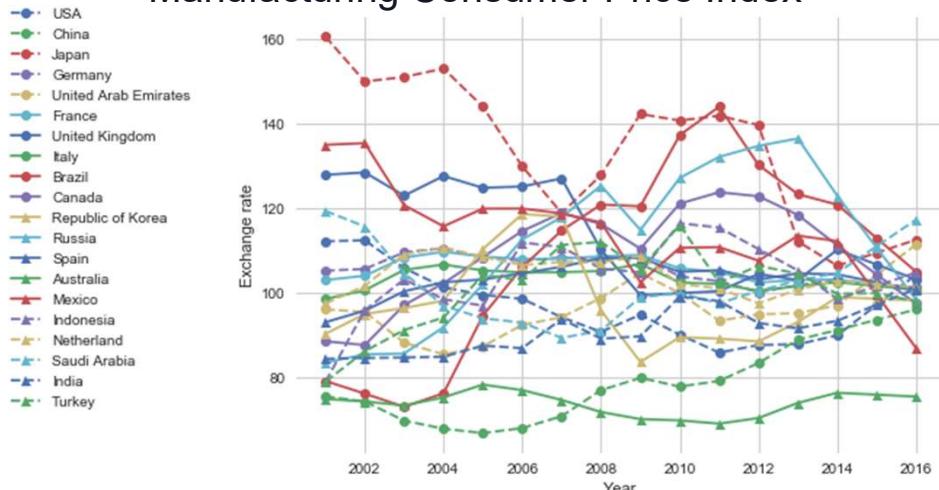
Limitation

- This scenario analysis only shows, amount of change
- It cannot show strategical change(cutting-edge stuffs)
- financial sector which is out of trade but included in GDP is not considered in this scenario

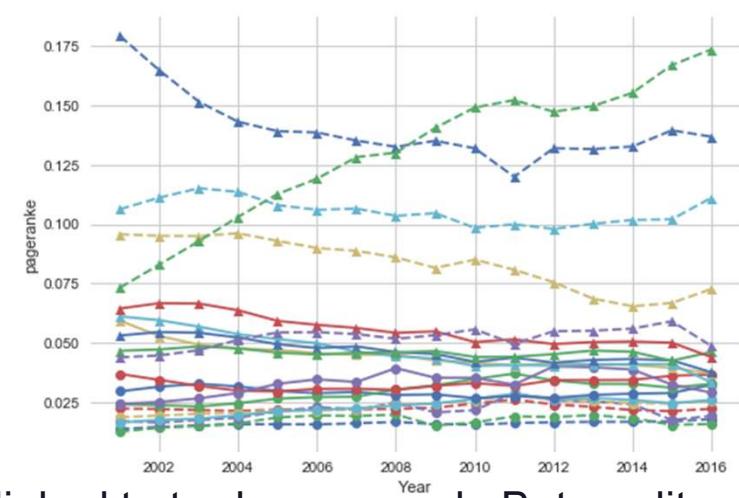
Follow up research topic 1

Marshall Learner condition states relationship between exchange rate and international trade. This might be linked to page rank

Real Effective Exchange Rates Based on Manufacturing Consumer Price Index



Page Rank



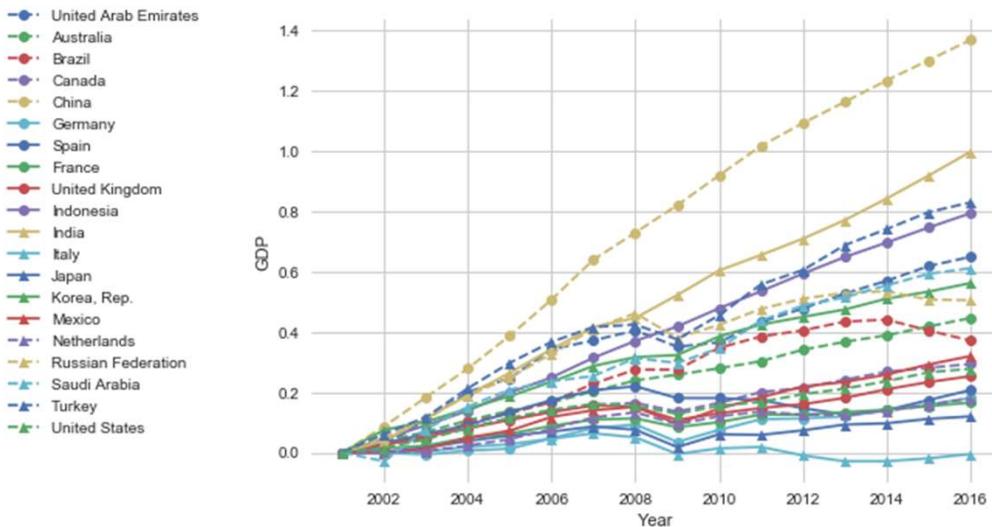
Exchange rate which is based on manufacturing field can be linked to trade page rank. But credit, commodity market volatility, political situation and so on also acts on exchange rate. Need to design precise multi variate model

Source: Federal Reserve Bank of Saint Louis, Economic Research

Follow up research topic 2

Service also consists of huge portion of GDP, but not explicit relationship with economic growth as manufacturing

GDP = Manufacturing + Service

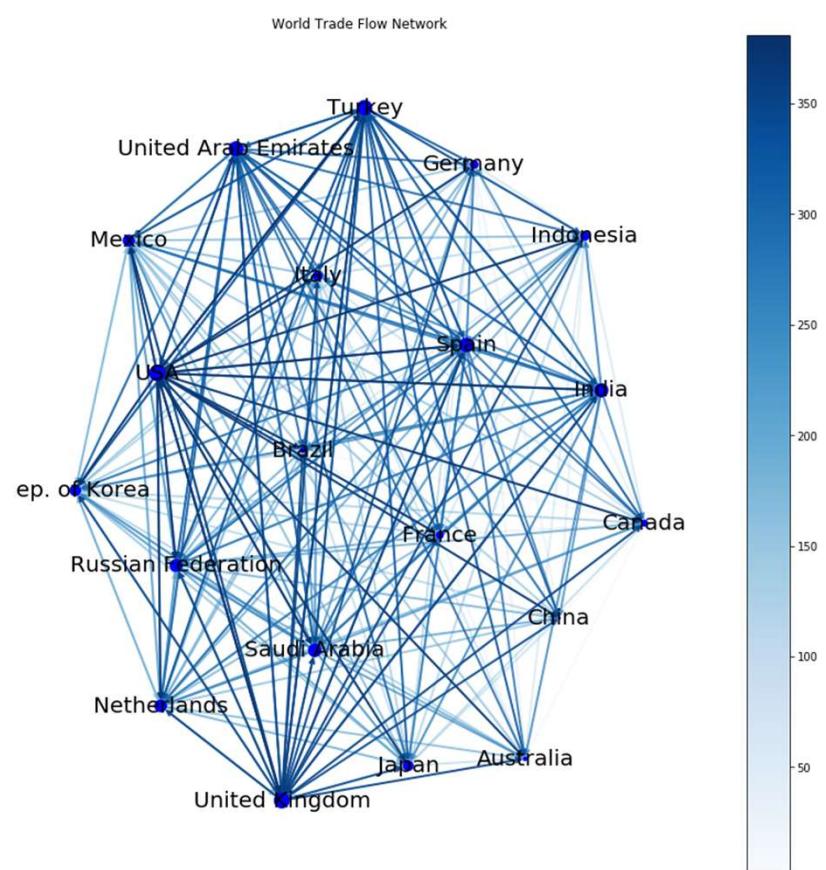
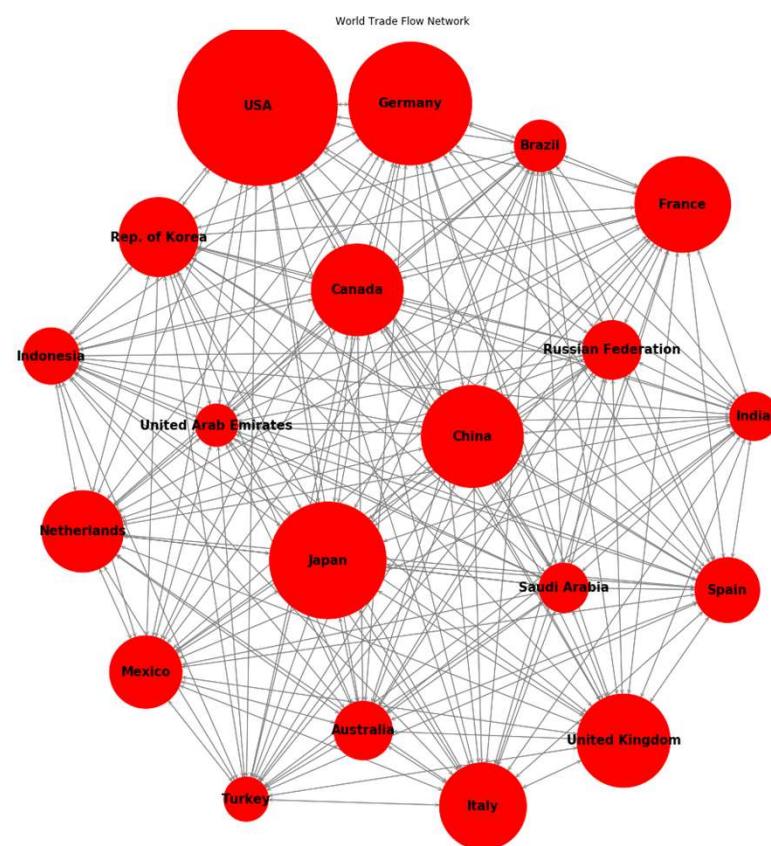


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- Service industry employment induction coefficient differ from Manufacturing's one.
- Need to adjust parameter in our manufacturing industry-based trade network to derive relationship.

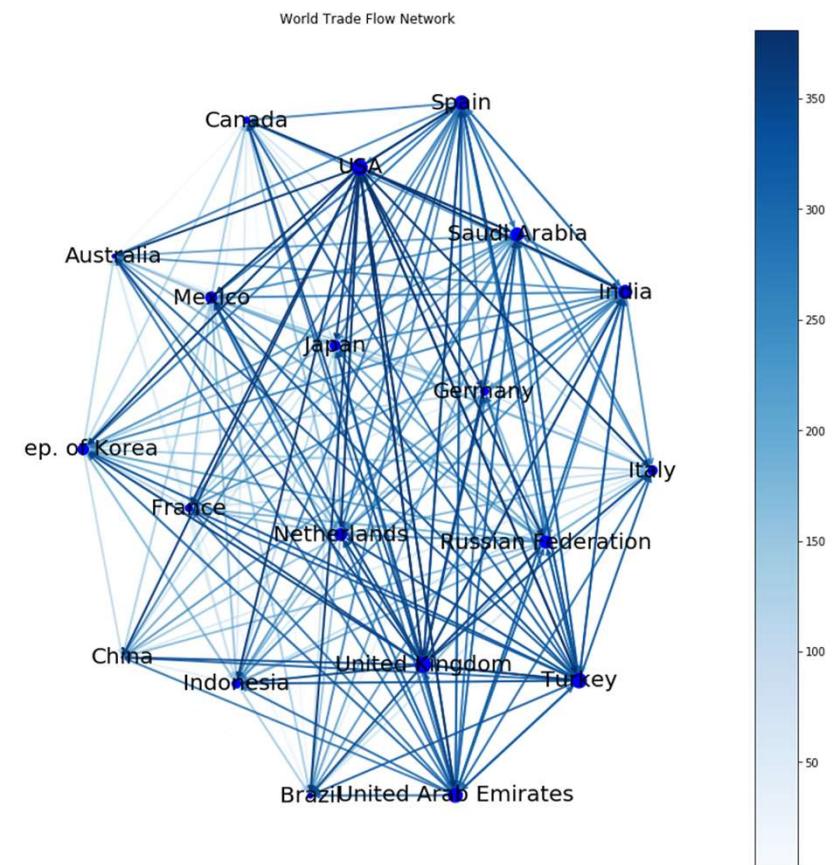
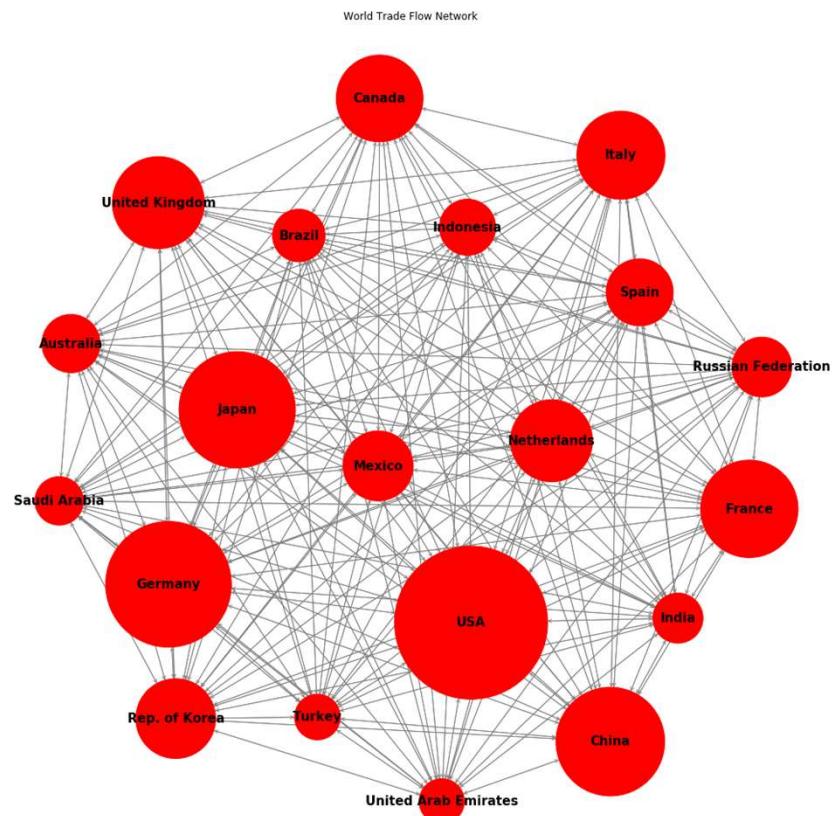
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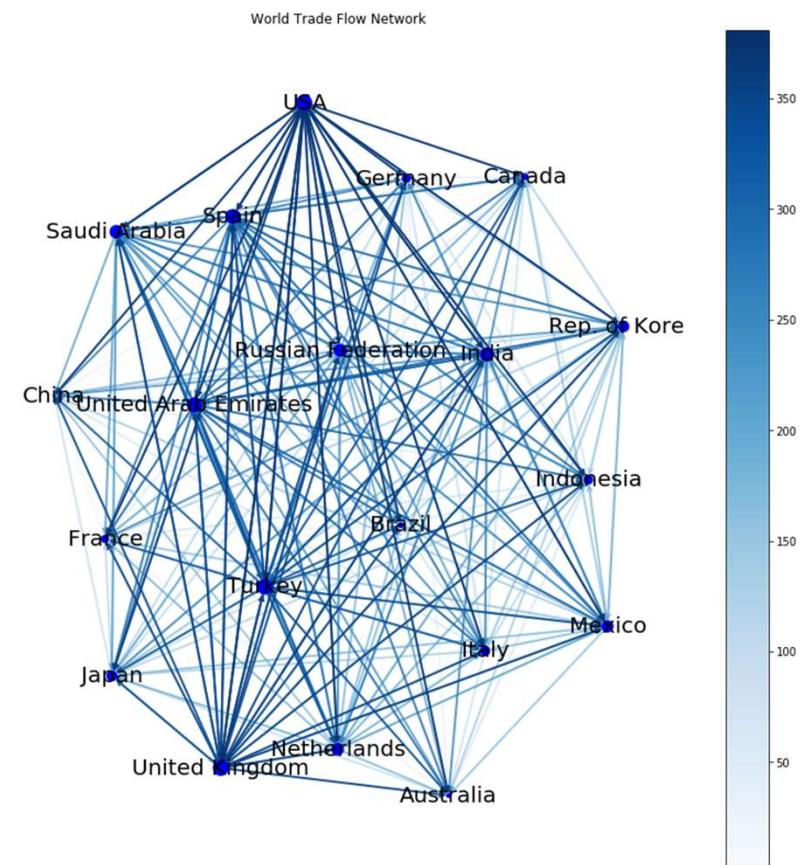
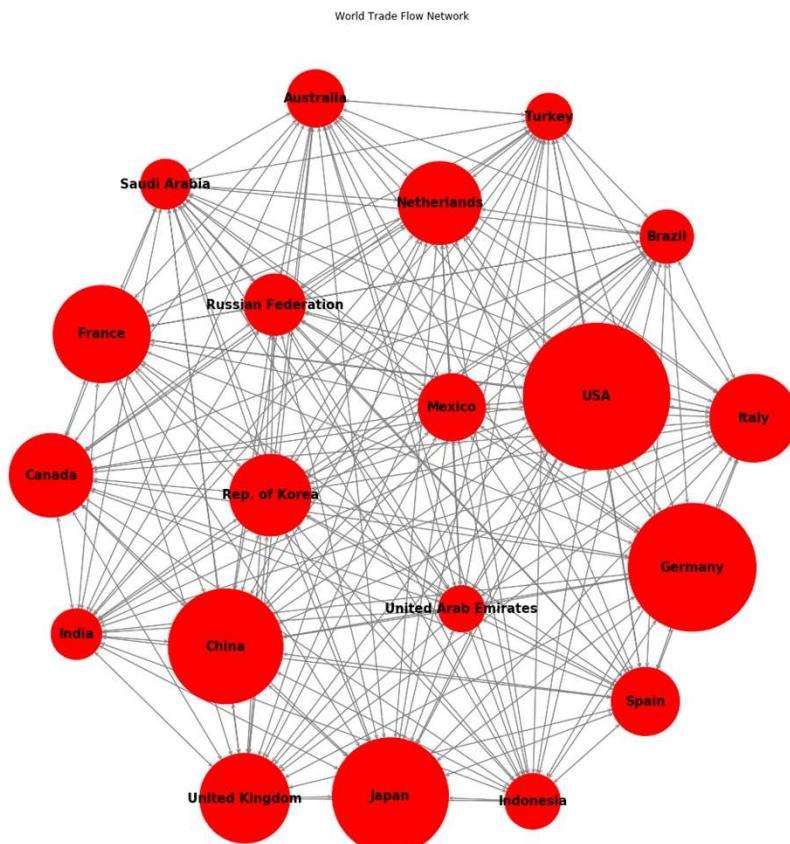
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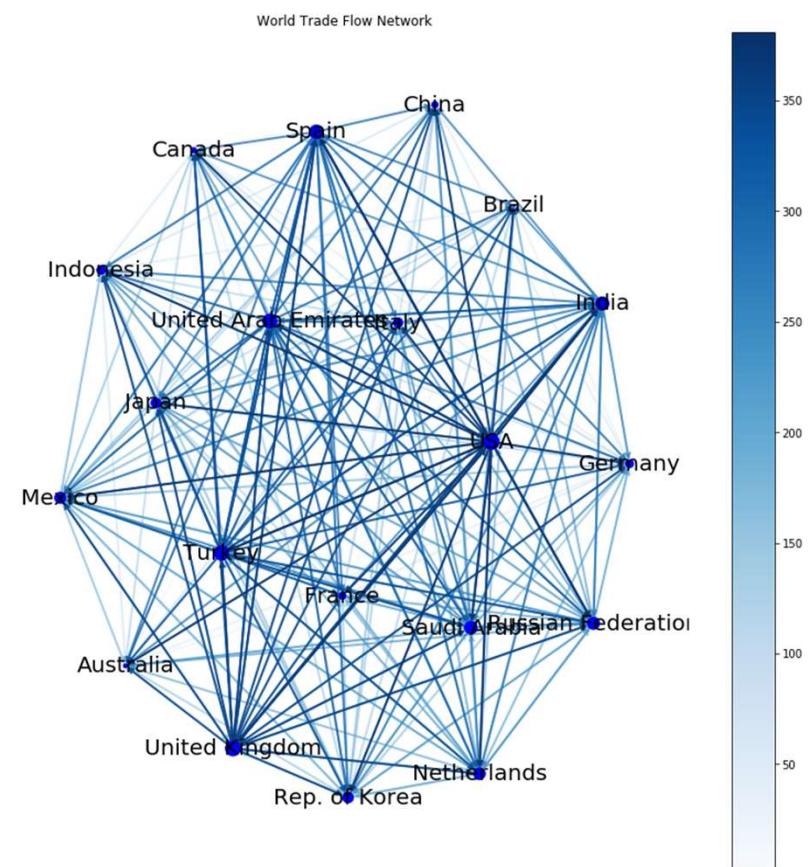
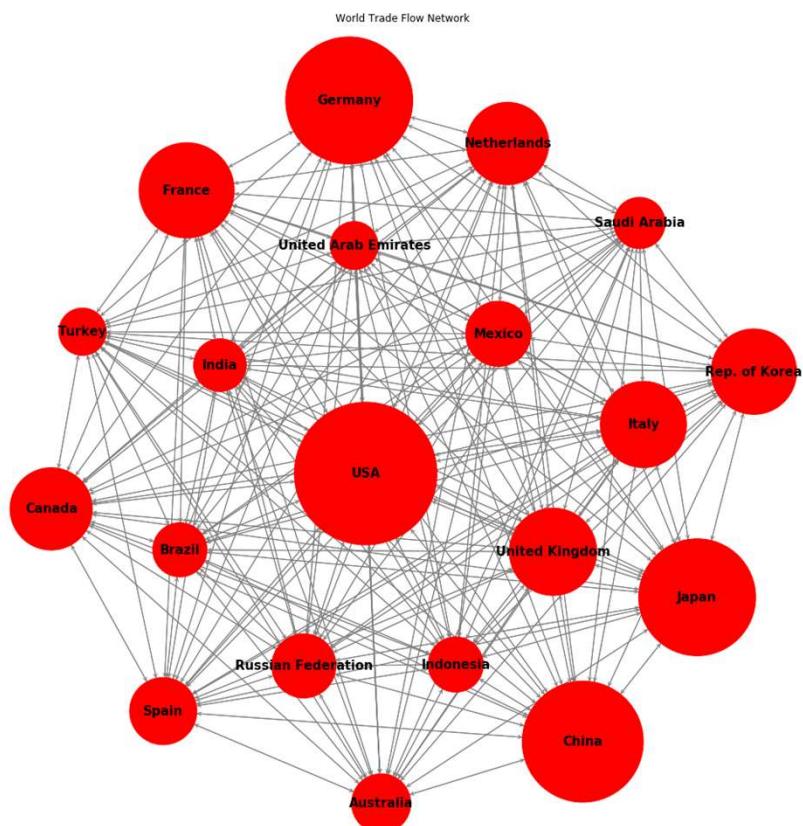
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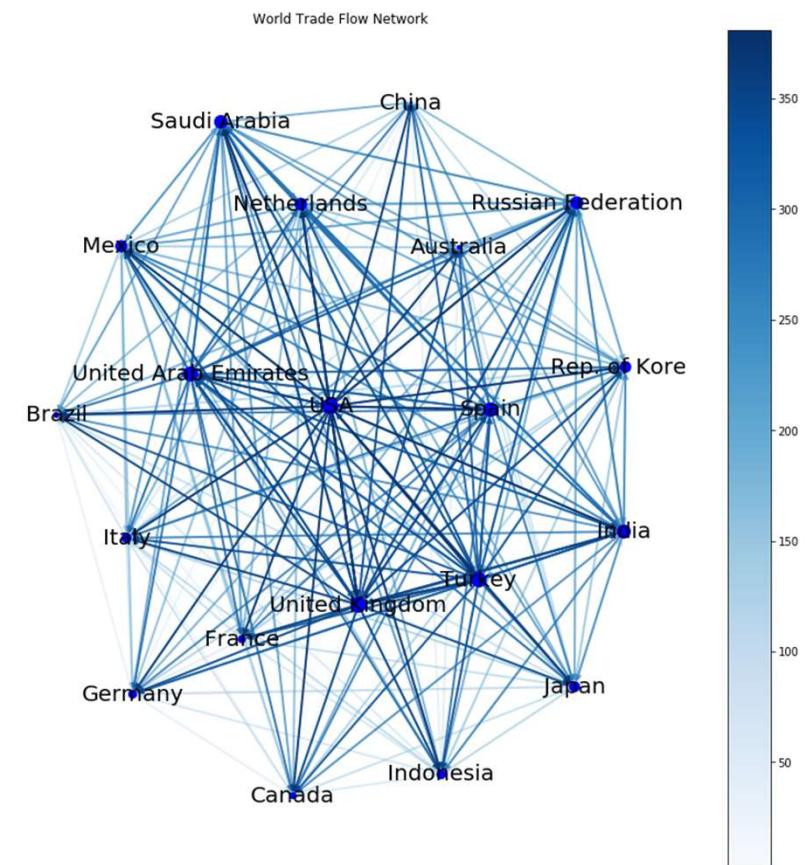
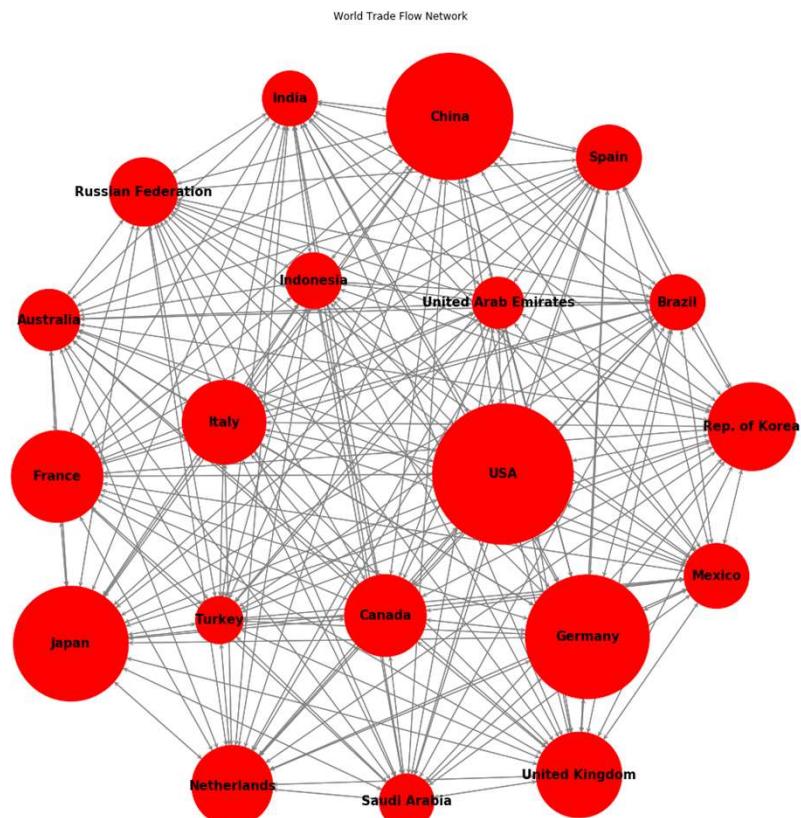
Appendix 2003



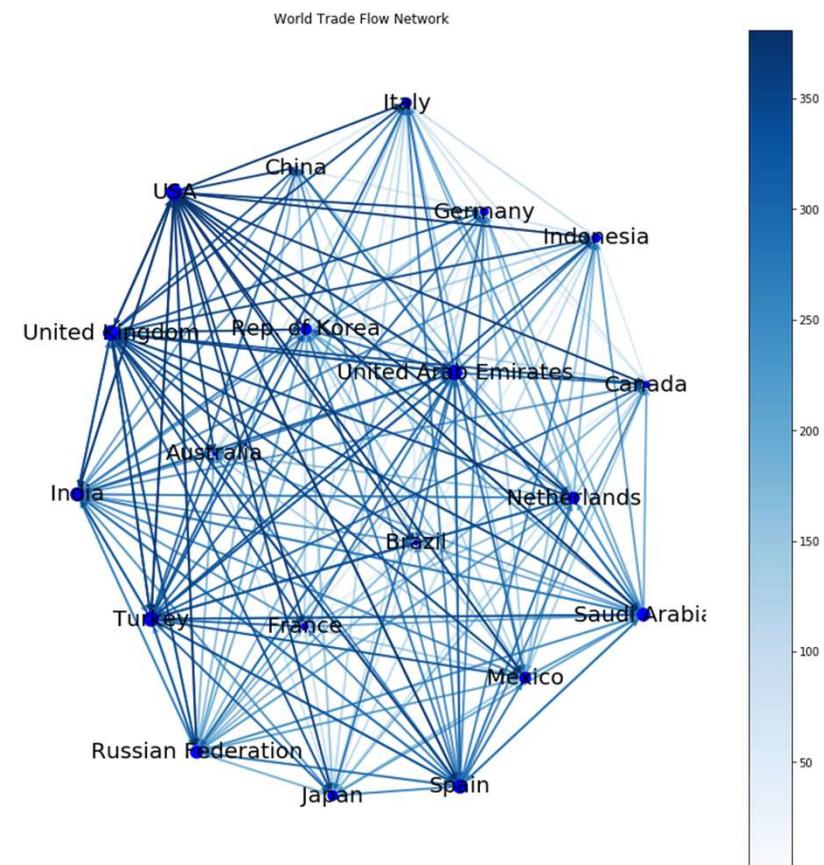
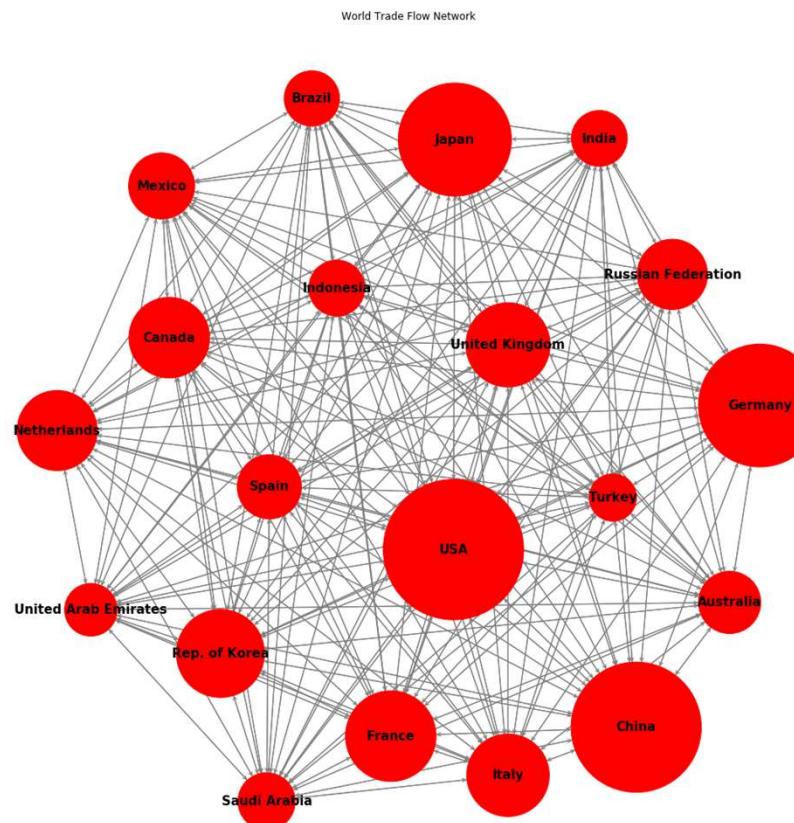
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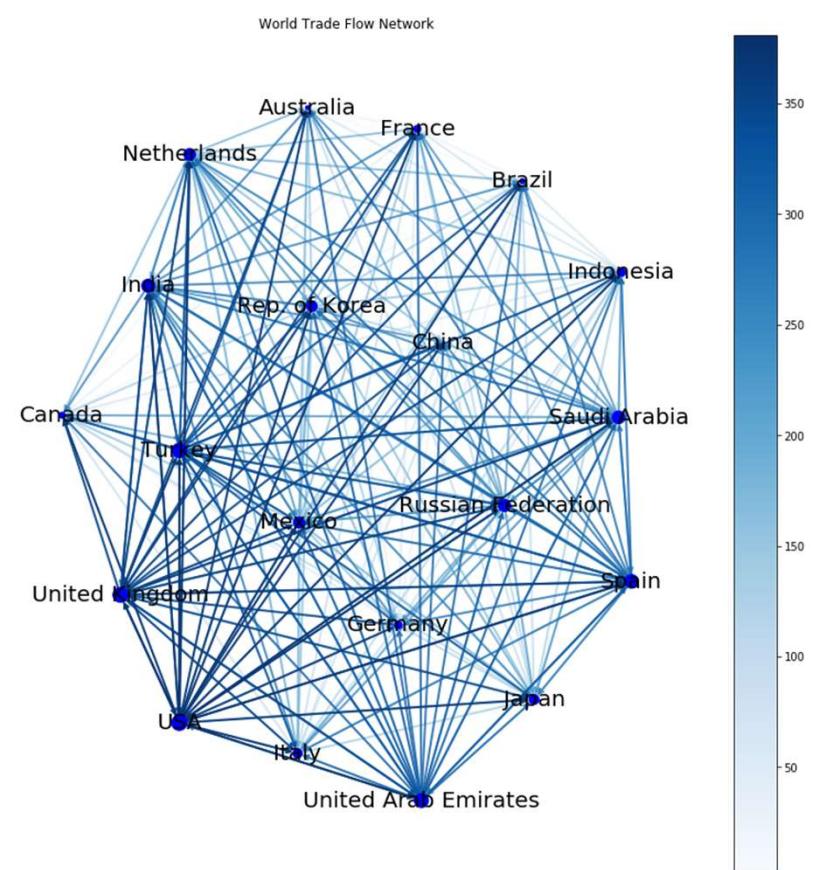
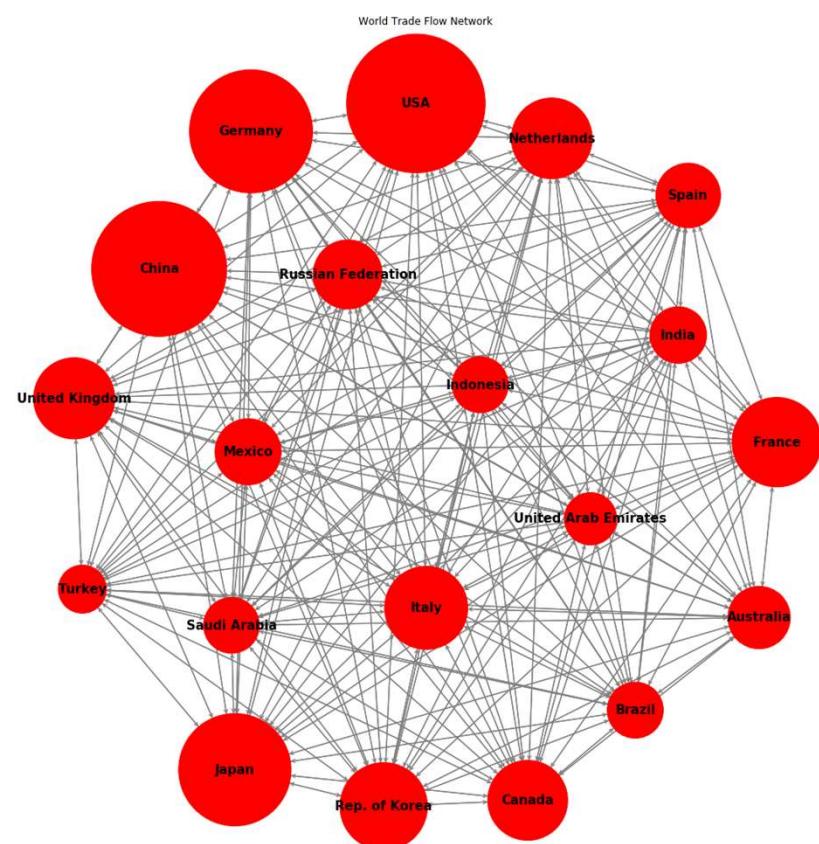
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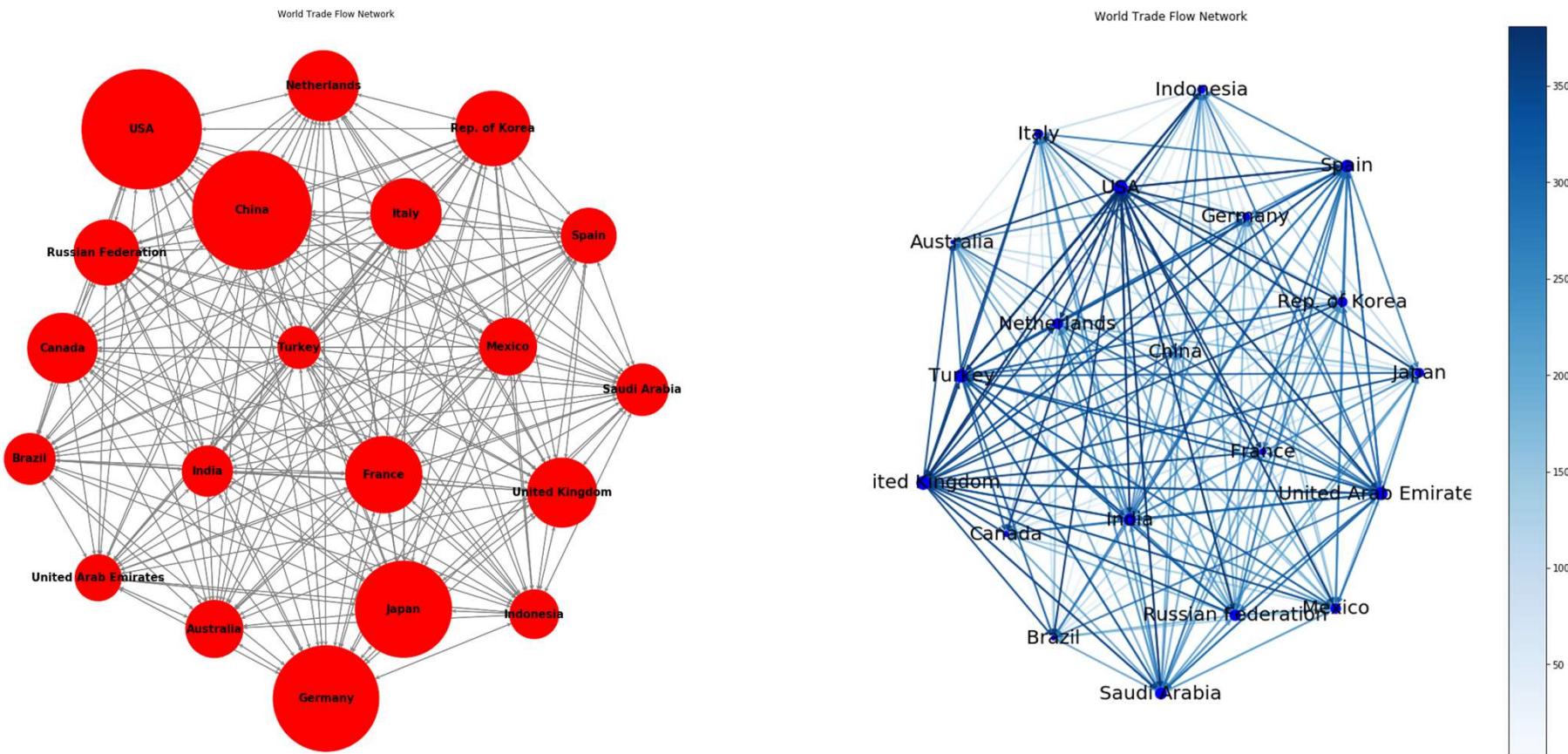
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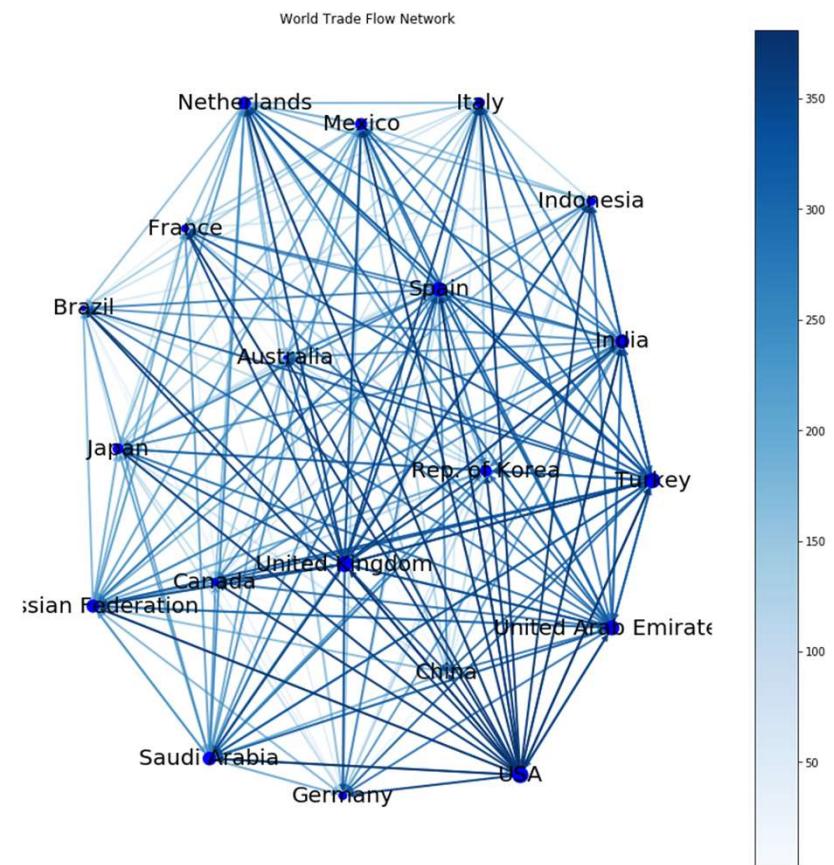
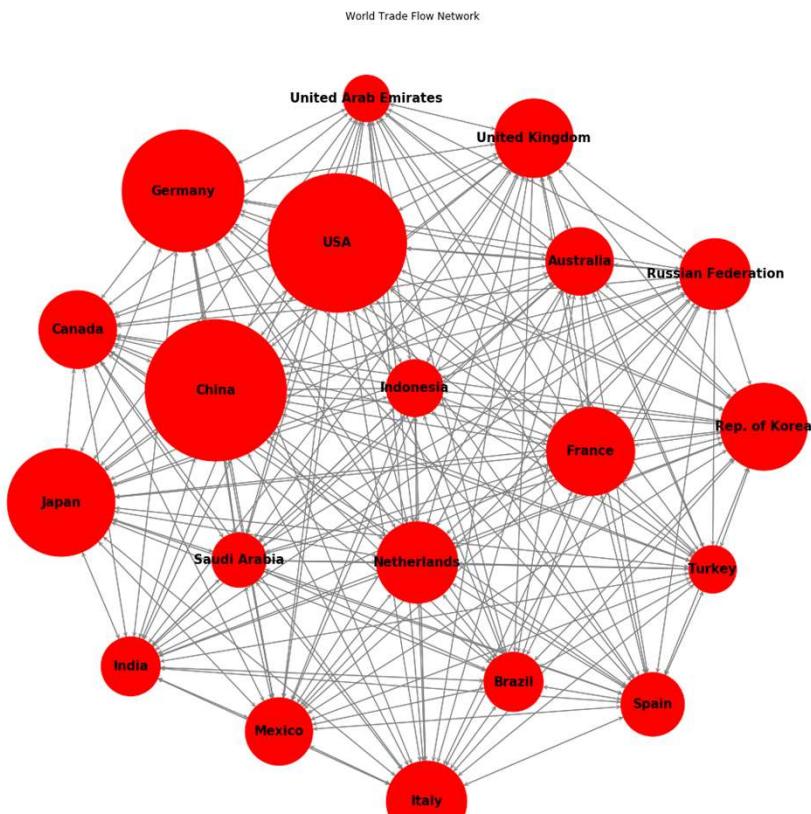
Appendix 2007



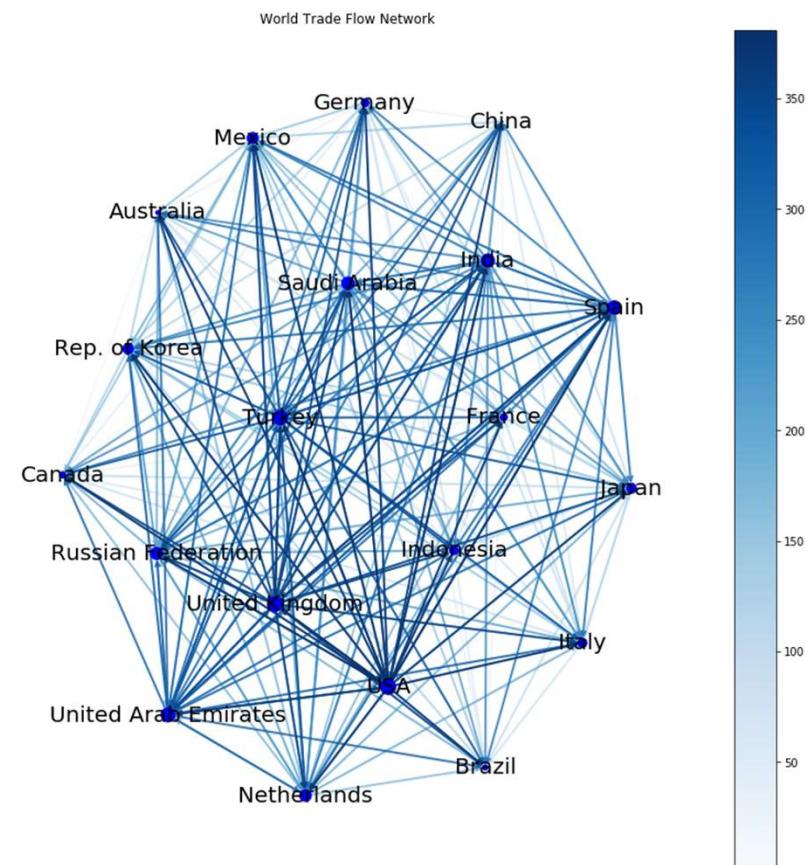
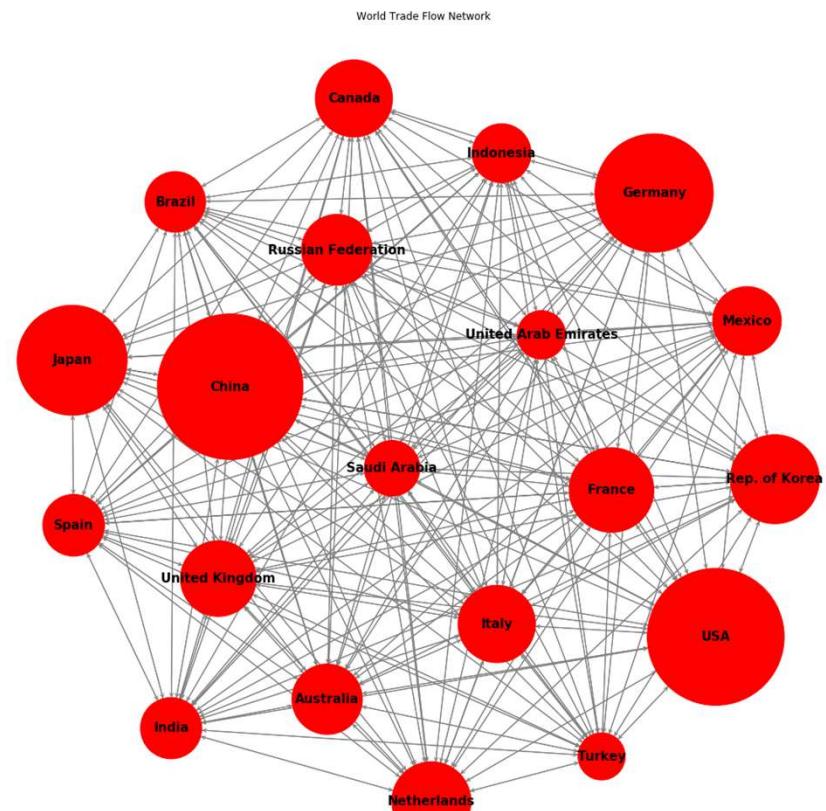
Appendix 2008



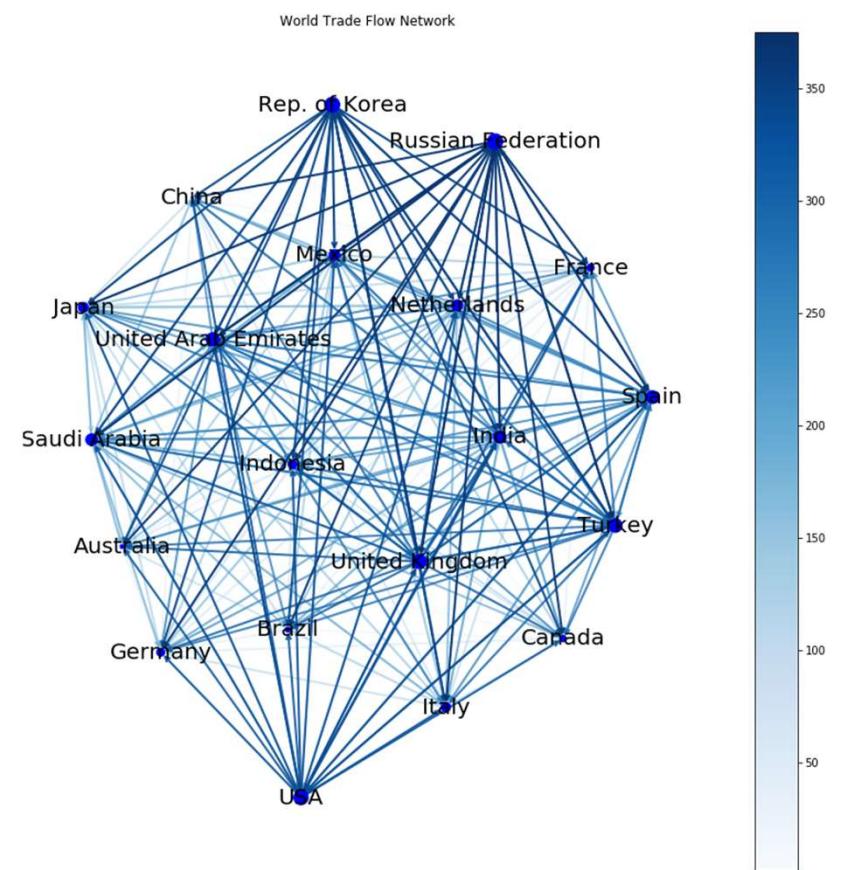
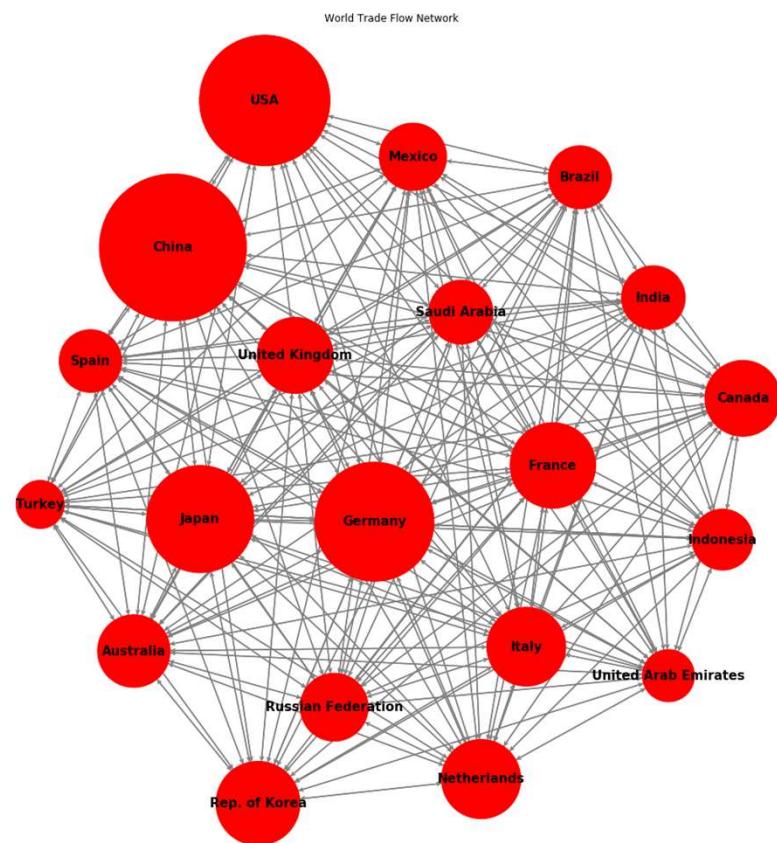
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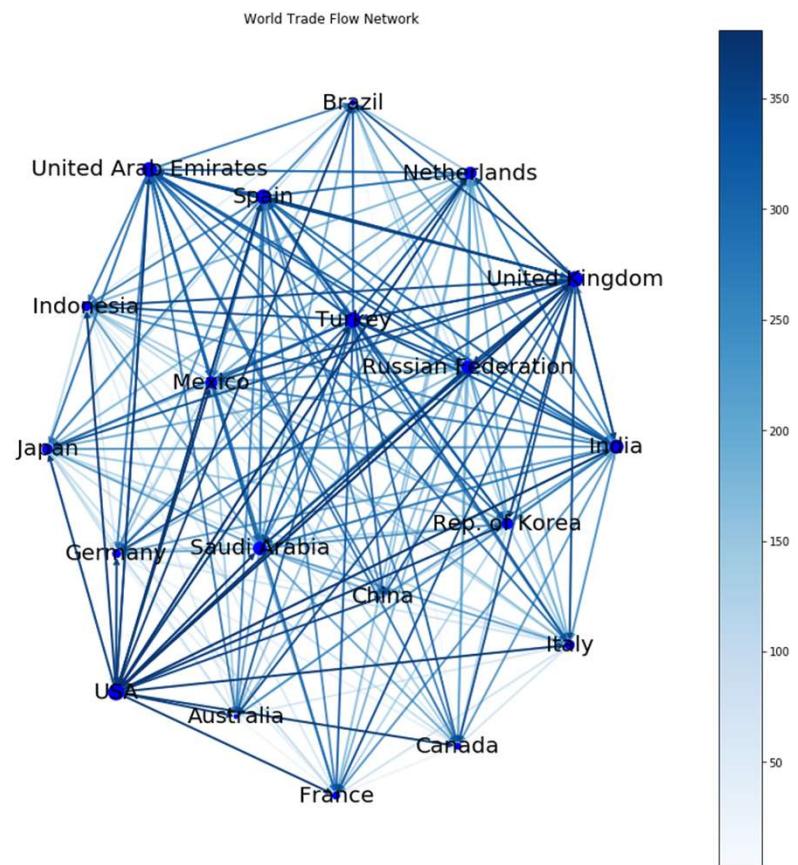
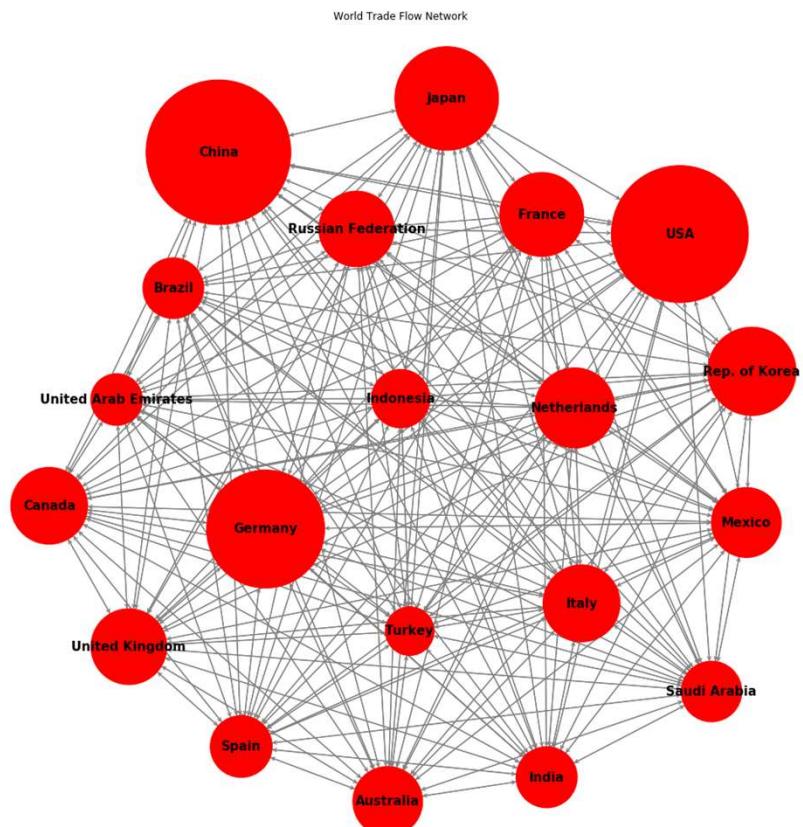
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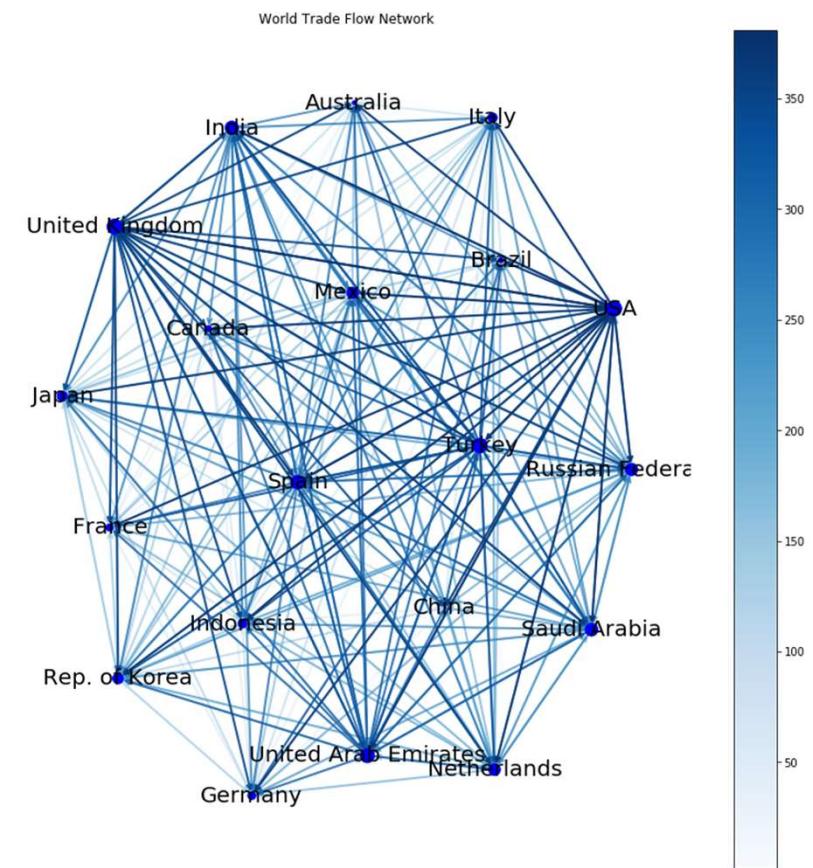
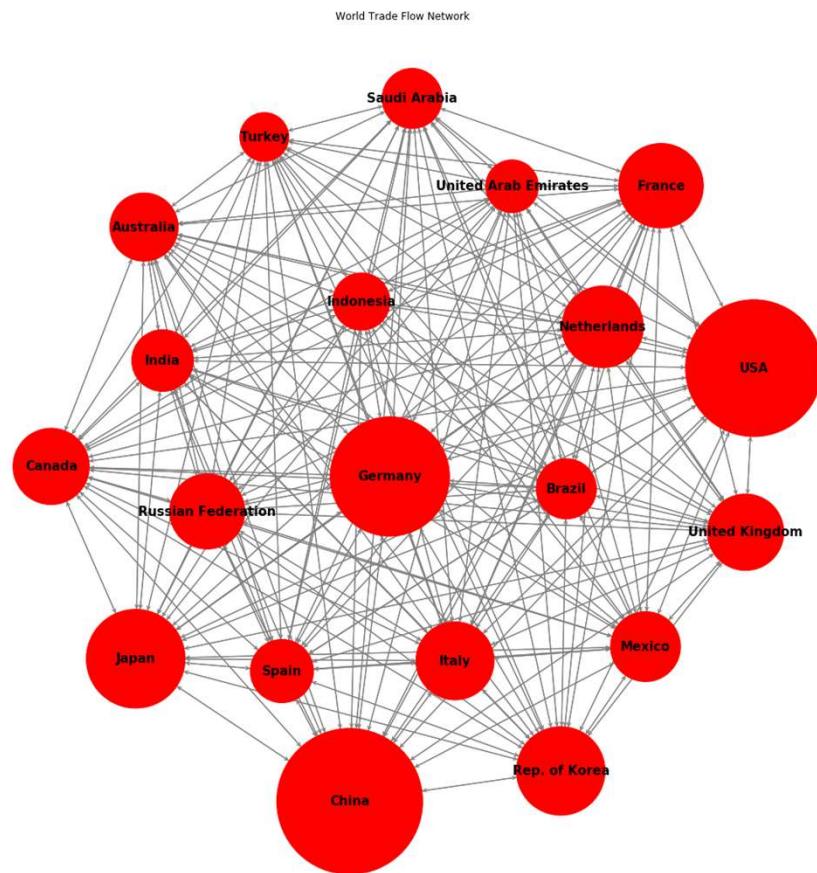
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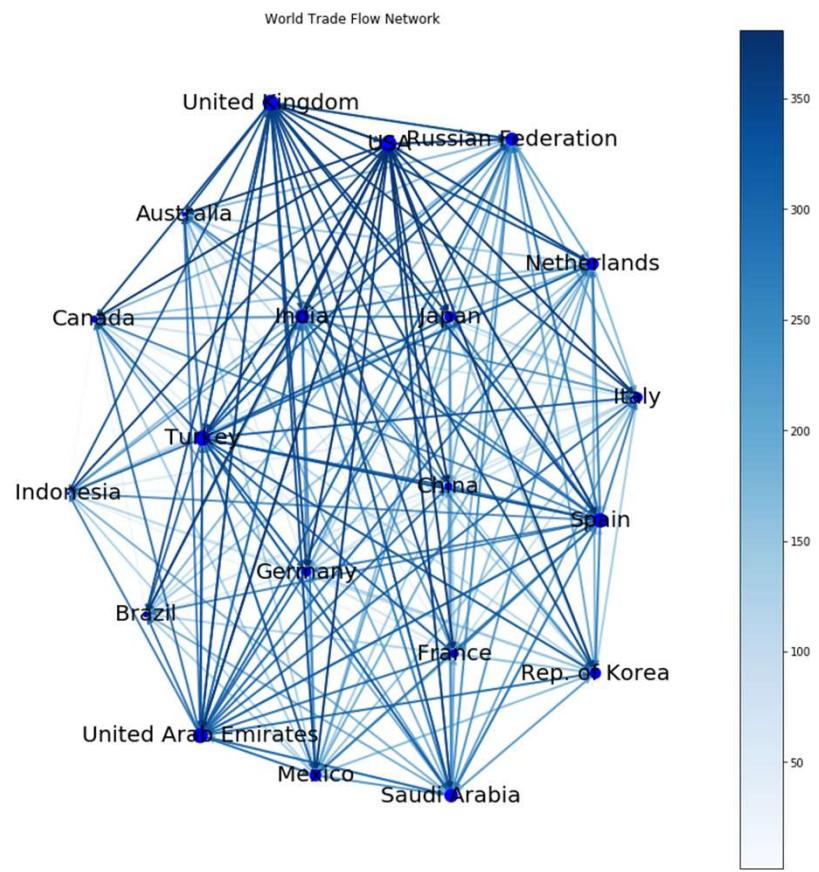
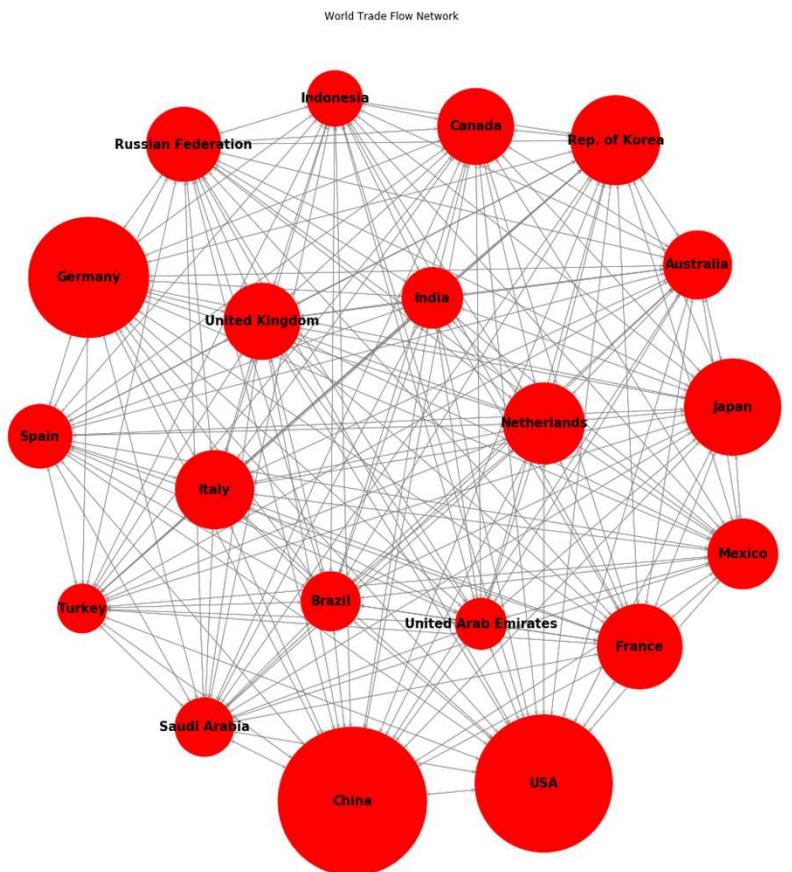
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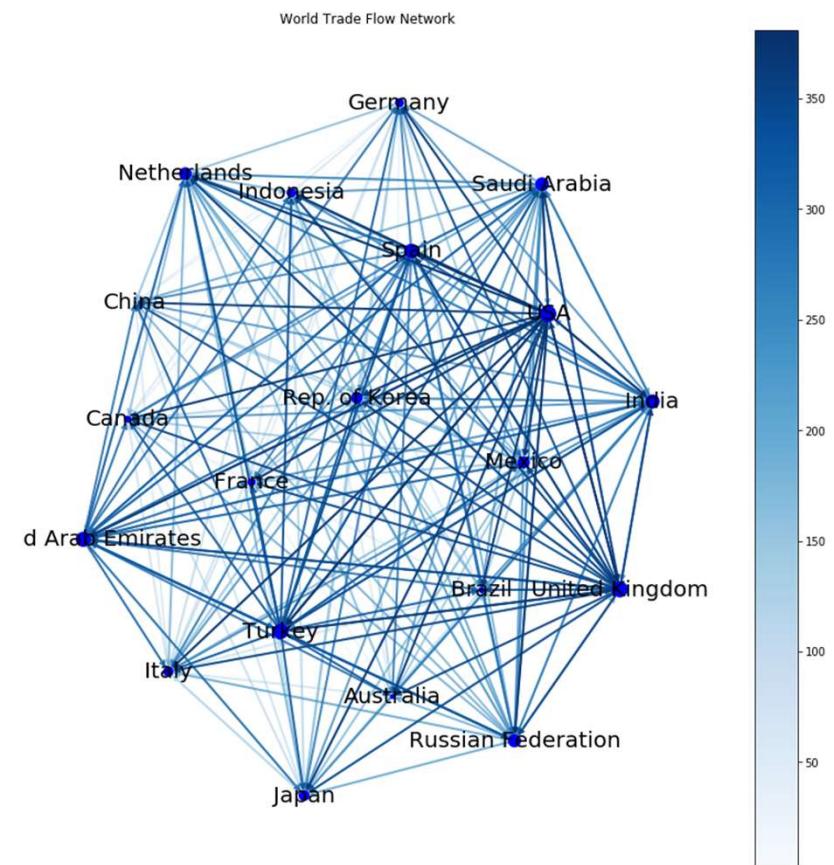
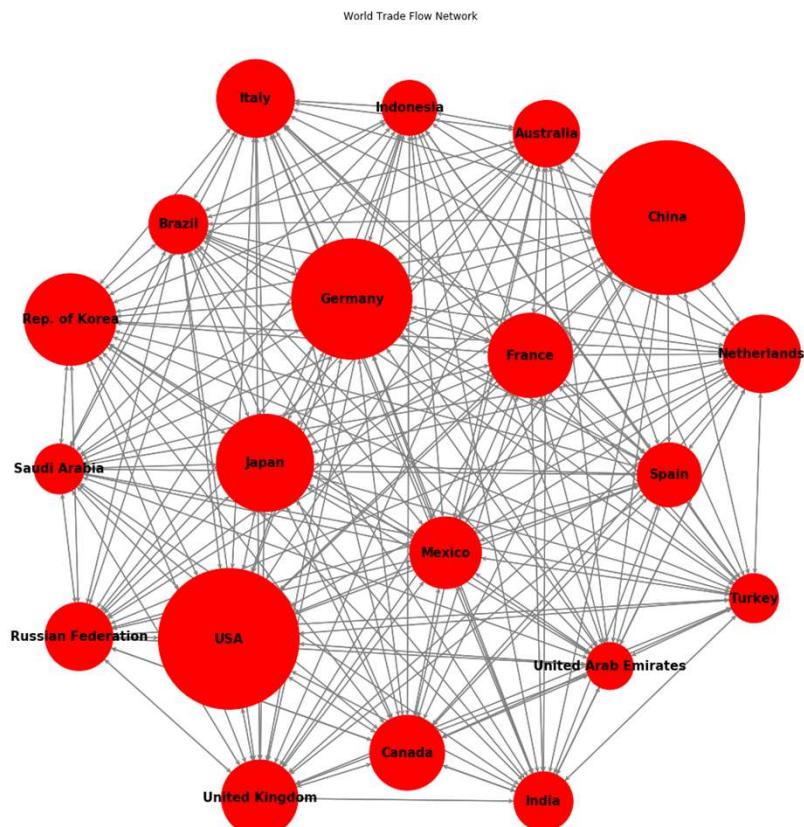
Appendix 2013



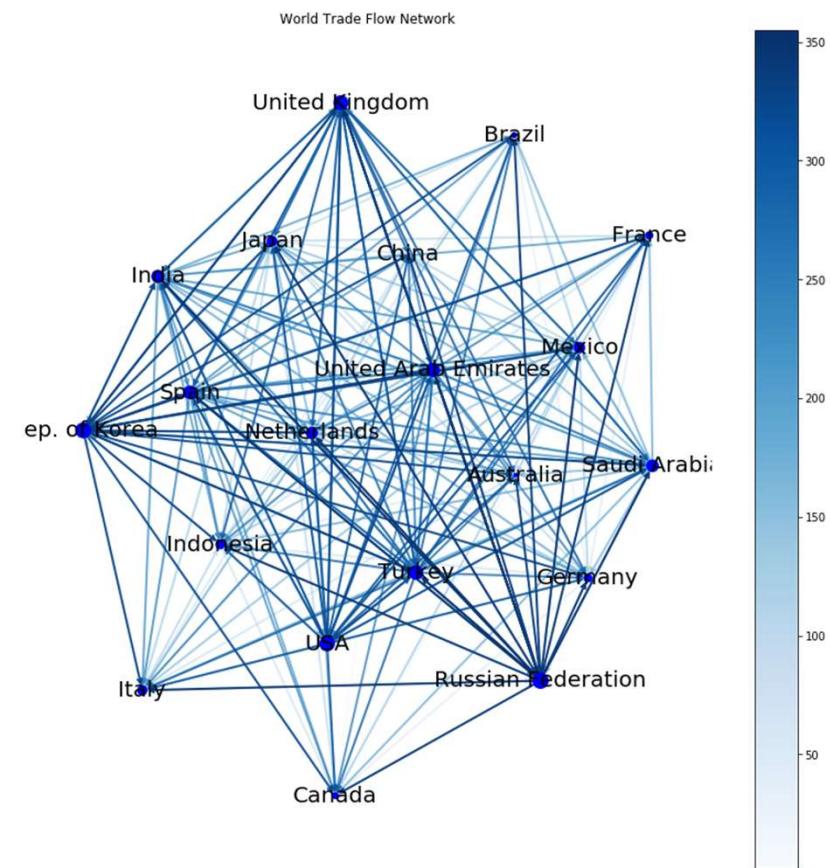
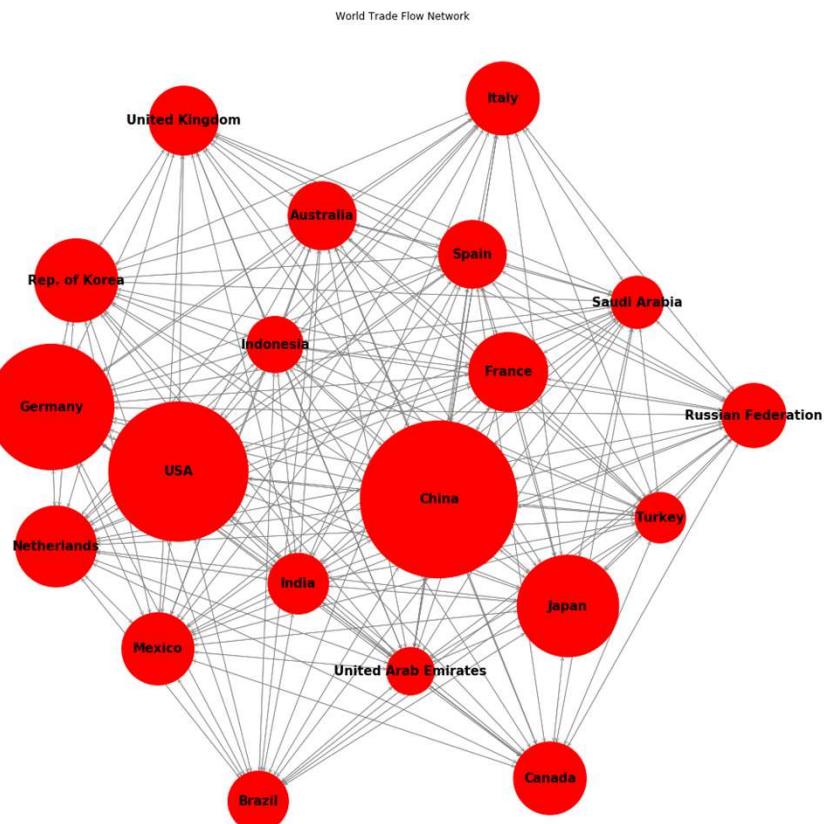
Appendix 2014



Appendix 2015



Appendix 2016



**Thank
You**

