

MIS 587: Assignment 4 – 2017 International Trade Analysis Using Network Science

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In 2017, there was a total of \$14.7 Trillion worth of goods exported internationally between 211 countries. This paper will analyze those relationships and the topology of the global trading network in 2017 using Gephi software for analysis.

The density of the overall network is .534, which represents the number of trading relationships divided by the number of potential trading relationships. This means that if you take two countries at random, they would have a probability of 53.4% of having an import/export relationship with each other. Of the 211 countries, the average degree (number of exports + imports) is 112.56. The degree centrality for each country ranges from as low as 18 to as high as 415. **France, the UK and the US** are the most directly connected countries in the network. The out-degree distribution indicates that the percentile of countries that trade with a high number of partners is slightly higher for exports than for imports.

country	Degree	Out-Degree	In-Degree
France	415	206	209
United Kingdom	414	209	205
United States	411	206	205
South Korea	407	204	203
Netherlands	406	207	199
Singapore	405	202	203
Germany	404	205	199
Italy	404	209	195
Spain	403	204	199
Canada	402	202	200
Japan	402	202	200

Eigenvector Centrality measures how connected a country is to other well-connected (high trading) countries. France and the UK again come out on top as being well-connected followed by Mexico. European countries are in 6 of the top 10 slots, indicating that Europe has many high trading countries and a well-developed network of trade.

continent	country	Eigenvector Cent...	Degree
Europe	France	1.0	415
Europe	United Kingdom	0.997264	414
North America	Mexico	0.990838	392
Asia	South Korea	0.990422	407
North America	United States	0.989927	411
Europe	Poland	0.988791	398
Europe	Czech Republic	0.98785	396
Asia	Singapore	0.986424	405
Europe	Germany	0.986302	404
Europe	Spain	0.984475	403

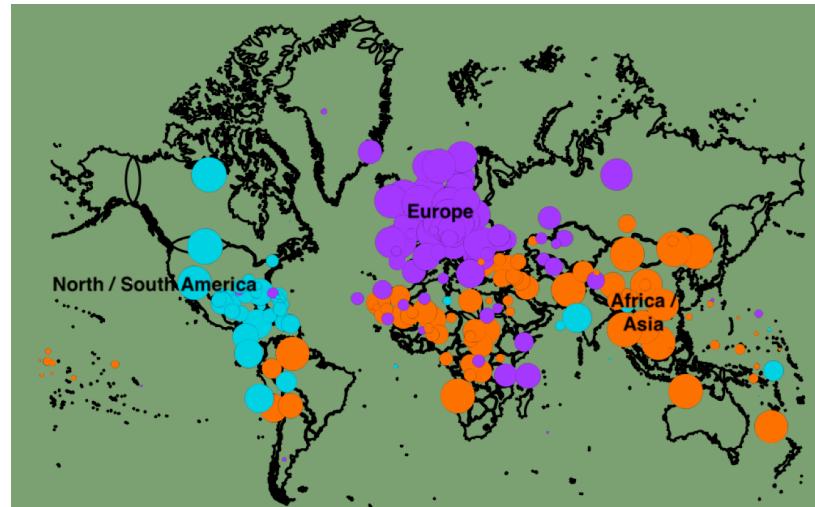
Using the Mutual Edge filter, the reciprocity of this network is .857. This is fairly high, meaning that 85.7% of countries have a mutual trading network (they import and export with the other country). Only 14% of the countries in this network have a 1-way relationship with another country where they are only importing or only exporting with another country.

Community Detection:

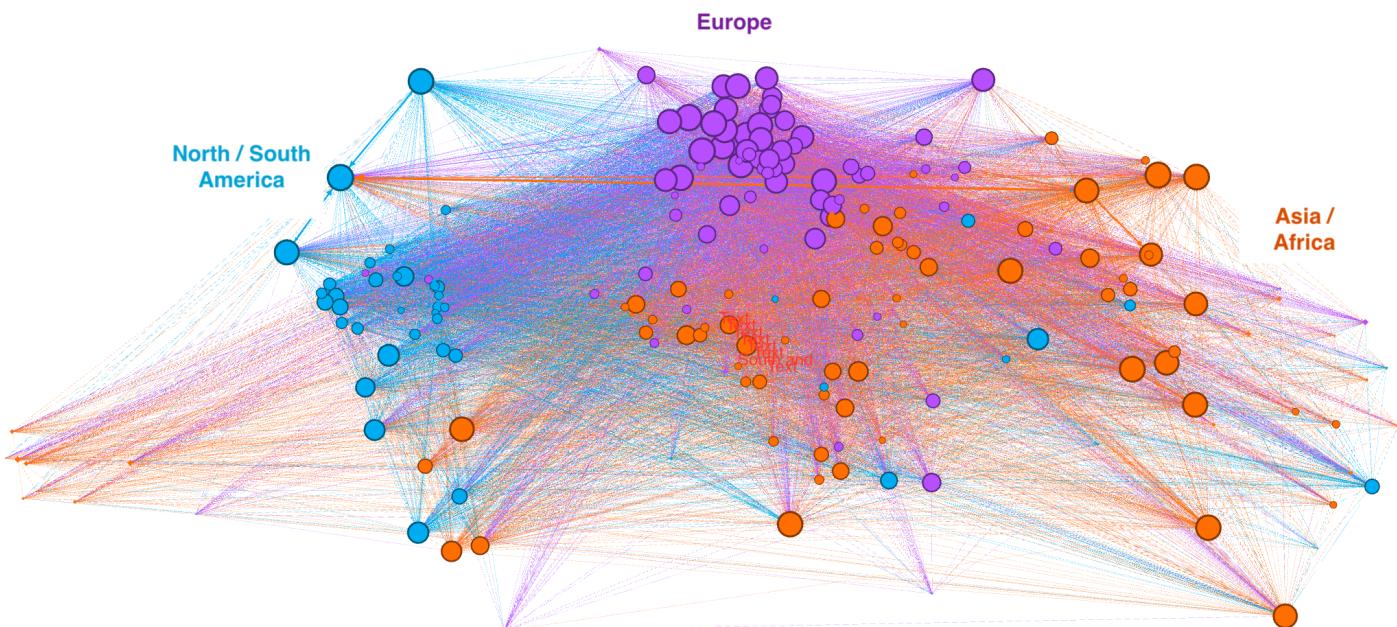
Using the modularity algorithm, three main communities within the global trading network presented themselves. Three communities:

- **Asia/Africa** (and Australia, New Zealand, Brazil, Argentina, Uruguay)
- **Europe** (and Russia, Kazakhstan, Madagascar)
- **North America / South America** (and Sri Lanka, Fiji)

This map shows the three communities. Each node represents a country and the size of the node represents the Out-Degree (# of export relationships). The Asia/Africa community has the largest number of countries trading in their community network and the North/South American community has the smallest number of countries trading within their community network.



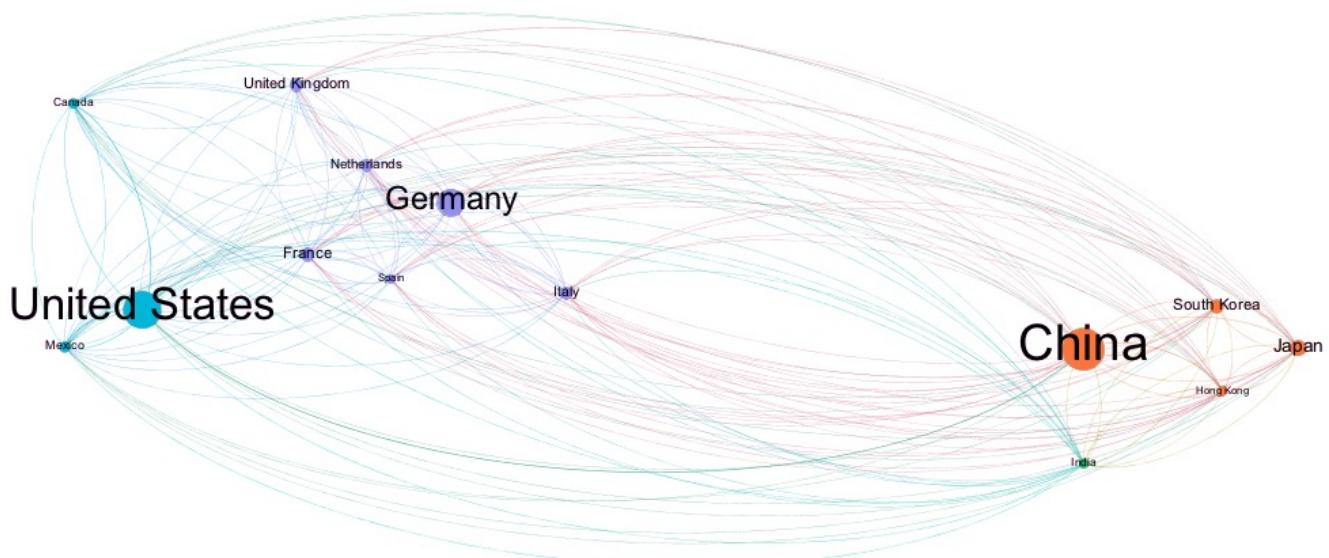
China and the United States did the largest dollar value of mutual trading followed by Canada and the United States. This graph below is showing the trading relationships between countries and their community. The thickness of the connecting lines represents the weight of the relationship, in this case the export dollar value. See the heavy line between the US and China indicating large dollar value exports. The number of trades is represented by the size of the country node.



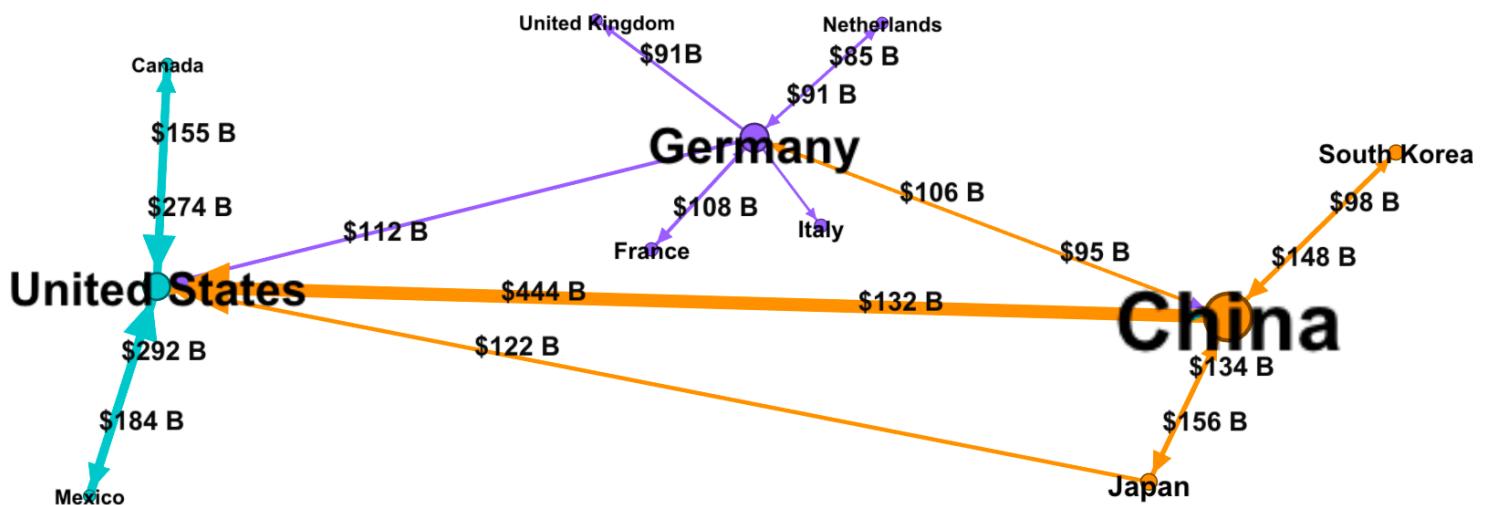
2017 Exports:

The biggest dollar value export relationship in 2017 was from **China to the US at \$444 billion**. The second biggest was from Mexico to the US at \$292 billion. The third biggest was Canada exporting \$274 billion to the US in 2017. Clearly, the US is importing a large dollar amount of goods! But, the US is also exporting big with Mexico, Canada and China. It's interesting to see the 3 communities represented again here – Asia / North America / Europe. In addition to its exceptionally strong trading with the US, China is doing big exports within its own community with Japan and South Korea and also to Europe, specifically with Germany. Germany exported pretty big with 4 European countries and China, but its biggest export in 2017 was to the US.

2017 Biggest Exporters



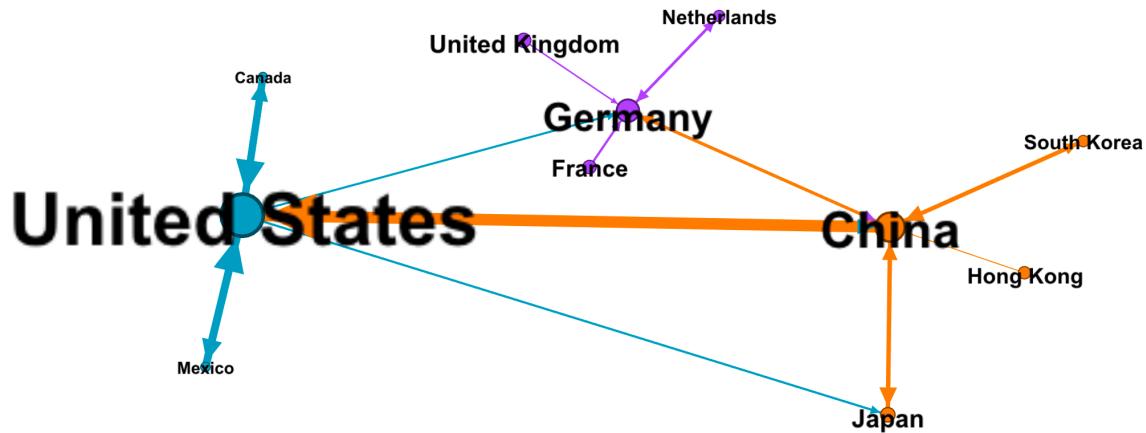
2017 Biggest Exporters



Biggest Importers:

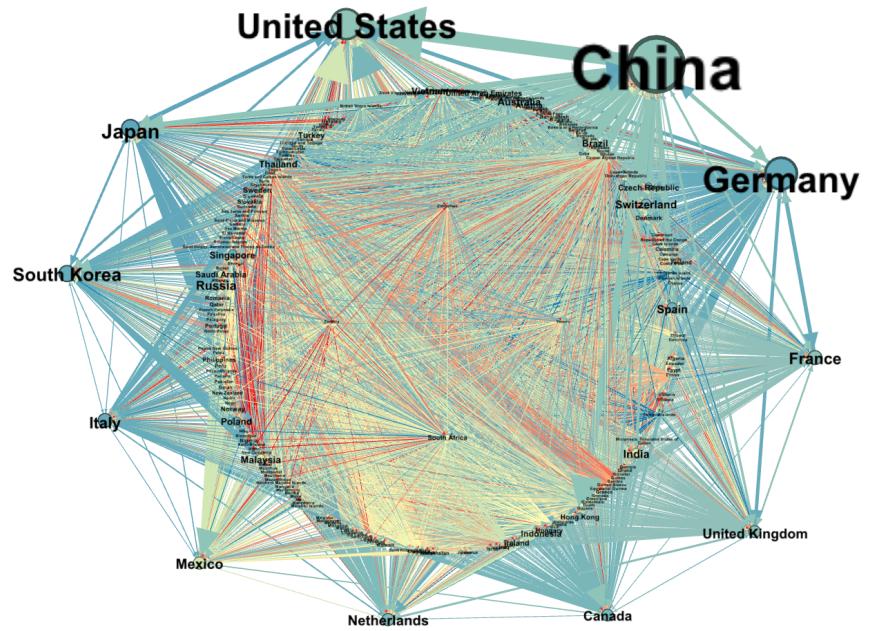
If we look at the biggest importers and their relationships, the **United States** is clearly the largest importer (\$2 Trillion in 2017), importing large amounts from China, Mexico and Canada. China was also a big importer in 2017 with a total of \$1.3 Trillion from various countries. It's interesting to see that many of the same countries that were large exporters are also large importers.

2017 Biggest Importers



Birthrate and Exporting Industry:

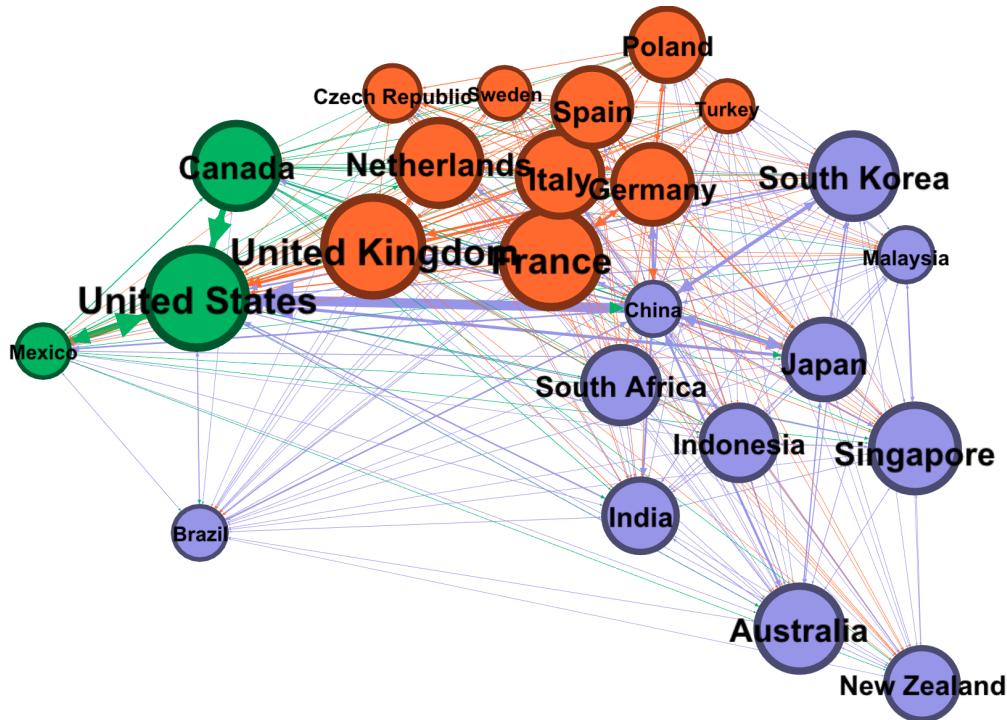
Big exporting countries tended to have low birthrates. This graph shows the biggest exporters on the outside of the circle. All other countries are in or on the circle. Color represents the birthrate in that country. The lowest birthrates are blue, average is yellow and the highest birthrates are red. No countries with a high birthrate (red) did big exports. Often, high birthrates occur in developing economies as it can be related to wealth and access to family planning. Mexico is the only country having an average birthrate and appearing with the top global exporters.



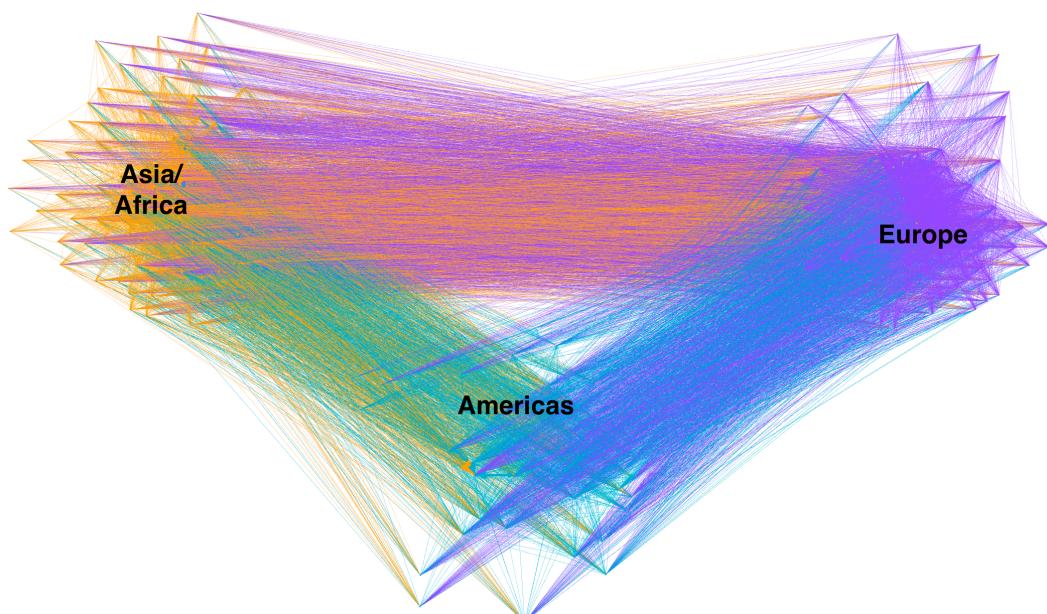
Key Countries

This graph below shows countries that are key to the global network, having a high "betweenness", exporting and importing with many countries within the three communities. These countries have a well-established network of imports and exports. The **United States, the United Kingdom, France and Singapore** are at the top.

2017 Biggest Global Connecting Countries



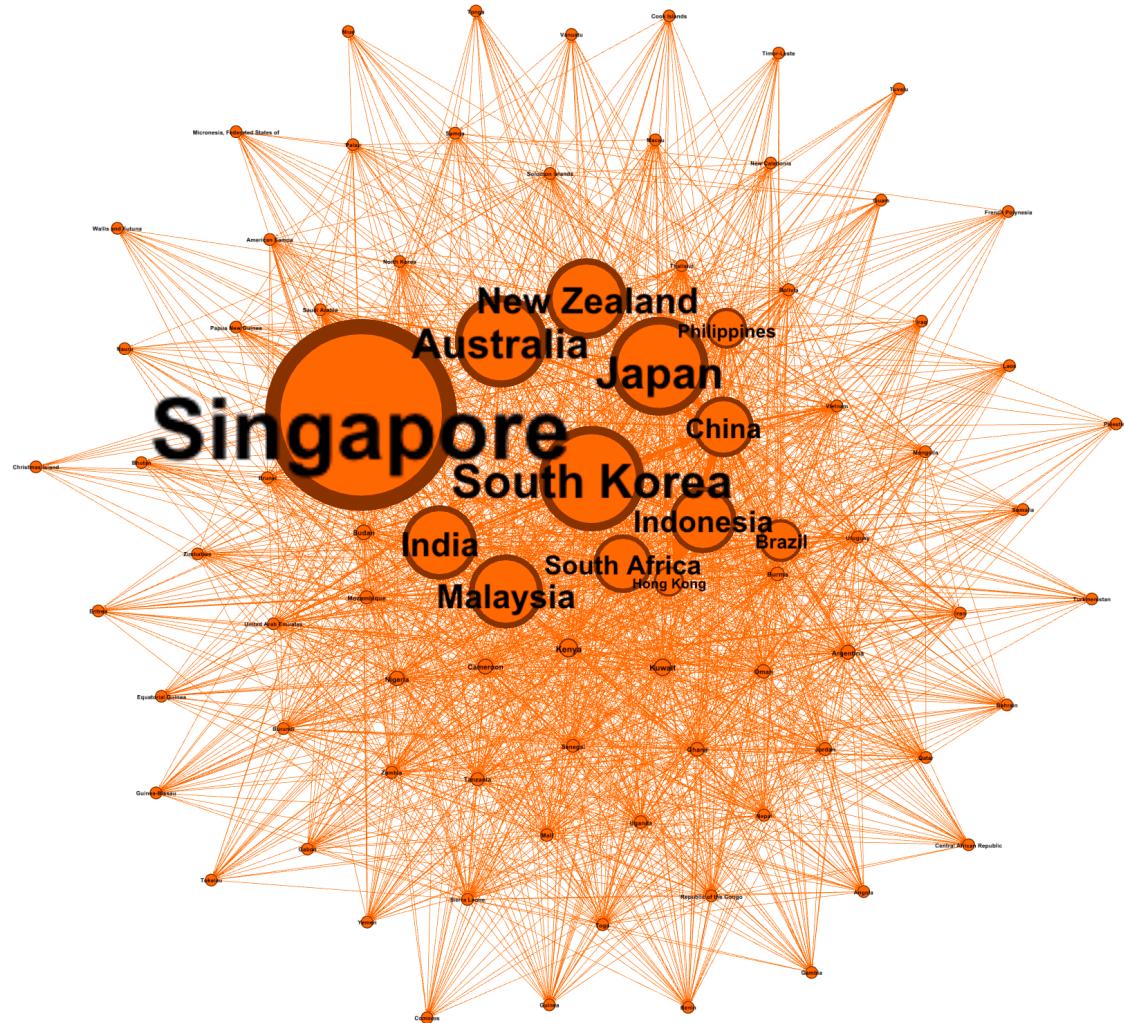
The three communities have some distinct characteristics on their own, but are still very connected to each other. In this graph shown below, the communities were separated/filtered into three distinct areas and then re-united.



Asia / Africa Community:

This community has the largest number of countries at 85 (40% of the total). Within this large community, Singapore has the highest “betweenness”, exporting and importing with the most countries within this Asia/ Africa network. South Korea is second and Japan is third. China does the largest dollar volume in the world, but the other countries shown here with high betweenness have a large network of imports and exports within this community that make them key players. The Asia/Africa community has a network with about 10-11 main countries leading the group of 85, but the Asia/Africa community on its own it a little less dense (.48) than the global network giving an average degree of 39.

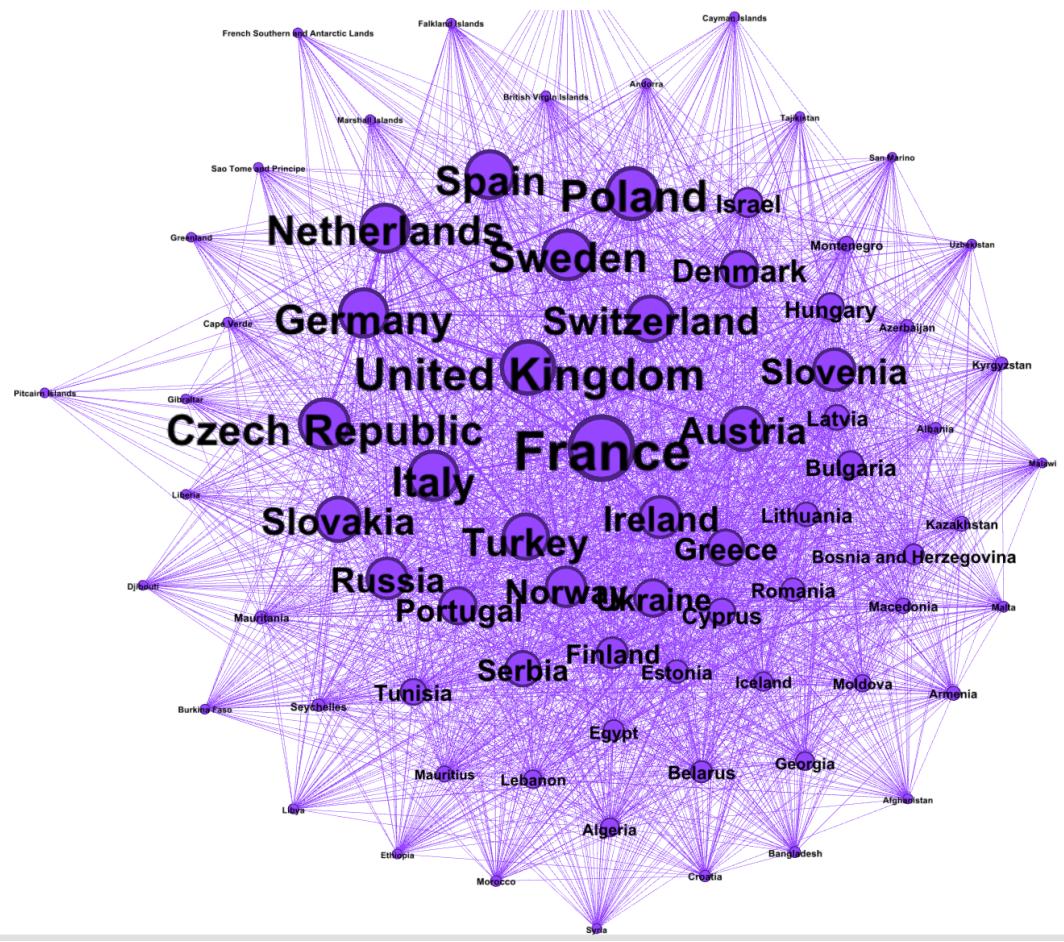
2017 Asia / Africa Community: Biggest Connectors Within Community



Europe Community:

This medium-large size community of 78 countries (37%) is the most dense (.7) of the 3 communities, also having the most imports/exports on average (56) for each country within their community network of 78 countries. This community also has the highest average weighted degree of the three communities, showing its importance in trading dollar value and volume. Many European countries have a well-established trading network (high betweenness) within this community, with France, the United Kingdom and Poland leading the top. There are about 20 countries well-connected showing how this dense network is and more distributed among the countries, varying from the other two communities.

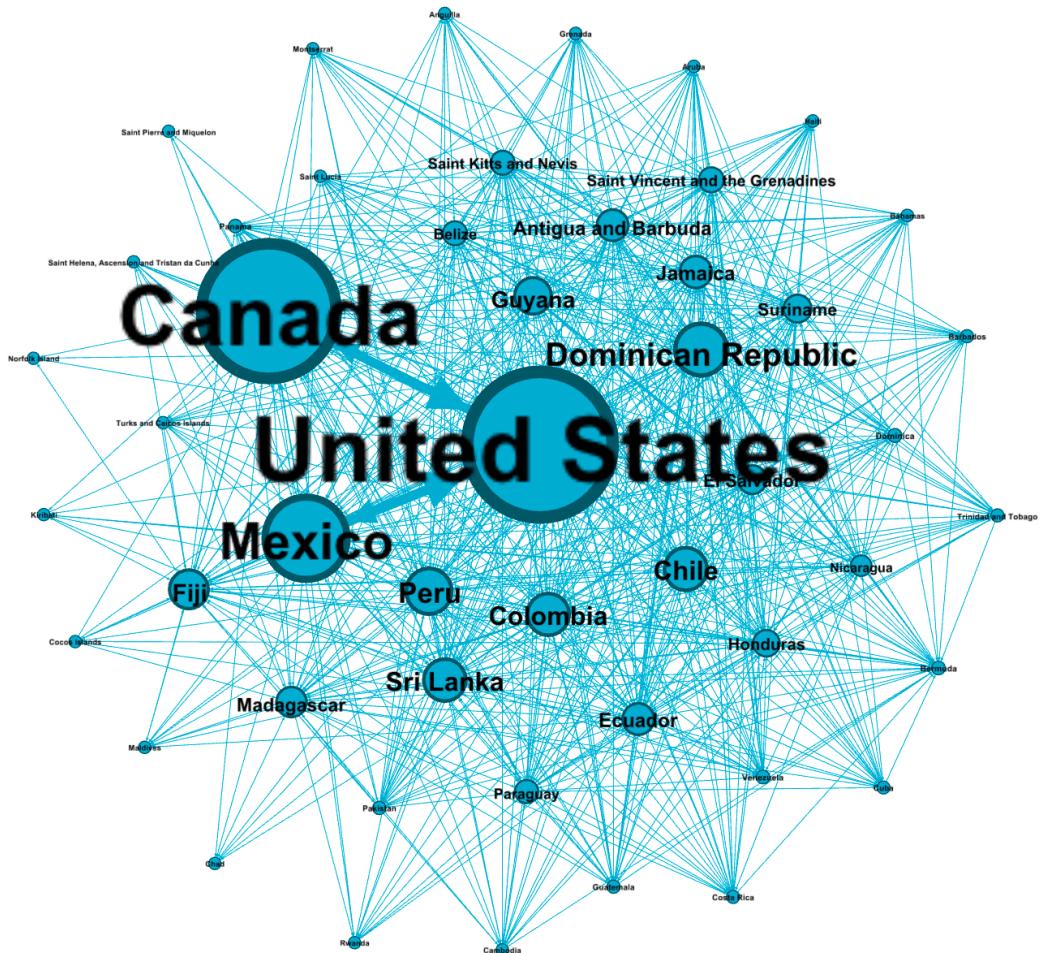
Europe Community: Biggest Connectors Within Community



Americas Community:

This is the smallest community of 49 countries (23%) and lowest average number of trades (24) between the countries within the network. The density is slightly less (.5) than the density of the overall network showing that the Americas and the Asia/Africa communities do not necessarily have more import/export relationships within their community than globally. There are three countries that have the most established trading network and also trade large dollar values as we saw earlier in this report: the United States, Canada and Mexico. The trading behavior is less distributed within this community and heavily relies on the three dominating countries.

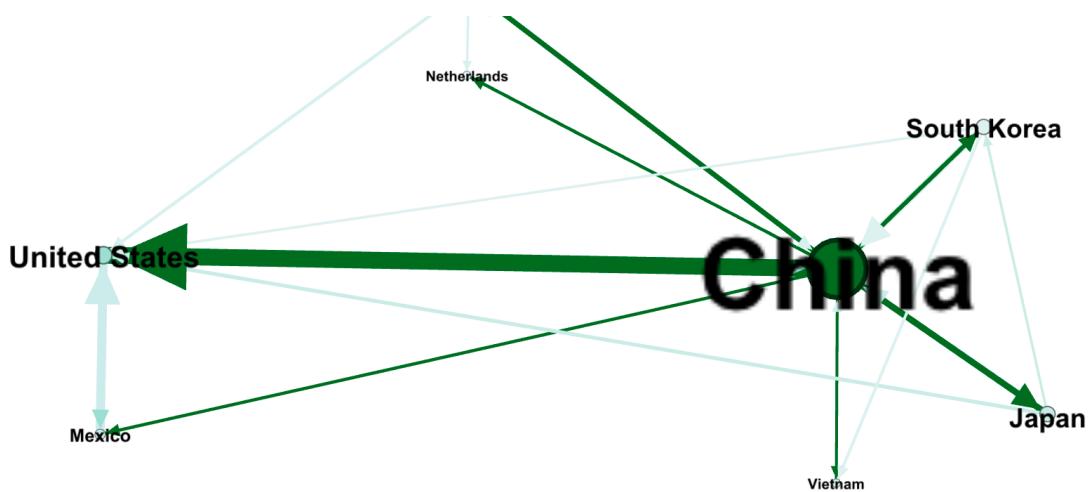
Americas Community: Biggest Connectors Within Community



Machinery/Electrical Exports:

Machinery/Electrical exports was the largest trading commodity in 2017 totaling \$3.8 Trillion, which is about 26% of all export dollars (\$14.7 Trillion) in 2017. This category includes all kinds of machinery and electrical machinery such as: nuclear reactors, boilers, turbines, engines, construction trucks and cranes, generators, etc. which can be utilized in many industries. Surprisingly, every country did at least one export within this category! **China** is the biggest player, with the largest dollar value export (\$210 B) from China to the United States. The next largest is Mexico to the United States and then South Korea to China. This graph below shows how China is dominating the exports of machinery/electrical equipment. The arrows are weighted by the export dollar value. The size of the node represents the weighted out-degree. The color in this graph represents population of the country. China by far has the greatest population among these key players.

Biggest Machinery/Electrical Exporters

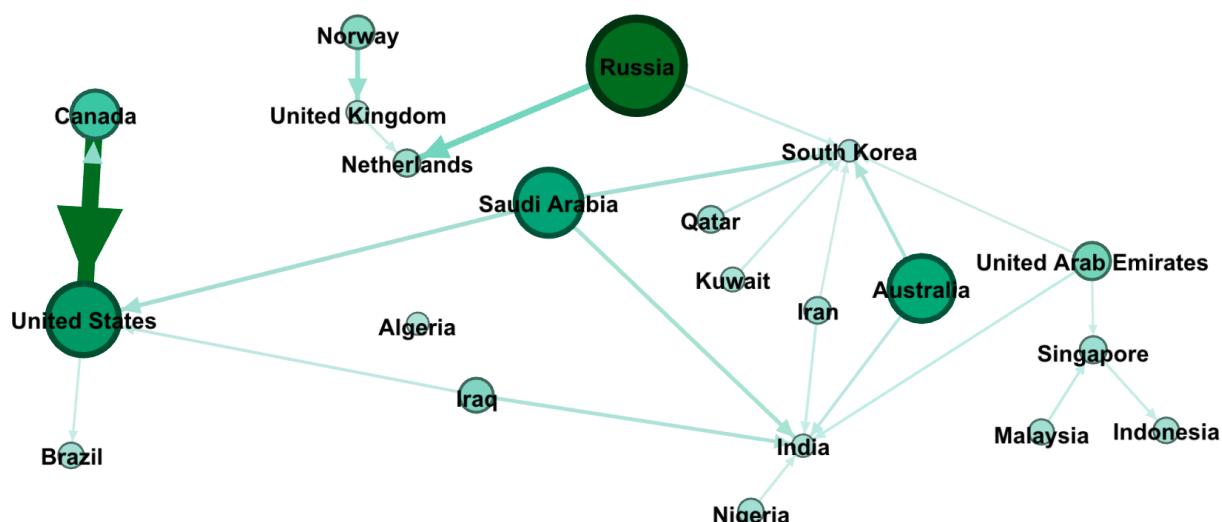


Mineral Exports:

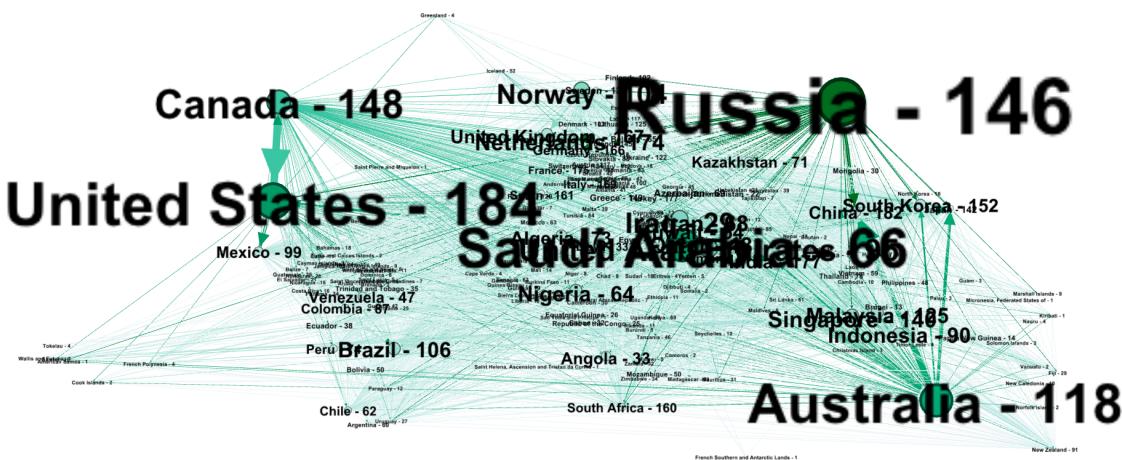
Mineral exports was the second largest trading commodity in 2017 at \$1.95 Trillion, which is about 13% of all export dollars in 2017. Minerals include mined materials such as: fuels, oils, petroleum, metal ores, stone, cement, etc. To focus on mineral exporting, I set the overall weight of the graph edges to the mineral export dollar value, filtered out countries and relationships that did not include mineral exports and ran statistics with that data. This resulted in 203 countries that exported minerals in 2017. The top 5 key players in this market were **Russia, the United States, Saudi Arabia, Australia and Canada**. The single largest dollar value mineral export relationship was from Canada to the United States. The next largest relationship is from Russia exporting to the Netherlands.

To understand this graph, the size of the arrows/lines represents the dollar value of that single exporting minerals relationship. The size of the country node and the darkness of the color represent the weighted out-degree (the combination of the volume of mineral exports and the dollar value).

Biggest Mineral Exporters



The numbers on the graph below represent the out-degree (number of non-null mineral export relationships) for each country. The United States had the largest volume of exporting relationships within minerals, exporting to 184 countries. However, **Russia** had the largest weighted out-degree when you combine dollar amount and volume. Russia did \$191B in mineral exports. **US** did a total of \$141B. **Saudi Arabia** \$130B. but only in 66 relationships. Australia exported \$128B. Canada, although it had a large dollar relationship with the United States only did a total of \$91B on a global scale. This can help countries track their competitors as they compete in the mineral export market.



In Summary, China, the United States and Germany trade in large dollar amounts and are key players in the global trading network. France, UK and the US are the most well connected globally with the most trading relationships. Europe has a well-connected and distributed exporting market among their countries. Machinery/Electrical exports are the largest dollar amount exported commodity and China is dominated that market. In the mineral export market, Russia, the US and Saudi Arabia were the leaders. Most countries tend to reciprocate their trading, mutually importing and exporting with each other.