

COMPGW01- Complex Networks and Web

Coursework 2: Project

Network Analysis of Gold Trade between Countries

Introduction

Gold is a very rare metal and it has long been considered as the most desirable precious metal. In the past, due to its stable value, its value was used as a standard for many currencies known as gold standard. (1) Although most countries have moved on to use fiat system, many still prefer to store wealth in the form of gold. (2) Besides, gold is widely used in jewellery and electronic manufacturing. (3) Therefore, it will be interesting to know the supply and demand of gold for countries and how gold is traded between them.

In this project, I will use gold trade data from UN Comtrade Database to form directed weighted network. The nodes will be countries and the link represents the gold trade between them. The weight of the network will depend on the amount of gold traded between countries.

Objective/Research Questions

Objective 1: Gold Trade Orientation

First of all, I want to examine the property of gold trade network. I will examine whether rich club exists, and if it exists, the position of the countries in the rich club. Besides, it is worth checking whether countries would prefer to import from gold production countries (China, Russia and Peru) or from neighbouring countries. (4)

Objective 2: Key Countries

It is common to everyone that there are several major gold trading countries such as United States, United Kingdom, Switzerland and Hong Kong. (1) In this project, I would want to evaluate the importance of these countries by using the measure of betweenness centrality. Betweenness centrality for a country would count the number of times that country has to be passed through the shortest path between all other country pairs in the network (5) . Besides, I would use this measure to discover the existence of other important gold trading countries.

Objective 3: Flow of Gold

Last but not least, I would want to examine the flow of gold. Since gold is an indication of wealth, it would be interesting to see the direction of gold.

Data and Methodology

Comtrade Data and Data Extraction

UN Comtrade provides an API that can be used to obtain data about commodity trades between countries in the JSON format. (6) By using the API, I created a Java program to retrieve gold trade data (commodity id: 7108) of 2013. The data that the API returns include:

- Source country

- Target country
- Trade Value
- Trade Direction (Import/Export)

However, the API has imposed several limitations to prevent overloading of the server. For instance, it is not possible to use the API to retrieve all gold trade between all countries in one go. To solve this problem, I first retrieved the list of countries that trade gold from the API. Next, for each of the countries I proceeded to obtain the gold trade data between that country and all other countries. Moreover, API limits the access to 100 retrievals per hour. Since there are around 200 countries that trade gold, the data extraction process was time-consuming, as it required 2 hours to be completed.

Network Processing and Visualisation

The data retrieved using the Java program were then analysed and visualised by using Gephi (7). Some of the graphs were also plotted by using Microsoft Excel.

Methodology

The gold trade between countries can be depicted as a network where countries are nodes and trades are links between them. Therefore, in this project, a weighted directed network can be created with the direction of the edge denoting the trade direction and its weight as the trade value. In this network, a country can both import from countries and export to the same or other countries at the same time.

Once the network was created, I studied the properties (Objective 1) of this network by using Gephi. Gephi also allowed me to calculate betweenness centrality to determine key countries (Objective 2).

Results and Discussion

Objective 1: Gold Trade Orientation

Out of 196 countries recognized by the UN as of 2013, I found 187 + 1 countries (Taiwan, Taiwan is not recognised by the UN) participate in gold trading and there are 2782 trades between them. Most countries do both import and export of gold, whilst 20.7% (39) of the countries purely export and 11% (21) of the countries purely import.

The average degree is only 10.298, which means countries tend not to connect to every other country. The diameter of the network is 5 and the average path length is 2.327. Whilst, the average clustering coefficient of the network is 0.545. Comparing these values with values obtained from a random graph generated with the same number of nodes and edges, both network graphs have small network diameter but our gold trade network graph has much higher clustering coefficient. This coincides with the small-world model.

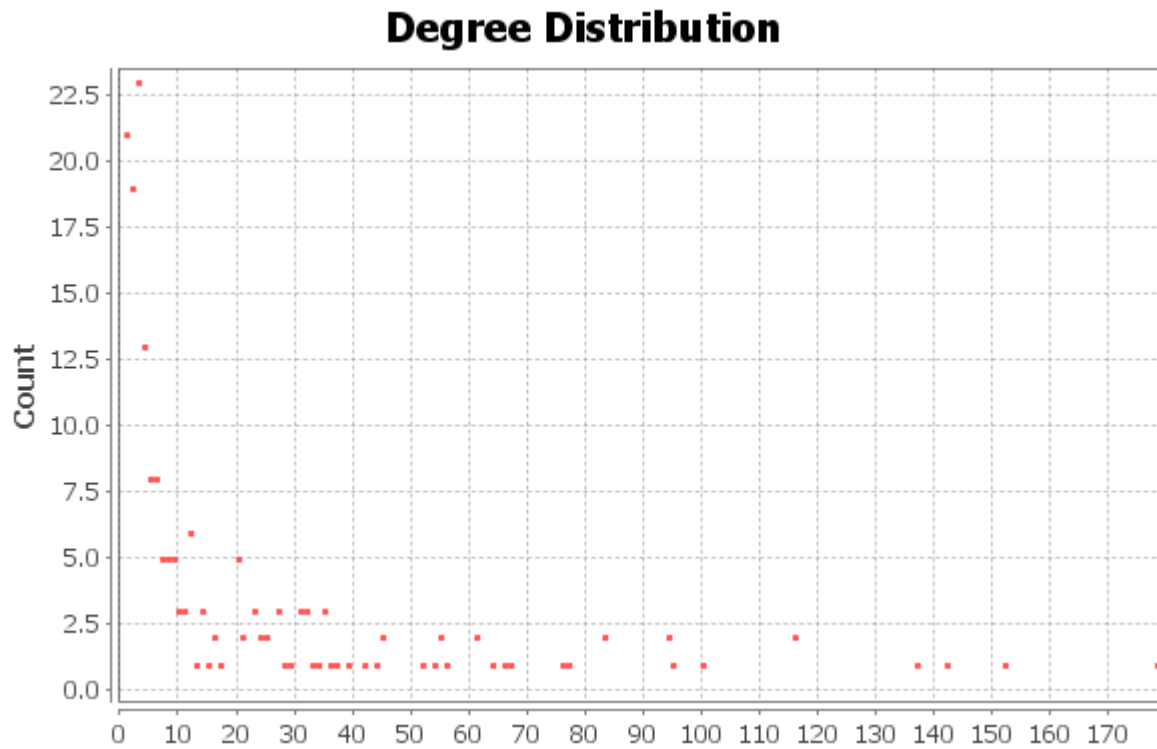


Figure 1 shows the degree distribution of the network

From Figure 1, we can see that this network follows the power-law distribution. This indicates that the network is heterogeneous and confirms the existence of rich-club in the network. That is not surprising, as we know that there are major gold trading countries in the world.

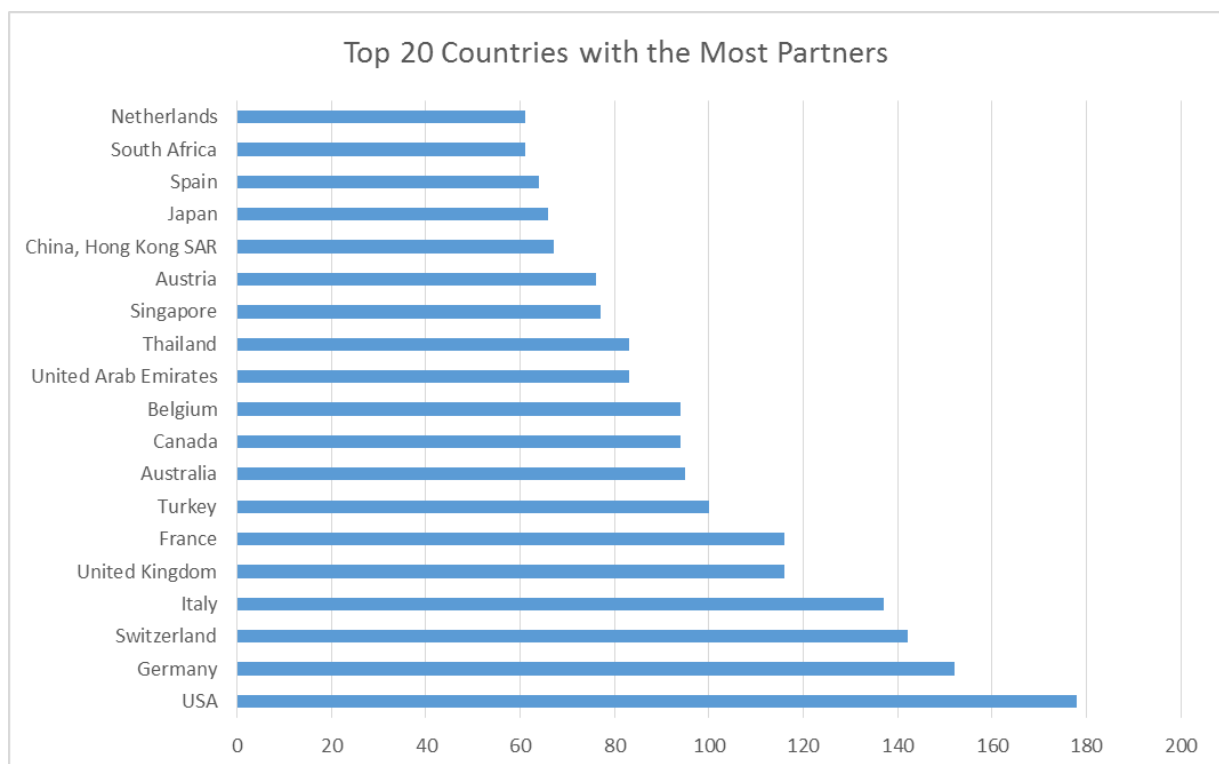


Figure 2 shows the list of countries with the most partners

If we plot the graph of top 20 countries with the most partners (highest number of degree (in-degree + out-degree)), we can see that apart from trading with South Africa, a gold production country, countries tend to trade with gold trading hubs such as USA, Switzerland and Hong Kong.

Objective 2: Key Countries

As mentioned above, I would use betweenness centrality as the measure to examine the importance of each country in gold trading. Betweenness centrality will tell the role and effort of a country in providing network connectivity to the world and thus represents its importance.

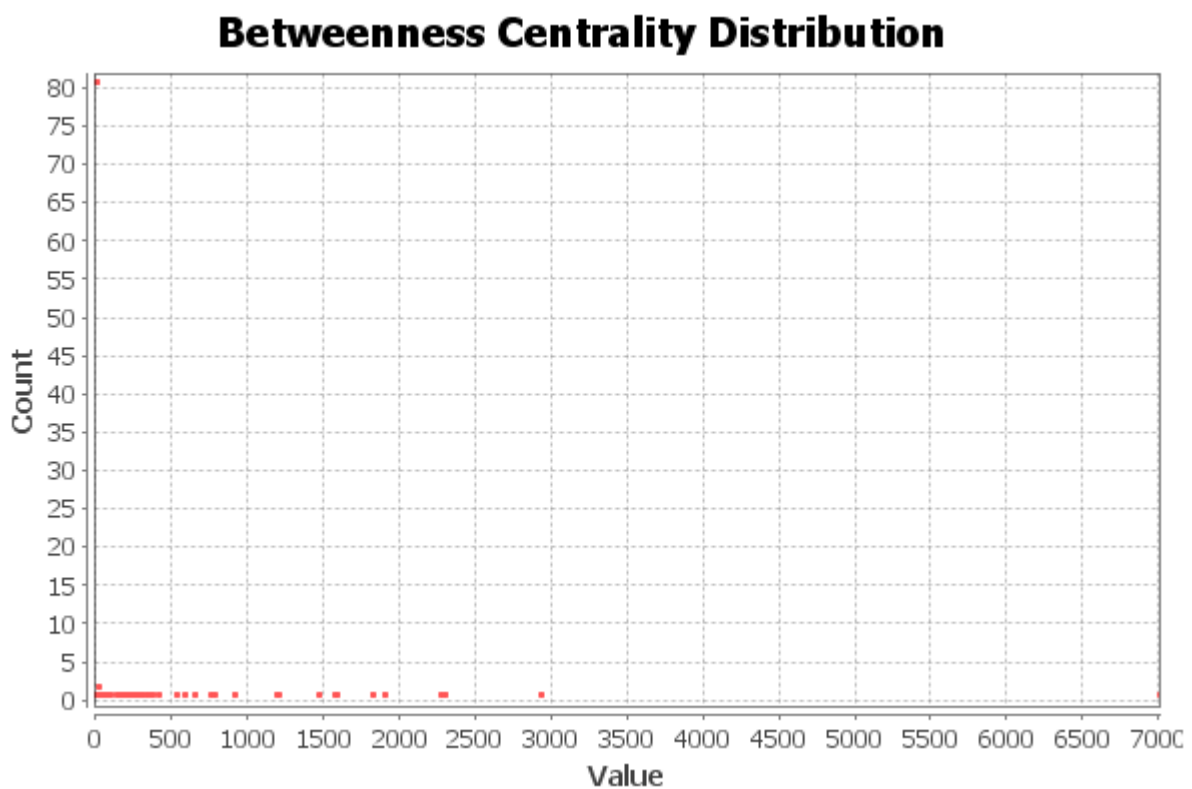


Figure 3 shows the distribution of betweenness centrality

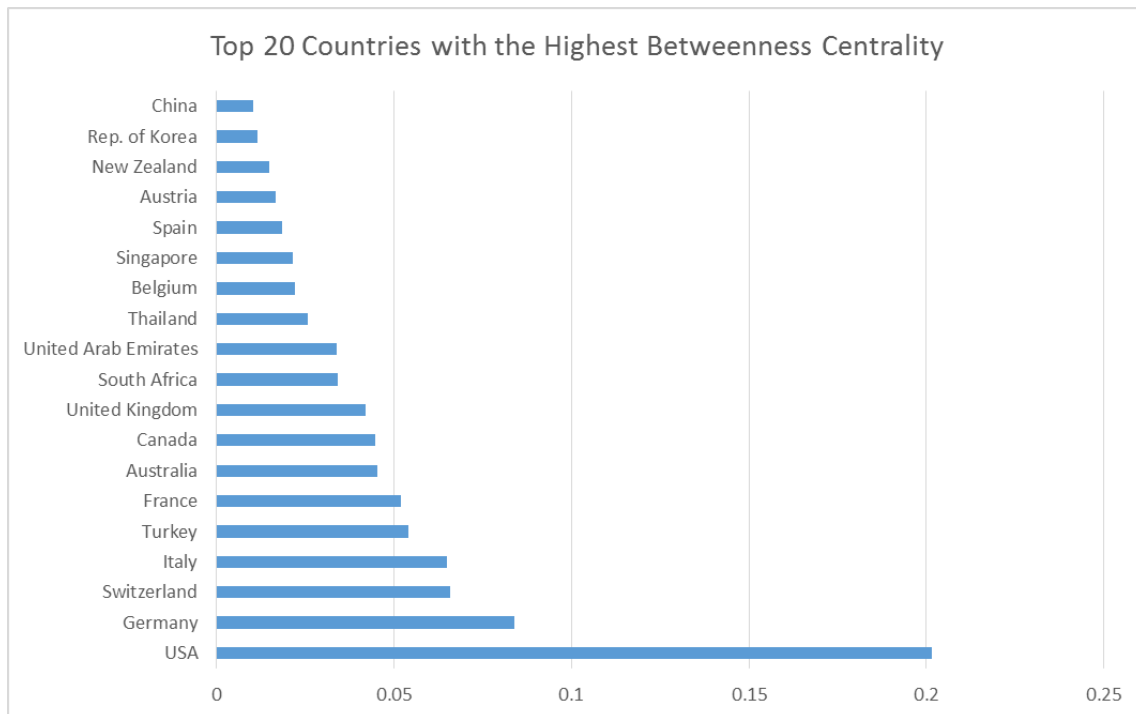


Figure 4 shows top 20 countries with highest normalised betweenness centrality

As we can see from Figure 3, only small numbers of countries have high centrality value with most countries have their centrality values lower than 500. Besides, the United States has the most centrality value (7000) and it is significant higher than Germany that comes second with centrality value of 2800. We can see that apart from USA, Europe dominate the gold trade market with 4 of the top 5 are situated in Europe.

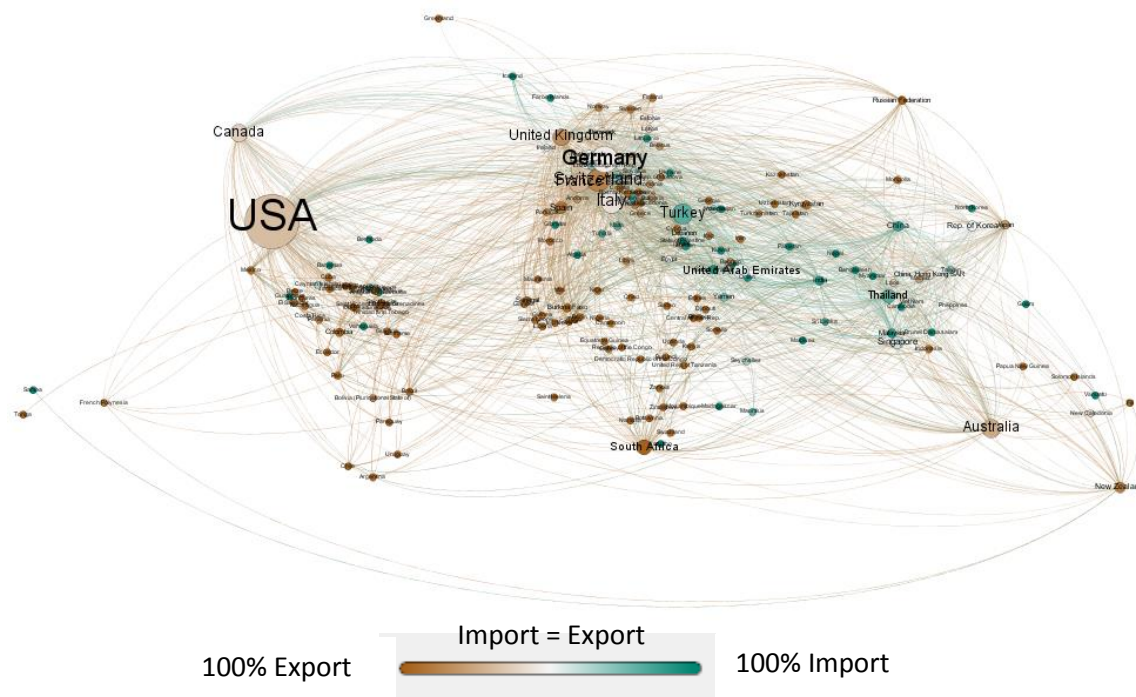


Figure 5 shows the world map gold trading network with the size of the node representing its betweenness centrality and the colour of the node represent its percentage of import/export (difference/total)

The top 20 graph enables us to discover a few interesting things that is not obvious before. First of all, it is very surprising that Germany is second on the list and has greater betweenness value compared to Switzerland and United Kingdom which are the two major gold trading countries. This could be because Germany connects to lot of countries around the world. Next, Hong Kong, despite being one of the most important gold trade market, is not even in the top 20. By plotting the network graph (Figure 5), I found out that this is because Hong Kong mostly only connects to other important gold trade countries such as Switzerland, United States and United Kingdom. Lastly, I discovered that Thailand have the potential to become a gold trading hub as it has significant high value of betweenness centrality.

Objective 3: Flow of Gold

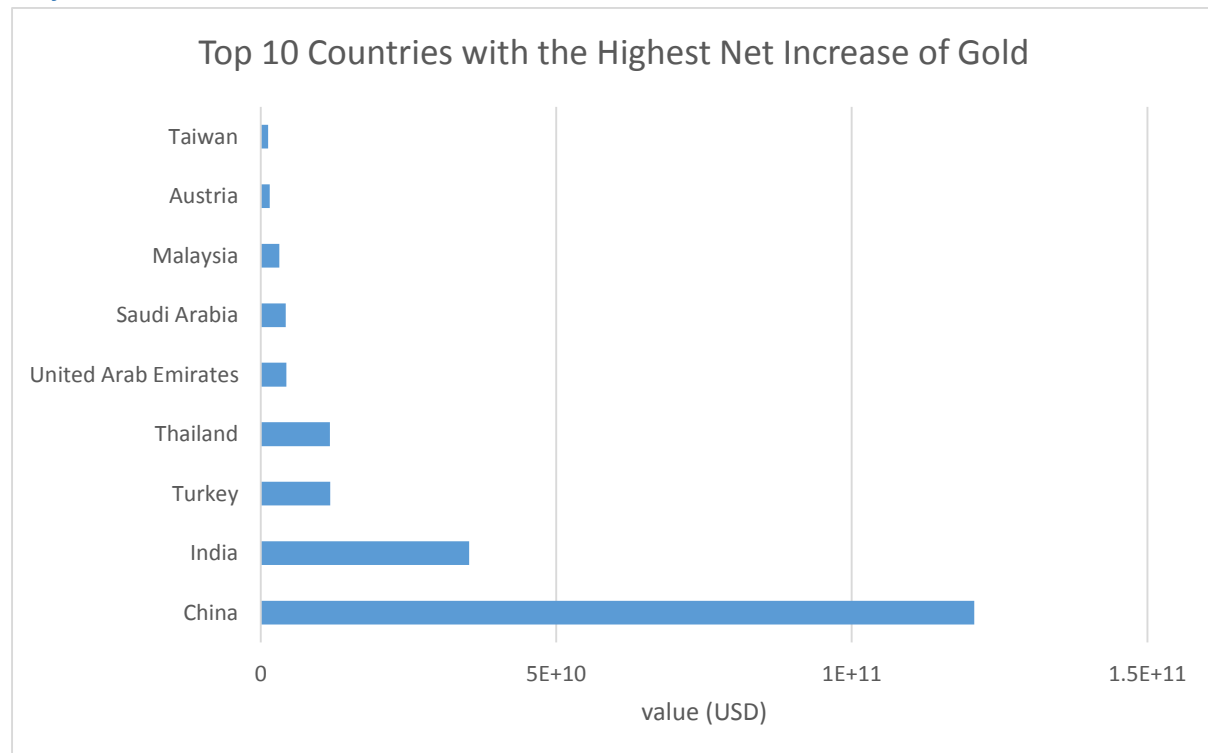


Figure 6 shows the top 10 countries with the highest net increase of gold

The network graph in Figure 5 shows us a real good overview of gold trade happen around the world. We can see that most European countries as gold trading hubs with their import equals to their export. Furthermore, we can see that Africa and South America countries is the gold supplier to the gold trade network, whilst Asia countries tend to import and buy gold. This could be due to two reasons: the rising of Asian economy and/or due to the fact that Asia is the electronic manufacture hub. In fact, in top 10-country list with the highest net increase of gold (Figure 6), only Austria and Turkey are not located in Asia.

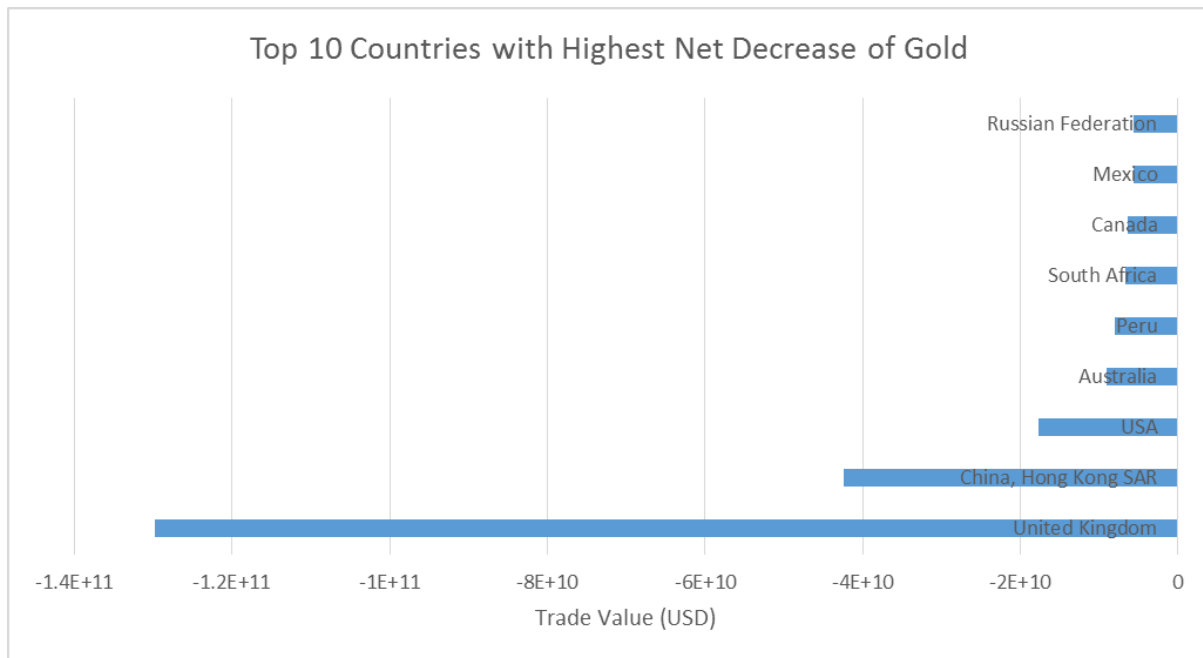
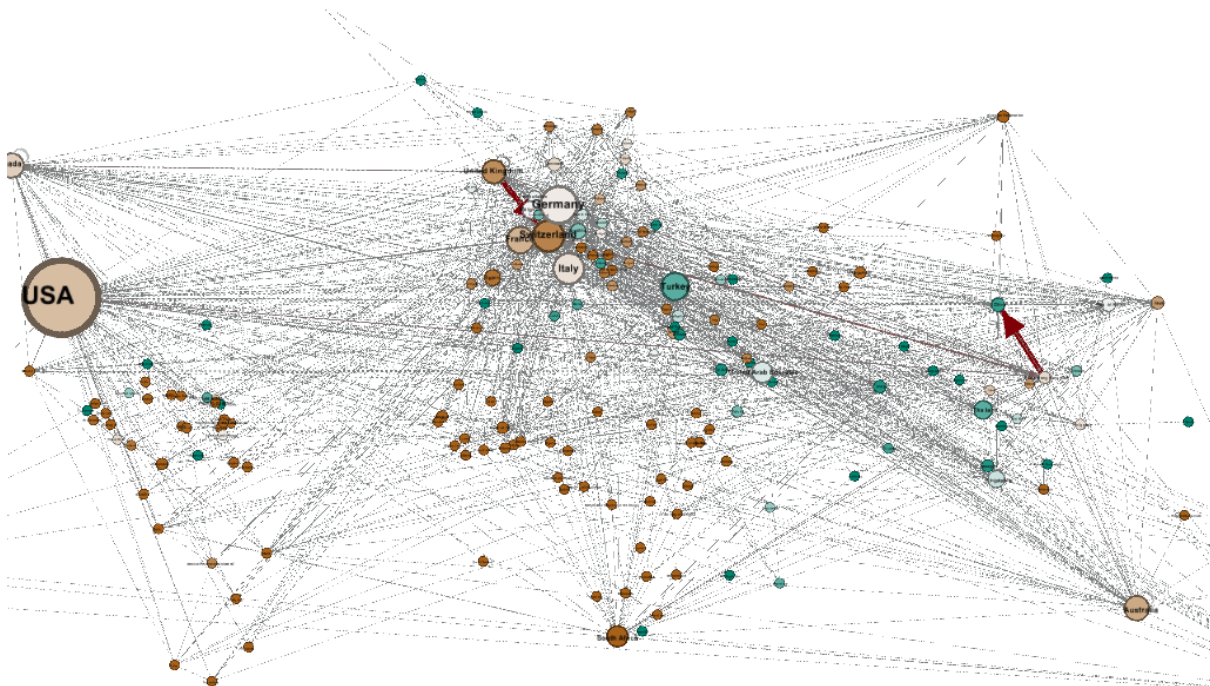


Figure 7 shows the top 10 countries with the highest net decrease of gold

In Figure 7, most countries on the list are gold production countries apart from United Kingdom and Hong Kong. It is both surprising and shocking that these two countries lose huge amount of gold in 2013. To determine the reason, Figure 8 was plotted.



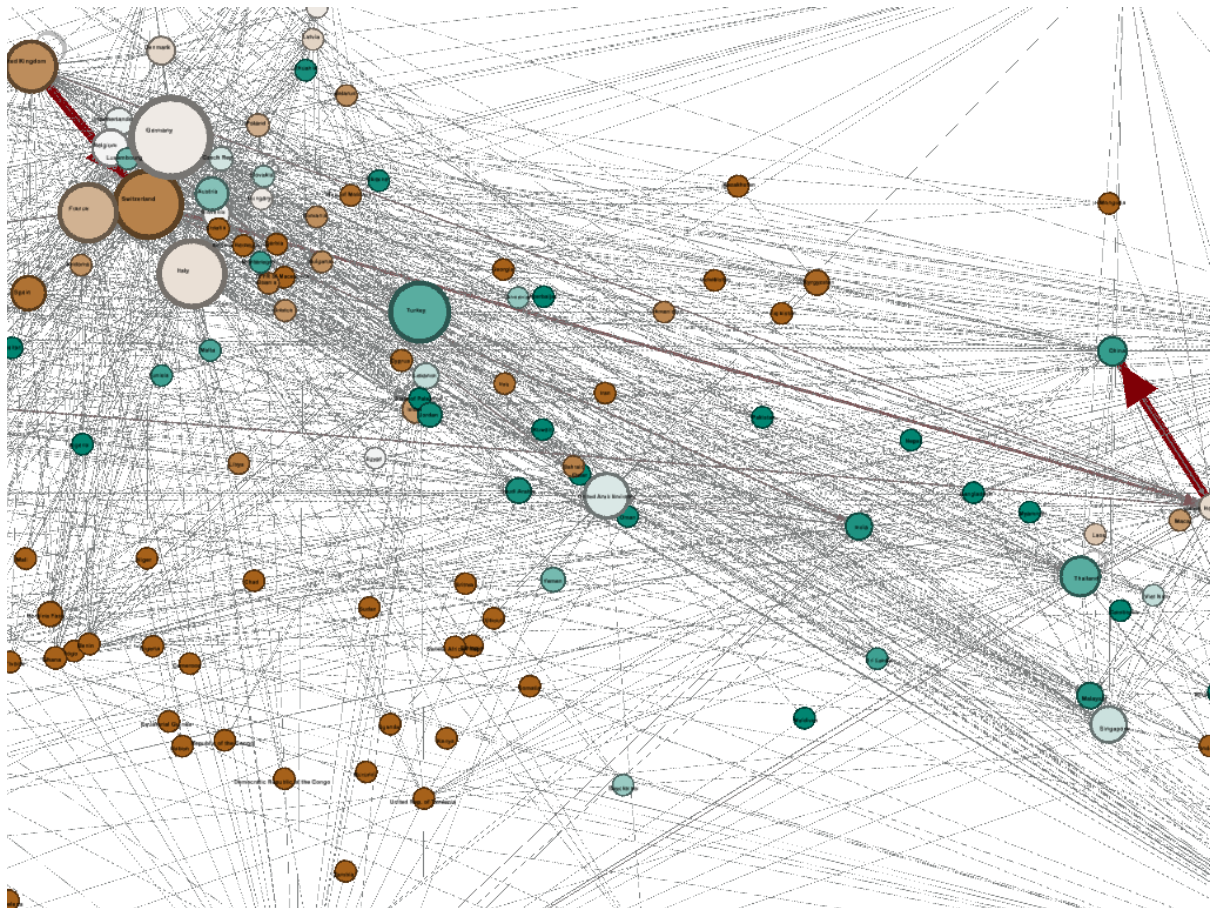


Figure 8 shows the global gold trade network with the size of the arrow denoting the trade value

We can see from Figure 8 that there is huge amount of gold flowing from the United Kingdom to Switzerland, from Switzerland to Hong Kong and from Hong Kong to China. (Note: the size of the arrow denoting the trade value) This means that the decrease of gold from United Kingdom and Hong Kong could be due to the increase of gold demand in China. As a proof, China indeed has the highest net increase of gold.

Conclusion

To best of my knowledge, the project has met the objective that I set. I discovered that countries prefer to trade with gold trade hub rather than gold producing countries. Besides, although Hong Kong one of the major gold trade hubs, it is not important in terms of providing network connectivity to the world. The reason that it is considered as one of the most important gold trade hubs could be because it serves as a bridge between Switzerland and China. Moreover, I found some countries that have potential to be the future gold hub such as Germany and Thailand. Lastly, the network graph also enabled me to see the flow of gold and I discovered that gold are flowing towards Asia.

References

1. Gold Trading Knowledge. [Online].; 2013 [cited 2014 December 3. Available from: <http://www.goldpriceoz.com/gold-trading-knowledge.html>.
2. BullionVault. [Online]. [cited 2014 December 4. Available from: <https://www.bullionvault.com/guide/gold/Why-gold>.

3. King H. Geology.com. [Online]. [cited 2014 December 6. Available from: <http://geology.com/minerals/gold/uses-of-gold.shtml>.
4. Trading Economics. [Online]. [cited 2015 Jan 4. Available from: <http://www.tradingeconomics.com/commodity/gold>.
5. Seaquist JW, Johansson EL, Nicholas KA. Architecture of the global land acquisition system: applying the tools of network science to identify key vulnerabilities. Environmental Research Letters. 2014 October; 9(11).
6. UN Comtrade. [Online]. [cited 2015 1 1. Available from: <http://comtrade.un.org/data/doc/api/>.
7. Gephi. [Online]. [cited 1 January 2015. Available from: <http://gephi.github.io/>.