Analysis of Evolution in Trade Network

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1 Abstract

The exchange of commodities and services across international frontiers is referred to as world trade. It is essential to the functioning of the global economy because it promotes employment creation, economic expansion, and higher living standards. With the emergence of emerging economies, the expansion of international trade agreements, and the increased use of technology in commerce during the past few decades, there have been substantial changes in global trade. Through this study, we have tried to see various trends in the world trade network in the trade of certain goods such as **Wheat, Rice, Iron, Crude Oil, and Pharmaceutical products**. We have taken the help of **network analysis** to gain insights into the trade network of the countries of the world. We have tried to track down the change in **average degree, clustering coefficient, hub, and authority scores and the community structure** over the period of time starting from 1990 to 2022. We have also tried to analyze the effect of **distance effect** in the trade network

2 Introduction

Trade has been an integral part of human society from the very past. In earlier times, people exchanged their goods with each other whenever they needed something. This system was known as the **Barter system** of trade.

This is a world where no country is fully capable of producing all goods within its boundary. Some countries are rich in **crude oil** but poor in their ability to produce **edibles**. Hence there is always a need of cross-country trade to satisfy the need of their own people.

Before moving further, we want to formulate the trade network which we form for our analysis. In a trade network of a particular year and a particular commodity, the **nodes** are the countries which are involved in the trade and there is a **link** between two countries **A, B** if the two countries are involved in the trade of that particular good. In our analysis, we are forming a directed trade network, So when country **A** imports from the country **B**, there is an **incoming edge** to country A and **Outgoing edge** at country B. The graph we form is weighted and the edge weights are the trade value in terms of **US Dollar**.

We have considered the analysis of trade of food grains such as wheat and rice as they are essential for the survival of people and hence we think of the network as dense. We also hope of finding the distance effect in its trade as **cultural similarity** between neighboring countries makes the two countries highly likely to involve in its trade. So if **India** produces rice, it is highly likely to have trade relations of neighboring countries and **South East Nations** as these countries are very culturally related.

Crude oil is also an essential commodity in the world trade platform. One cannot think of life without the crude oil and fuels generated by refining it. Moreover, the interesting thing is that very few countries produce crude oil, especially the **Gulf countries**. Hence trying to analyze its trade network can give valuable insights on the trade network and the **community structure** . We will also try to analyze the change in **hub and authority score** of countries to confirm the fact that only few countries have a strong monopoly over oil trade.

Trade of basic raw materials such as **iron** is also an interesting trade network to analyze. Its analysis can give us how the countries have tried to improve their infrastructure and whether is there any relationship between

infrastructural development and the economy of the country. Since iron is a heavy good and countries would prefer to minimize their shipping costs. So this can be a good analysis to see how the trade has evolved over the years with transportation costs becoming cheaper and the opening of new ports.

Pandemic such as **Covid 19** has resulted in an increase in the trade of pharmaceutical goods. More and more countries are coming into the picture of pharmaceutical trade .

3 Related Work

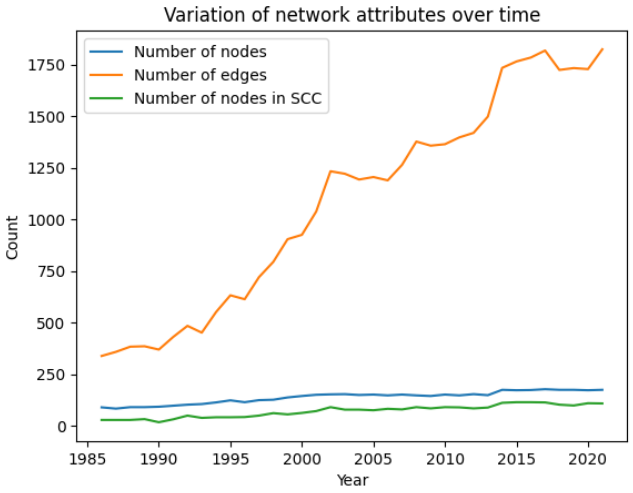
Predicting Crisis in the Global Trade Network Christina Kao, Lili Yang, and Ye Yuan

In this paper, the authors have tried to
build a model that can identify the occurrence of a local crisis simply by examining the trade network. They focus on natural disasters; in particular, earthquakes, floods, and hurricanes and typhoons .By the use of machine learning, the authors have developed a machine-learned classification model

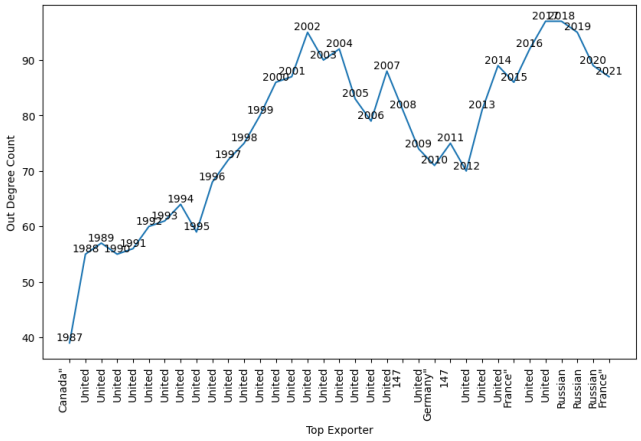
Community Structures in Trade Flow by Pedro Garzon, Gerardo Rendon,Fidel Salgado In this paper, authors have tried to find out the relation between trade and war between countries. They show that trade networks often point to military alliances so recognizing which trade networks are strongest is important to also identify which countries are at a lesser risk of going to war.

4 Discussion and Experimental results

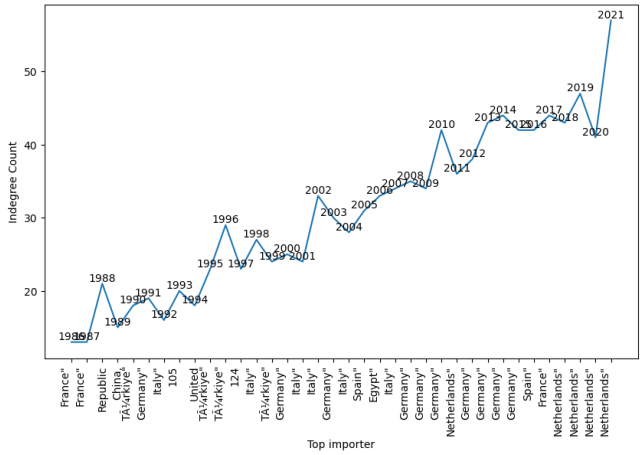
Analysis of Wheat Trade
The variation in the number of nodes, edges, and strongly connected components in the rice trade is given in the picture below.



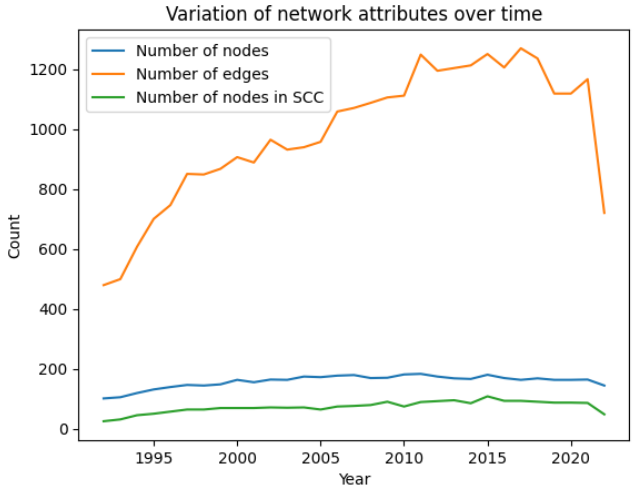
We observe that the number of trade links has increased over the year. We find that number of links slightly decreased from the previous year in 2002 and around 2020. For 2002, we can relate it to the economic crisis, and for the year 2020,we can say that trade was severely affected when countries of the world were affected by **Covid 19** Also, the number of nodes in the strongly connected component increased from 28 in 1986 to 108 in 2021. The number of nodes has become almost constant after the increase in the initial period
We calculated the hub score of each nodes and tried to plot the top hub for each year and the number of outdegree link
The picture is attached below



As we can see in the image, United represents the United States of America. We find that the USA has been the hub of wheat trade over the years.There is some interesting thing to note here. When the covid period came, Russia emerged as the top exporter. During this time , Russia Ukraine war was going on and Ukraine is one of the largest producers of wheat. Ukrainian ports were seized and taken under the control of Russia. Russia is also one of the largest producers of wheat. It increased its export of wheat to many countries during this period.
The variation in the top importer is shown in the picture below.



Analysis of Crude Oil trade The variation in the number of edges , number of nodes and number of nodes in the strongly connected component is shown in the picture below.

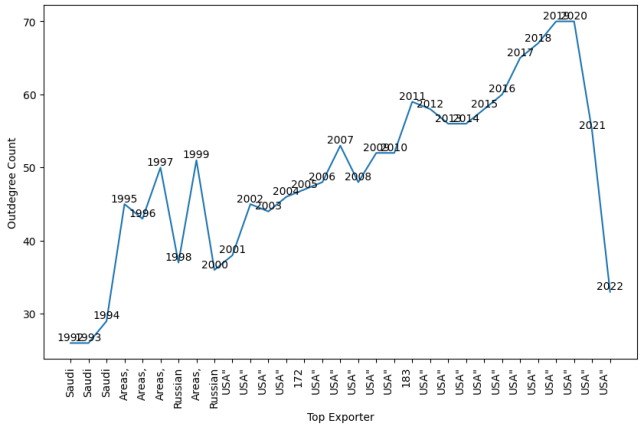


Unlike the steep increase in the edges as compared to the wheat trade network, the increase in the number of edges is not that steep in the oil trade network. There can be several other reasons, but one reason we could think of is that most countries have come up in the oil trade up till the time because it is a very essential commodity.
The number of links dropped around 2020. One reason we could think of is the Russia-Ukraine war and the prevailing covid conditions at that time.

The number of nodes in the strongly connected component is almost constant. There were 25 countries in SCC in the year 1992 which increased to 45 in the year 2022.

Clustering coefficient of the network in the year 1992 was 0.188 . By the end of 2000, the clustering coefficient was 0.312. The clustering coefficient was almost constant between the period 2000 and 2010 which was around 0.28. By the end of the year 2022, the clustering coefficient rose to 0.373.

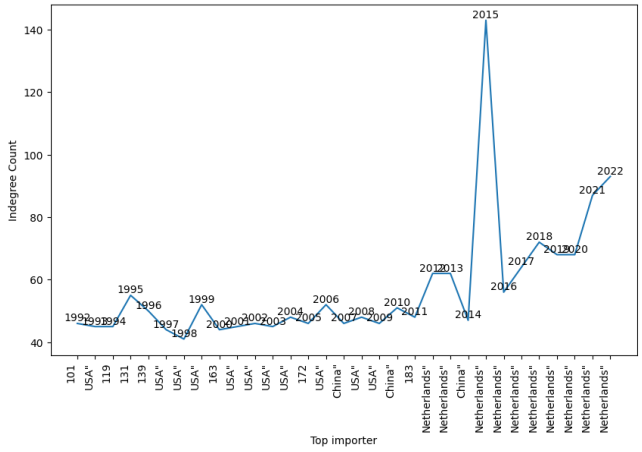
We also tried to capture the variation in top exporters. The variation is shown in the picture below



As it is clear from the picture in the initial years, Saudi Arabia was the top exporter. Areas represent regions that were not specified elsewhere. We found out that the Gulf countries were featured in the top 10 list

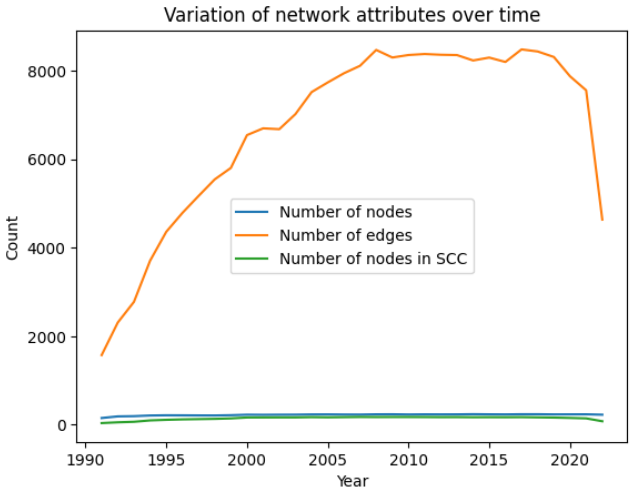
most of the time. Some African countries such as Nigeria and Angola also made their presence in the top exporter list. However, our analysis finds out that the USA took over the oil market and has a monopoly over the trade. This is because it imports crude oil and refines it and then exports the finished products to other countries. This is justified when we plot the graph of top importers as shown in the picture below.

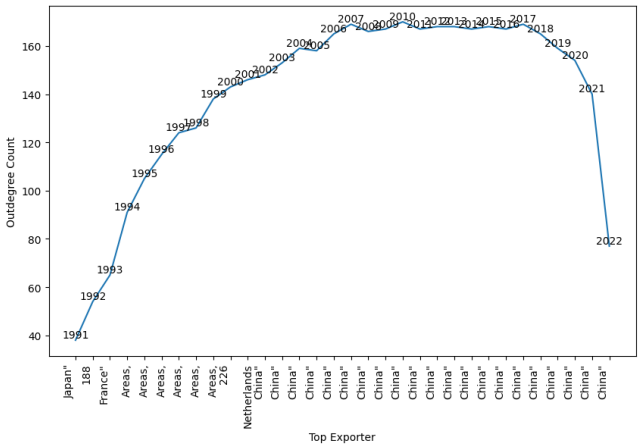
There is one thing to note here, the number of outgoing links for the USA decreased in the recent period i.e. 2020,2021, and 2022. The reason is the rise of oil prices in the USA due to Russia Ukraine War and the financial crisis in the US and some recent developments in the oil industry.

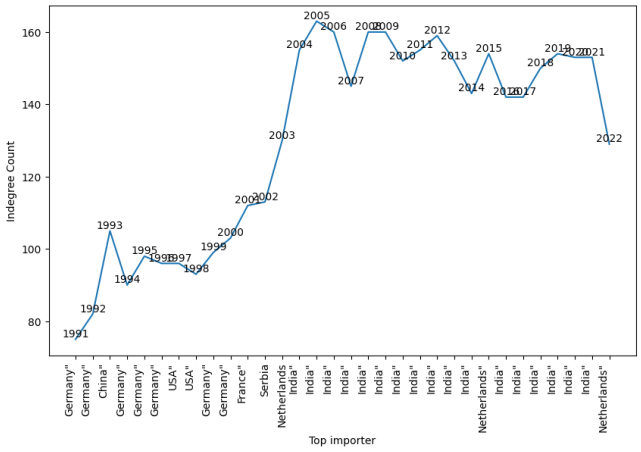


As we can see in the picture above, the USA become the major importer and exporter roughly around the same time. The USA with its advanced refineries was able to maintain monopoly over the trade network.
In the recent period, European countries have become the largest importers of crude oil. This was due to the fear of a total cutoff of oil export from Russia to European countries over Ukraine joining the NATO issue.

Iron Trade Network We performed the same analysis in the iron trade network.







The growth in the number of edges in the iron trade network is similar to the crude oil network evolution.Here also we find the number of links decreased in recent years. This can be again attributed to a stall in world trade due to covi d 19 along with several other reasons.

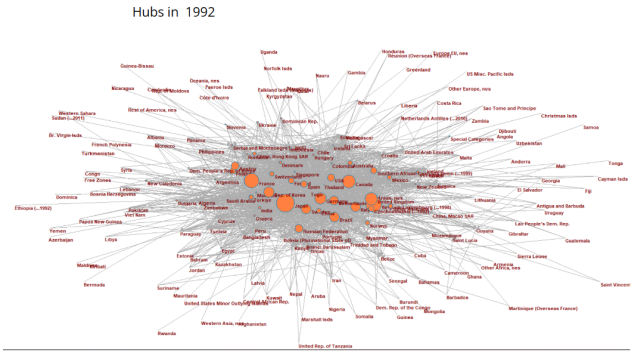
One can argue that China's development

can also be related to its emergence as a major exporter of iron and steel. It not only rapidly developed its infrastructure but also exported iron and steel as it produced iron and steel in excess.

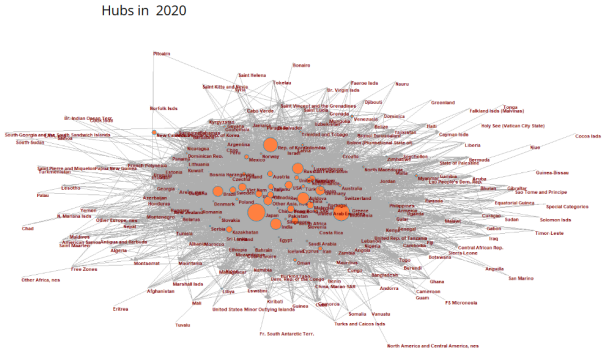
India has become a prominent importer of iron as it has been focussing on the infrastructural development within the country . It has developed several iron plants which are equipped with advanced technology . It also exports the finished goods.

Analysis of Pharmaceutical trade Net

With our analysis, we find out that this trade network has the highest clustering coefficient among all trade networks we analyzed so far. Between 1990 and 2000 , the clustering coefficient, it was almost constant at 0.54. By the end of 2010, the clustering coefficient was 0.566. However, the clustering coefficient increased to an all-time high by the end of 2022 at 0.690. No trade has shown such a high jump in the clustering coefficient. The reason for this rise is the sudden outbreak of covid 19 pandemic.Al so, the COVID-19 pandemic has led to an increased focus on pharmaceutical research and development. Companies, researchers, and governments may have collaborated more in the pharmaceutical industry, leading to a higher clustering coefficient. The pandemic may have caused supply chain disruptions in the pharmaceutical industry, leading to a need for more collaboration and clustering to ensure the continued production and distribution of essential pharmaceuticals.

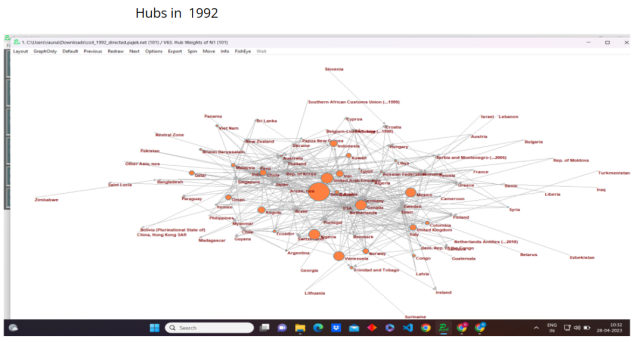


Hubs in 2020



Generated Network of Crude Oil trade

Hubs in 1992



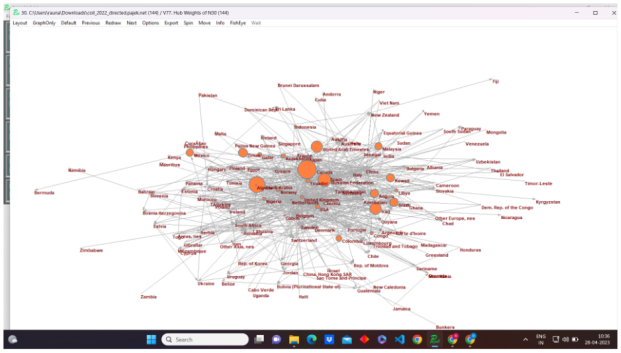
Hubs in 2015

5 Generated Network

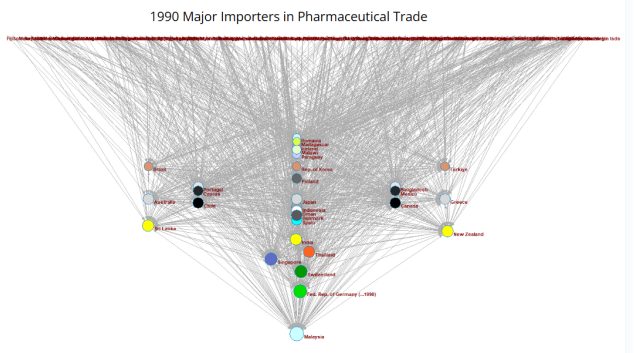
Generated Network of Iron trade

Hubs in 1992

Hubs in 2015

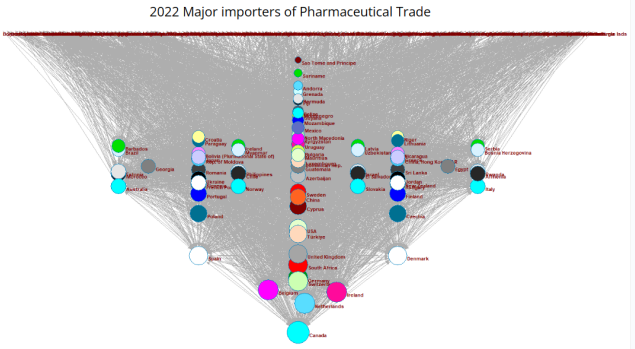


1990 Major Importers in Pharmaceutical Trade



Major importers in 2022

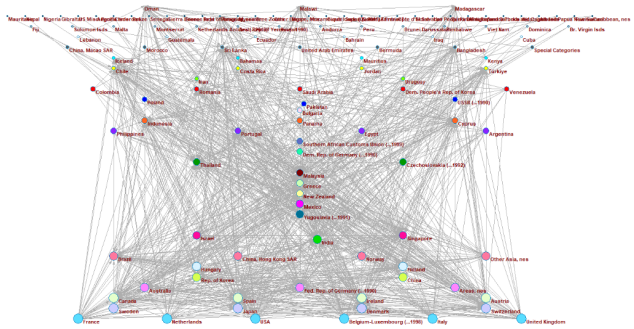
2022 Major importers of Pharmaceutical Trade



Generated Network of Pharmaceutical Trade

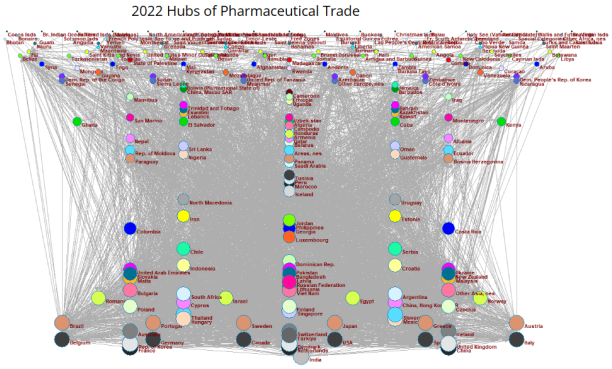
Hubs in 1990

1990 Hubs of Pharmaceutical Trade



Hubs in 2022

2022 Hubs of Pharmaceutical Trade



Major importers in 1990

6 Conclusion

With our analysis, we find out that generally, developed countries form the core of world trade. World trade is prone to pandemics, economic crises, natural disasters, and several other factors . World trade network has a high clustering coefficient which has only increased with new nodes joining the trade network and new links being formed.

The number of nodes has become constant but the number of edges is dynamic. This is because trade links are being formed and vanished whenever there is some problem on the trade relationship between two countries. As we saw, the trade links fluctuated owing to the Russia-Ukraine war and covid 19 pandemic

As far distance effect is concerned, the trade of edible goods is highly influenced by

the distance effect. We find that countries in the same region form strong clusters. This is because the countries in the same region have similar cultures and hence eat the same food.

For Future work, we would like to extend our analysis to several other products and generalize the results on the basis of the overall picture

References

1 https://www.fao.org/faostat/en/data

2 https://comtradeplus.un.org/TradeFlow

3 Predicting Crisis in the Global Trade Network Christina Kao, Lili Yang, and Ye Yuan

4 Community Structures in Trade Flow by Pedro Garzon, Gerardo Ren-don,Fidel Salgado