# Trade and Economic Growth

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The exchange of services, goods and capital across international territories existed throughout history. This exchange among nations of the world, the international trade, represents a significant share of the *Gross Domestic Product* (GDP) which is a measure of the economic performance. In recent decades, the economic, social and political importance of the international trade has risen.

The impact of trade on economic growth is an empirical question. In theory, the impact of trade liberalization on economic growth is absent. However, since liberalization leads to reduced prices and hence improved welfare, its impact on the long run rate of economic growth is positive. Although an appropriate aggregate measure of welfare in an economy is uncertain, technological progress, in other words research and development, is widely used to determine the growth. In this project, we aim to extract insight over the growth and robustness of the world economy based on the world trade network.

Globalization and its consequences is a main concern in trade networks. A historical analysis of the trade network shows that the world became globalized between 1959 and 1996 due to the development of the countries in the middle strata [1]. *World Trade Network* (WTN) has become more dense but decentralized as a result of globalization. Globalization is described as an increase in interconnection and interdependence between countries in terms of scope and intensity. Its economic aspect denotes a worldwide participation in economic exchange. The *Preferential Trade Agreements* (PTA) increased rapidly among subsets of countries. Since many PTAs are based on the geographical regions, this effect is labeled are regionalization.

Globalization is not contradictory to regionalization as the world became regionalized simultaneously. Trade regionalization is not a recent phenomenon. Since the ancient times, geographical proximity has been a primary condition for commodity exchange due to distance acting as a barrier to trade. Adjacent regions do not meet a simple boundary but rather merge across borders. The intra-regional trade density is greater than the inter-regional density therefore intra-regional ties are stronger than the inter-regional ones [1]. Transportation and communication advances have significantly neutralized the importance of geographical distance. However, there is still a significant *home bias* in the international trade network. Quantitatively large informal trade barriers may lead to explain the home bias in international trade. Community enforcement of sanction that may deter contract violations can promote international co-ethic networks. Co-ethnic networks, like ethnic Chinese networks, promote bilateral trade by providing market information and by supplying matching and referral services [2].

The world trade has been globalized and regionalized simultaneously since both the overall network density and the intra-regional density have increased. The fact that the intra-regional density increased concurrently with inter-regional density proves that globalization and regionalization are complementary rather than contradictory.

In this research, we look at the regionalization in terms of the co-ethnicity, adjacency and PTAs. Since we have a more up-to-date world trade data, we analyze, if any, the changes to the density and tie strengths in inter- and intra- regional countries.

Consider a world with two similar, developed economies. The economic integration can cause a permanent economic growth. In a trade network, each product subject to export or import can be thought as a tree [3] where the set of all the products forms a forest. The economic growth implies moving from a poorer part of the forest to the richer parts, the so called *tree monkeying*, as such from the periphery to the core of the product set. Historical analysis shows that the creation and transmission of ideas have been extremely important in the development of modern standards of living [4].

In this work, we use World Trade data from 2008 to 2014 to classify and examine the interactions between "rich" and "poor" countries. We implement detailed import and export data into a network representation

allowing us to use network analysis to see otherwise hidden patterns.

We examine the aggregated exports between countries above and below a cutoff threshold as well as the effect of changing that threshold. This enables us to define "rich" and "poor" transactions and countries. We analyze the relation between the trade and economic growth of a country to see how the economic growth is affected by being well connected to the outside world or by having a huge variety of goods flowing in/out the region.

We look at the so called *rich club slider* where there is a crossing between the "poor" and the "rich" countries. Similar to the transition dynamics of two-level quantum-mechanical systems, a transition from a poor to a rich club/community is observed, which also resulted in more developed economies.

We implement our data into a network of weighted and directed edges, allowing the calculation of edge and node weights as well as other network metrics. We pay special attention to community structure and its evolution in time.

# 1 World Trade Networks

Trade has been studied in the networks framework for the first time recently [5] where an empirical characterization of the trade relationships between different countries worldwide is presented using the properties of the complex networks. The common properties of a world trade network such as scale-free degree distribution, the small-world property, a high clustering coefficient, and, in addition, degree-degree correlation between different vertices make it a complex network, which is far from being well described through a classical network description [5].

A natural way of representing the trade flow between two countries is by means of an arrow pointing the direction of the flow and connecting two points that represent the trading countries. We can attach a value to the arrow indicating the strength of the flow. When we do this for all countries in the world we obtain a network, the so called WTN for international trades with vertices being the trading countries and links being the trading flows.

A network representation of the trade flows gives emphasis on the re-

lationships between the countries and the structure of the network itself. Therefore, it is fruitfully used to address the issues of the international trade and its dynamics. Using the multiplex nature of the complex network systems, the reflections of the international trade on the world economy can be analyzed as well.

There are a number of recurrent structures and measures of WTNs. In a WTN, the countries with many trade partners are usually connected with countries holding few partners. Therefore, on average WTN has a disassortative pattern [5]. Furthermore, well-connected countries are less interconnected that poorly connected countries [6]. The structural properties of WTN remained remarkably stable over time [7]. The historical data shows that the node degree is negatively correlated with the average nearest-neighbor degree [8] and with the clustering coefficient[9].

The network is weakly disassortative when treated as weighted. In a weighted WTN the majority of the existing links are associated to poorly connected countries. Moreover, the countries holding intense trade relationships are more clustered [10].

## 2 Data Collection & Network Implementation

In our research, we perform a weighted network analysis in order to take into account the existing heterogeneity in the capacity and intensity of the connections.

We obtained the GDP data from the World Bank Repository and the global trading data from the Observatory of Economic Complexity. The trading data set contained import and export records of around 6000 different goods between around 260 countries from 2008 to 2014. Such a data set lends itself naturally to a network representation. Countries are represented by nodes and imports and exports are directed, weighted edges. The depth of the data set means that we have the freedom to view the WTN in several different ways, like a network of average import/exports, or net imports/exports for a particular year, etc...

However, this same depth implies that the idea of "node degre" has little meaning. Since most countries deal in some small way with many

other countries, the interesting quantity is the volume of imports/exports, or "node strength" (Fig. 1). We summed the imports and exports between any two countries across all 7 years, and then calculate for each node the in-degree as well as the in-strength (net imports.) As expected, there is no clear structure in the degree distribution while the net imports is heavy tailed.

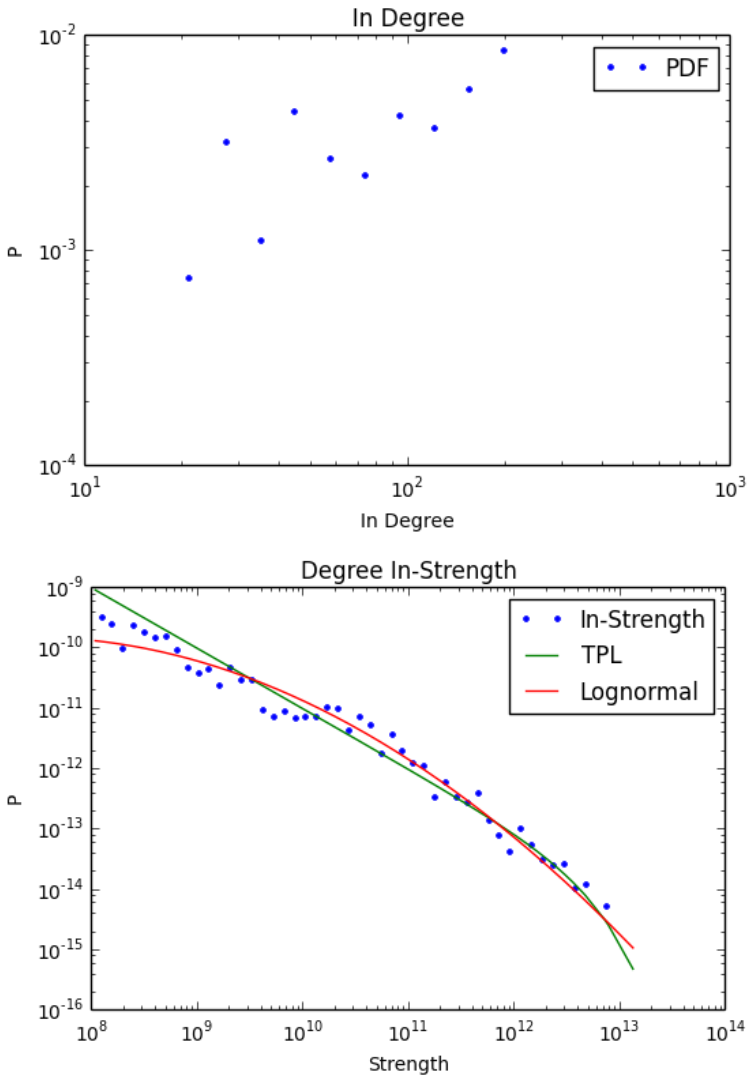



Figure 1: The PDF of the in-degree of countries offers little insight, while the in-strength is structured and indeed heavy-tailed

We also look at the structure of the WTN, as given in Fig. 2 for 2014, it is highly hierarchical with communities due to home-bias and preferential attachment.

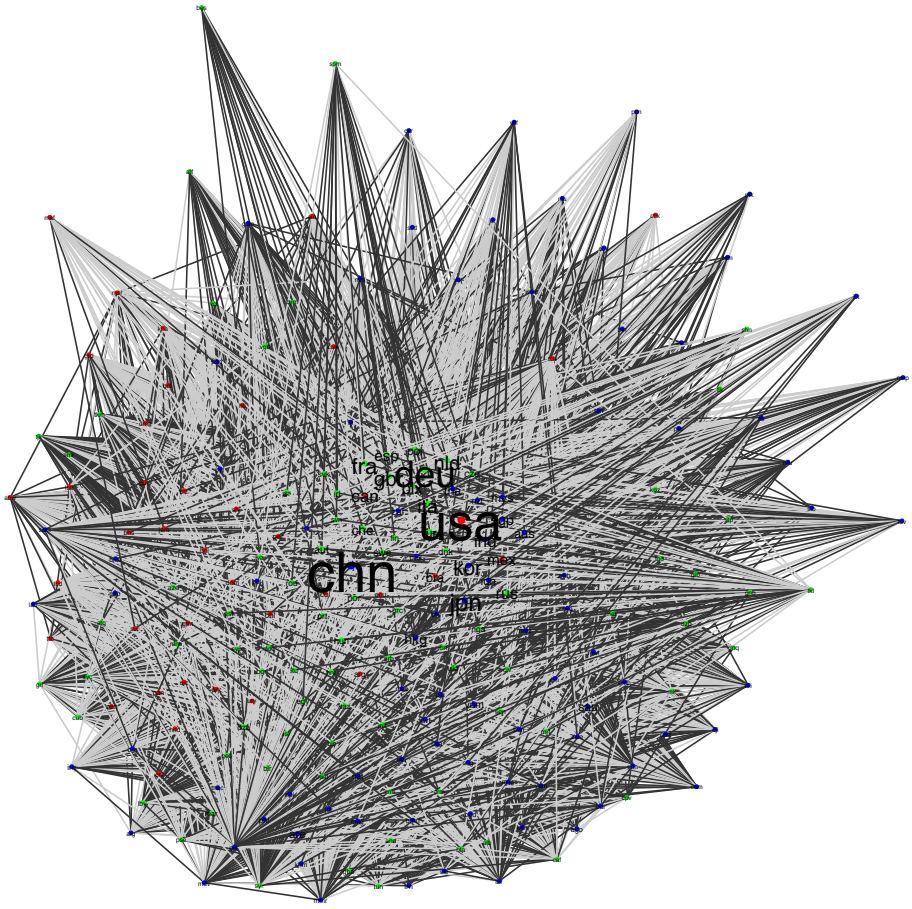
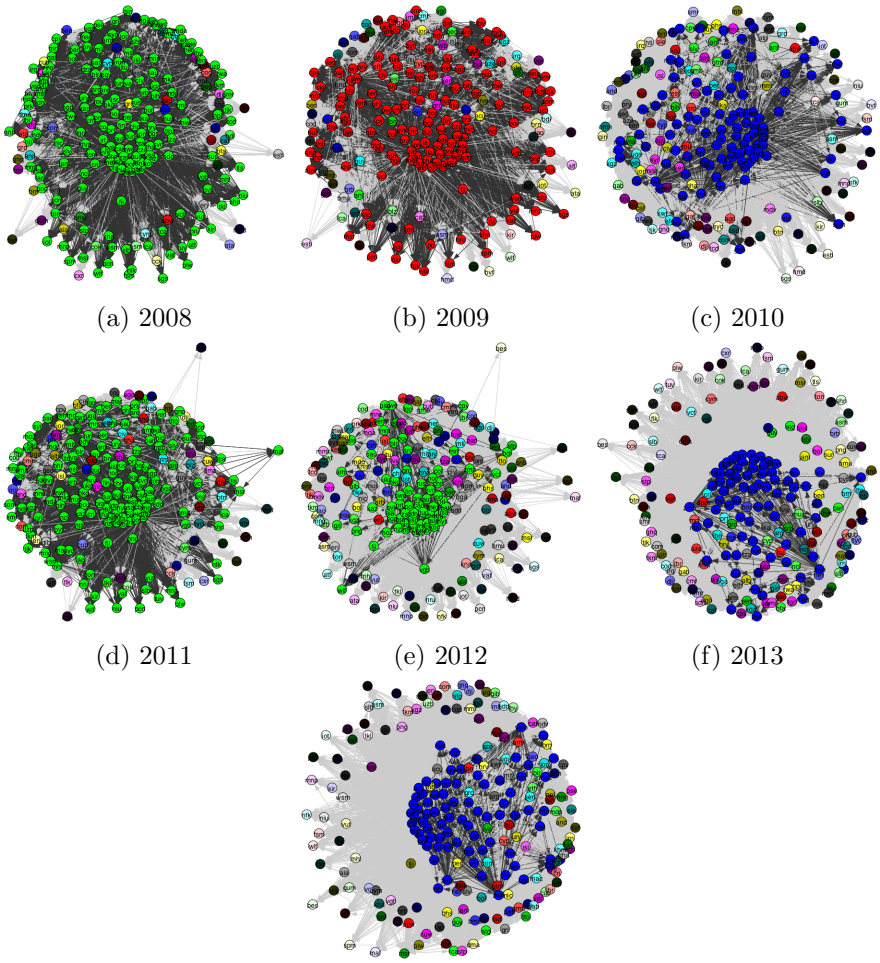



Figure 2: WTN in 2014

## 3 Community Analysis

In the light of the created WTNs, we analyze the community structure. With the network implementation, it is possible to examine community structure as the network evolves in time. We look at the sum of all imports/exports

between countries for each year. Using iGraph, we are able to look for community structure based on a node's betweenness, accounting for weights and edge direction (Fig. 5). We notice that in all years there is one "giant community", but it may be that the actual members of this community change as time goes on.



(a) 2008 (b) 2009 (c) 2010

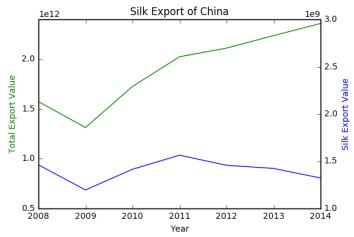
(d) 2011 (e) 2012 (f) 2013

(g) 2014

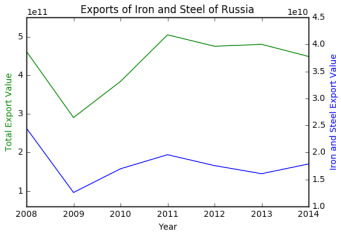
Figure 3: Net Import/Export network community structure for 2008 - 2014

The dataset is for a broad spectrum of goods. We look at different goods and identify the lead exporter of that particular good. In order to

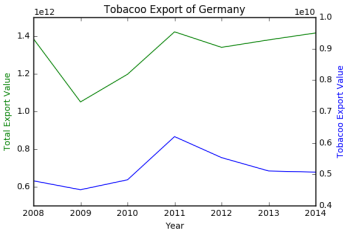
understand the standing of that particular good in the overall exports of the lead exporter country, in Fig. 4 we plot the total exports and the export of a certain good for selected examples of silk, steel & iron, tobacco, minerals, clocks & watches, and cork.



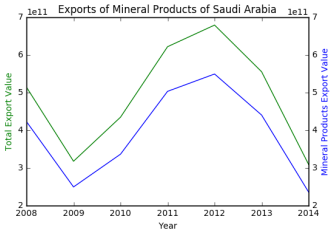

(a) China's Silk Export



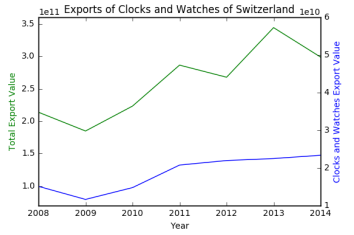

(b) Russia's Steel and Iron Exports



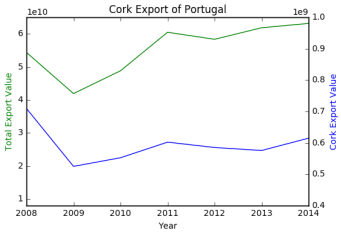

(c) Germany's Tobacco Export




(d) Saudi Arabia's Mineral Product Export




(e) Switzerland's Clock and Watch Export




(f) Portugal's Cork Export

Figure 4: Certain goods and their top exporters

For Saudi Arabia, what is surprisingly yet reasonably amazing is that, as shown in the plot, two curves that stand for the export of mineral products and total export volume respectively have a nearly identical shape, which shows that not only has petroleum (mostly for Saudi Arabia) export taken

up a great portion of the total export, it also has been the major drive of the total export for the country. Since it is well known that Saudi Arabia's economy is heavily dependent on its oil industry, obvious economic recessions can be observed from 2008-2009 due to the global financial crisis and 2012-2014 because of a decline in demand for some major buyers in the market.

For Germany, we may divide the entire period into three sub-periods, which are 2008-2009, 2009-2012 and 2012-2014. For the first and third sub-periods, we notice divergence in directions from the two curves. The divergence indicates during those two periods, although the export volume for tobacco having mild declines, Germany experiences a shock and a boost in some goods that constitute a giant part of its exports in 2008 and from 2012 separately.

Portugal largely experiences no exciting changes between cork and its total export despite the fact that some nuances such as a slight difference in terms of "slope" or the curves during 2009 and 2011 and divergence between the two curves in 2012 can be found.

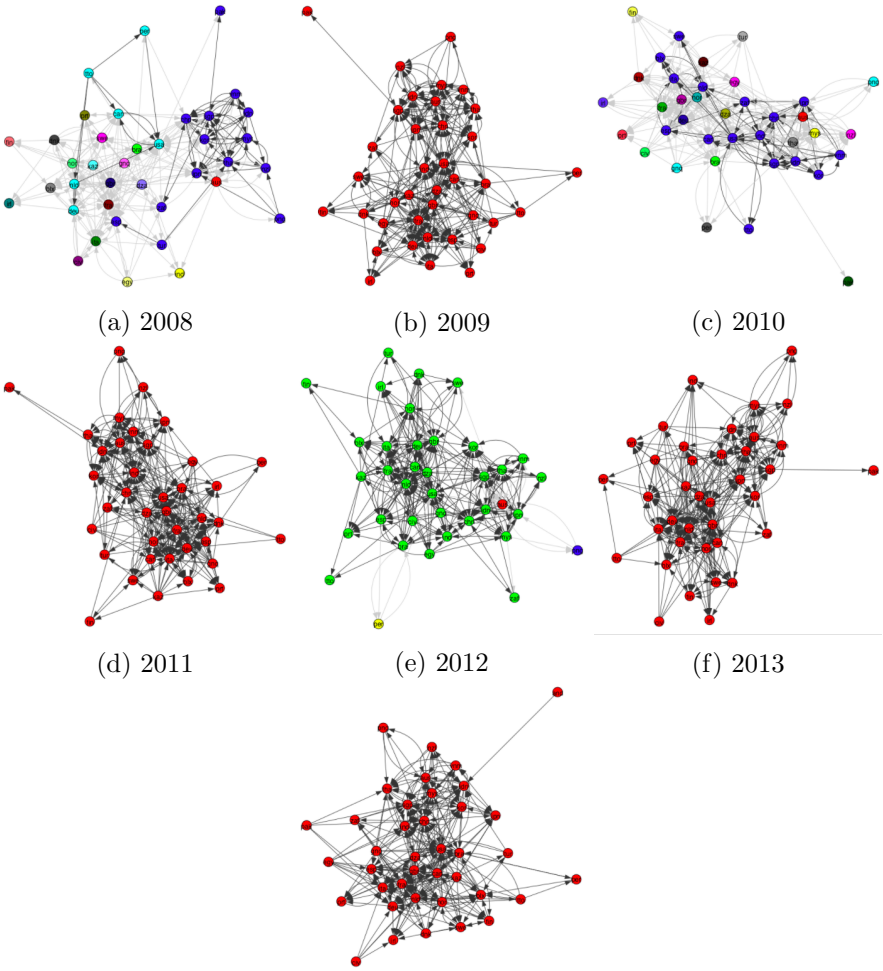
Nearly the same scenario of Portugal happens on Russia from 2008 to 2014 on Russia's steel and iron export and Switzerland's clock and watch export from 2008 to 2011. From 2011 to 2014, there is a slow but steady increase in the export value for clocks and watches, compared with a sharp fluctuation in total export over that period.

For China's silk export, we discover the same V-shaped part of the whole curve from 2008-2010 as other country's export for a certain product and total export owing to the financial crisis. The later deviation of the curves suggests the decline in the silk industry in comparison with China's booming total export.

Although the axes have been truncated and scales are different, our observations are valid and nontrivial for the reason that the trends, or the directions of curves remain constant throughout truncating and scaling the axes.

We narrowed our focus down to one good, oil, and captured the top 40 oil exporters of the world given in Fig. 6. The oil community plots for 2008-14 show that the multiple communities seen originally converge into a single community. This suggests an increase in the "interconnectedness" in the oil trade between these top countries as time passes on. The two

larger communities in 2008 have merged together to form a single one in 2010, suggesting that the "community merging" may be more than just an artifact of our aggregation/community detection method (betweenness.)



(a) 2008 (b) 2009 (c) 2010

(d) 2011 (e) 2012 (f) 2013

(g) 2014

Figure 5: Community structure of the top oil exporters for 2008 - 2014

The standing of all the countries that belong to the same oil community merged to a similar situation in time. By looking at the intra-community evolution we see that the countries in the same community strengthen their ties in time. Community wealth, based on the in-degree, over time plots in-

dicate changes in community wealth, but their use as a wealth-distinguishing measurement is nullified by the concentration into a single community.

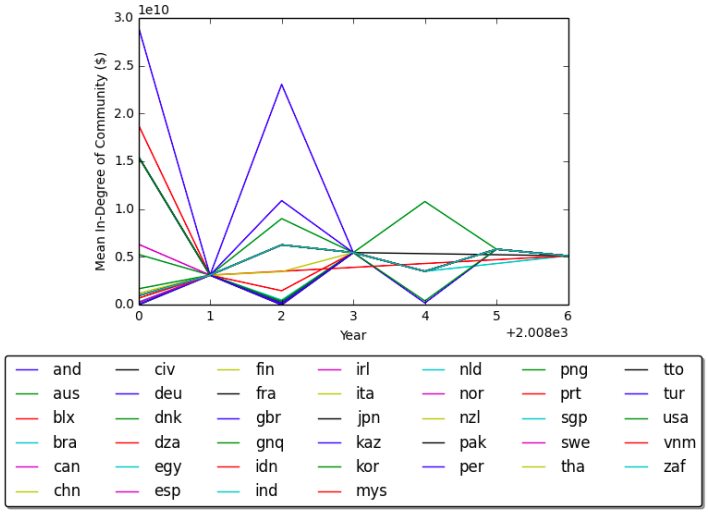



Figure 6: Evolution of the 40 oil exporters of the world

It is neat to consider countries' situation in and between communities over time when there is not as much stability in terms of trade and economic growth. Therefore, next we analyze the inter-community behavior.

### 3.1 Inter-Community

We look at the interaction between the so-called "rich" and "poor" countries/nodes. To this end, we classify transactions as rich and poor based on a tunable cutoff value and examine the aggregate value of transactions in either group. This type of analysis is possible for node degree/net wealth in addition to the transactions/weighted edges shown in Fig. 7.

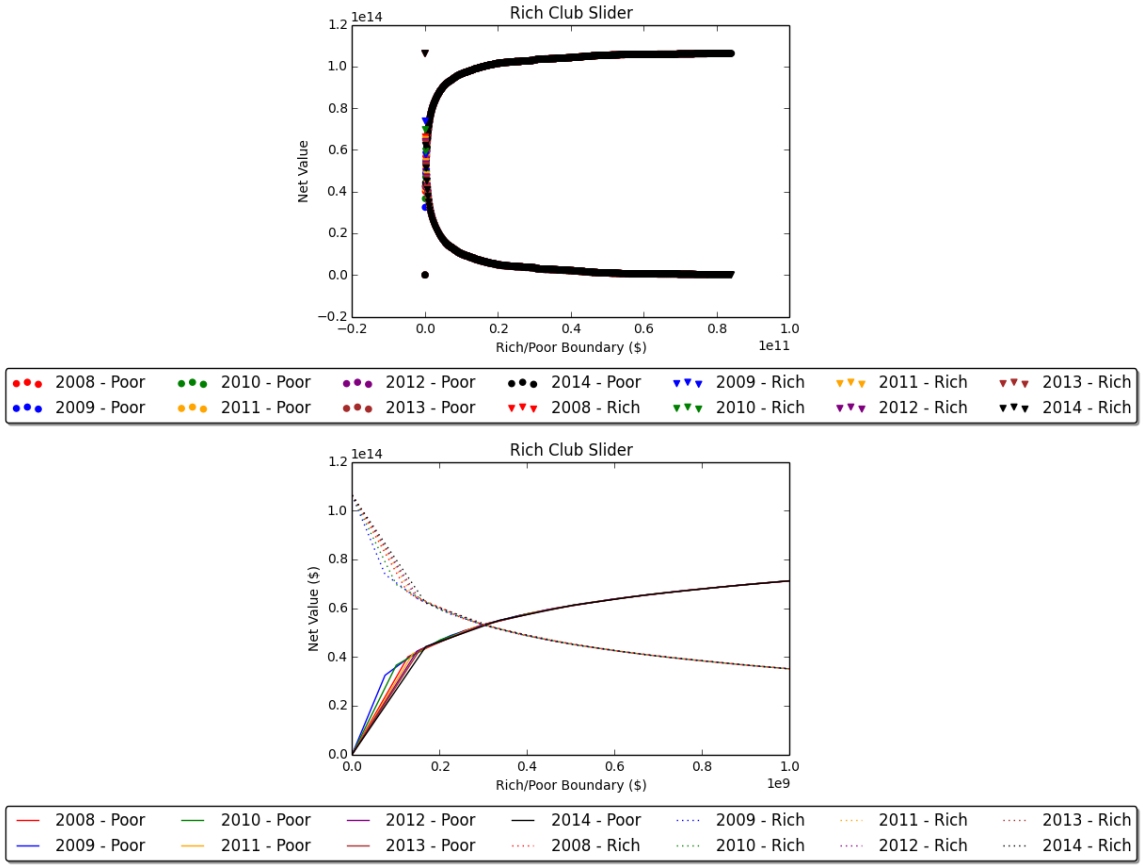



Figure 7: The net amount in dollars above (rich) and below (poor) a threshold value. We can tune our definition of "rich" and "poor" transactions in this way. Notice that the behavior is very similar for all years.

The community analysis provides the country clusters but does not provide any insight on the wealth of the communities. Therefore, using the World Bank repository to get the GDP of all the countries we add a new feature to the community, the mean GDP of the countries that belong to it. This provides insight on the wealth of the community as well as the economic evolution of the countries over the years. Since we have a network with economic wealth as an attribute, we look at the country-clusters to detect the "rich" countries,.

In order to validate our proposal of state-transition in the presence of a crossing between the states we concentrate at the countries that actually "slide" from poor to rich community. We observe that there are some countries that have been to rich and poor communities during 2008-14 (Fig. 8).

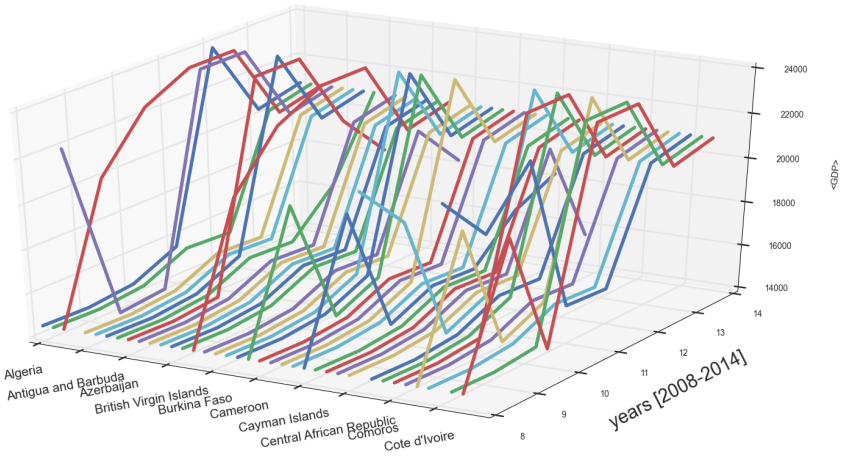



Figure 8: Countries been to the "rich" club during 2008-14

In order to understand the stability after changing the community, we look at Israel and Guinea in Figs. 9. It is observed that Israel has changed its community, moved to the rich club and stayed there. However, Guinea has a stable economic situation though it changes its communities.

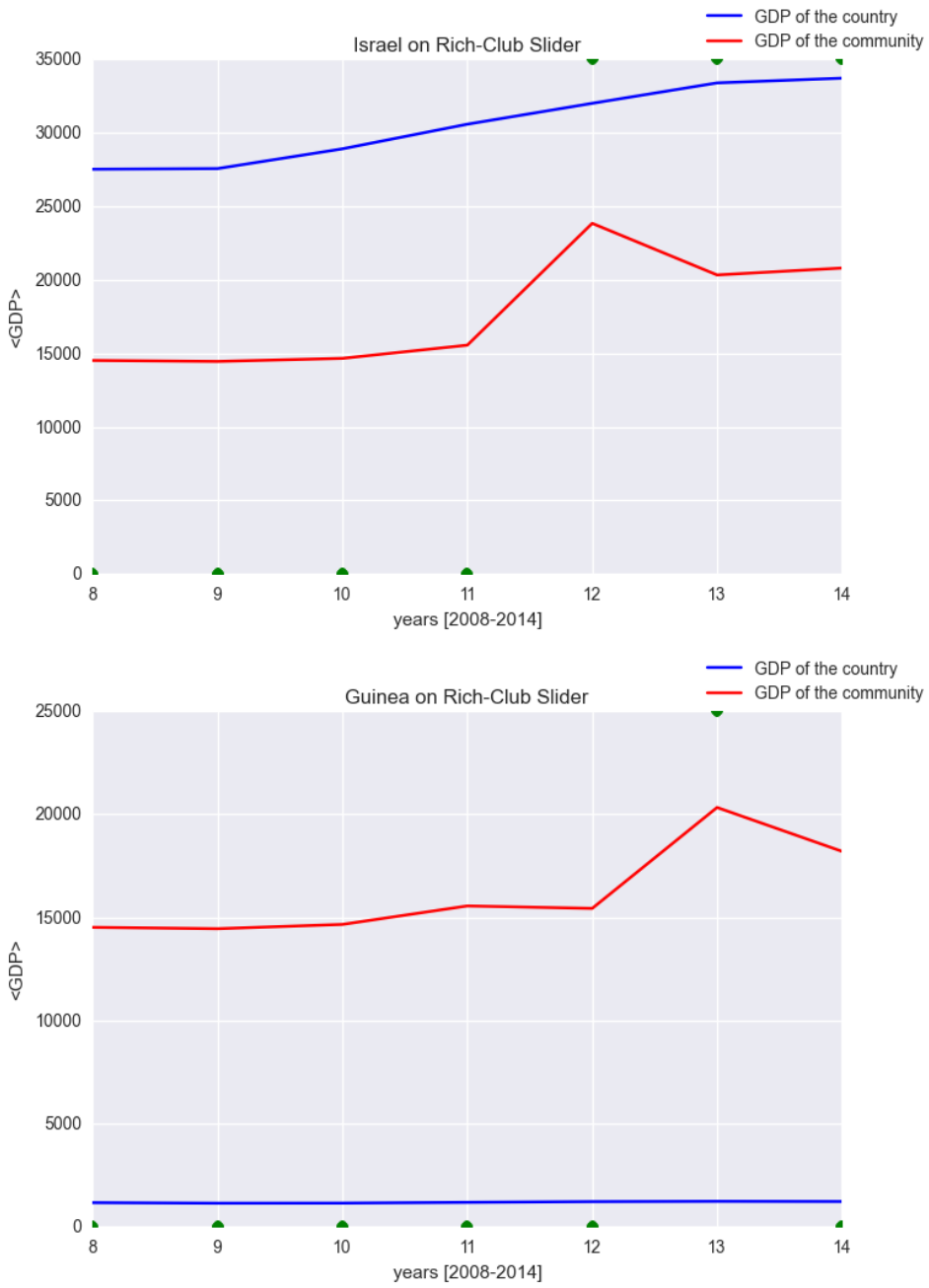



Figure 9: A closer look to countries Israel and Guinea, countries change communities from poor to rich

We analyze the trade and economic growth of a country to see how the economic growth is affected with good ties to the outside world. It is observed that well-connected countries are not as much connected to the poorly connected countries. There might be sociological, political and geographical factors in a country's economic situation and trade preferences. Therefore the fluctuations might be normal for some countries. Being new to a community, the strength of the ties might not be as good for the country so actually stay in one community.

# 4 Conclusion & Future Work

In this research globalization and regionalization are studied in a sequential order. The order means that on the macro level, we firstly processed data and obtained the entire network along with its properties such as communities, centralities, etc. The next step then was to analyze all results in detail: the feature within and between communities, the meaning behind every plot or number we got.

With the availability of high resolution global trading data, we think that a network implementation would be an insightful and natural way to examine it. Using various network metrics and analysis techniques, we search for interactions between characteristically different countries, particularly by "rich/poor" classification. Using community structure and various measurements of the aggregate interactions between countries, we observe consistent evidence of differing country "wealth" and use this to gain insight on the changing financial standings of countries by examining their evolution in time.

We examine multiple network analysis techniques to look at the influence that trading has on economic growth with in-depth analysis. To conclude, trading, which is resulted from globalization and regionalization, does have a positive impact on economic growth in terms of imports and export for countries, no matter what the community they are part of or which other countries they trade with. The endogenous connection between globalization and regionalization makes this seemingly contradictory pair to promote each other.

In this research, we look at the regionalization and globalization in

terms of the communities and bring a new concept of the "rich club slider" to examine the interactions between "rich" and "poor" countries.

Possible parameters that could affect a country's economic fluctuations and hence community need to be identified and studied in the future. A more detailed research per good with an emphasis on the certain research and development goods might provide a better visualization of the economic growth.

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