

**Network Structure Analysis of Bilateral Investments of One Belt, One Road Initiative countries****John Boamah<sup>1\*</sup>, Michael Appiah-Kubi<sup>2</sup>, Martin Osei<sup>3</sup>**<sup>1</sup>Wang Yanan Institute for Studies in Economics, Xiamen University, China<sup>2</sup>School of Economics, Xiamen University, China<sup>3</sup>School of Economics, Xiamen University, China**\*Corresponding author***John Boamah***Article History***Received: 04.08.2018**Accepted: 06.08.2018**Published: 30.08.2018***DOI:**

10.36348/sb.2018.v04i08.001



**Abstract:** The promulgation of the Belt and Road Initiative brings to fore the shift in world economic power to the east. The relations between members of Initiative and the changes of their positions will determine the long-term success or otherwise of this Initiative. The paper adopts social network analysis to set up the network relation between member countries, studies the network structure and its evolution trends, and identifies the position and role of members in the Initiative with data from bilateral investments for the period 2005 to 2015. We conclude that the network structure of Belt, Road Initiative's broad purpose of ensuring a greater level of economic integration between and among countries on the Belt, Road corridor with regards to bilateral investments is gradually being achieved although at a slower pace than may have been expected by framers of the Initiative with less influence being exerted by China. The beneficial economic integration will be very much enhanced with China in the core position.

**Keywords:** Bilateral Investments; Social Network Structure; Belt and Road Initiative.

**INTRODUCTION**

One Belt, One Road is the Chinese framework for organizing multinational development and was introduced by President Xi Jinping in the fall of 2013. The Belt and Road initiative is a way for win-win collaboration that encourages common development and prosperity and a road towards peace and friendship by enhancing mutual understanding and trust and strengthening all-round exchanges.

The belt will be a network comprising rail routes, overland road, oil and natural gas pipelines, and other infrastructural projects. It will stretch from Xi'an in central China through Central Asia, and ultimately reach Moscow, Rotterdam, and Venice. The Road is a maritime network of port and other coastal infrastructure from South and Southeast Asia to East Africa and the northern Mediterranean Sea [1]. There are at the moment sixty-seven (67) member countries.

The initiative hinges on five major goals; policy coordination, facilities connectivity, investment and trade cooperation, financial integration, and people-to-people bonds. The main themes of the initiative are cooperation and connectivity. The hot focus of the initiative is investment and trade cooperation which seeks to improve investment and trade facilitation by enhancing customs cooperation, expanding trade areas, and developing modern service trade and cross-border e-commerce. This will also involve eliminating investment barriers, expand mutual investment areas and push forward cooperation in emerging industries. The Belt, Road initiative represents China's attempt to shift the focus of development from the West to the East through cooperative trade and investment underpinned by the policy of non-interference. With the focus being on investment and trade cooperation, it is imperative to understand how the countries in this initiative are integrated and how they evolve to achieve the goals of the initiative.

This paper attempts to gain a better understanding of this initiative from the perspective of investment which is represented by bilateral investments among the countries by employing a network analysis. This approach has become very relevant in the literature on international trade [2, 3]. Network analysis is very effective in illustrating the relations of investment and trade as a network in which countries play the role of nodes, and a link indicates the presence of an investment relation between any two countries [4]. A network approach enhances our understanding of international economics because it allows investigation of the whole structure of interactions among countries and exploration of

connections, paths, and circuits [3]. The statistical properties of network analysis can also explain the dynamics of macroeconomic variables related to globalization, growth, and financial contagion [5].

This paper seeks to establish the interdependence or otherwise among the Belt, Road countries through a series of network measures; identify the countries that play the central roles in the network; and how countries' positions in the network change over time. The remainder of the paper is structured as follows; section II presents literature on network analysis. Section III presents the data and measures employed in the study, section IV presents the empirical results. Section V discusses and concludes the study.

### **Network Analysis of Cooperation and Integration**

Many economics scholars and especially international economists have looked at international trade and investment as a flow of a network relationship [6, 7, 3, 5, 8, 9]. The movement of goods and services and investments between and among countries can be described as a link connecting two vertices representing the two countries [4]. This understanding thus makes it possible to evaluate the relationship between countries in the network and or the overall network structure.

This structure of network continues to evolve over time and is based four types of international networks of trade flows, military interventions, diplomatic relations, and conjoint treaty memberships with international trade as a core-semi-periphery-periphery network structure [10, 6]. These findings have made it possible to focus on the relations and how these relations evolve over time in both a regional and world trade and investment structures characterized by an enlargement of the core countries, reduction of within-core distance and the progressive marginalization of peripheral countries. More importantly in the context of international investments, network analysis helps in assessing the attractiveness of a country's position within a regional and world trade structure [11].

It is important to note that in the hierarchical structure of global trade and investment, countries at the periphery of the structure which mostly are smaller in size over time integrate considerably into the network. The position of a country in the network has substantial implications for economic growth, and the network position of a country is not a substitute for its physical capital but a complement to its human capital [12]. In the event of an entrance into the network of world trading system by an important player, the structure and characteristics of the network change considerably with further implications for the countries on the peripheral [13]. The dilemma here is whether trade and investment liberalization should be made the stay of globalization or if there should be some level of protectionism.

The analysis of regional trade and investment has recently been in focus. This has helped understand the features of regional trade and investments and more importantly the role of the dominant players in the network structure. For instance, China plays the role of an export hub in South East Asia; Brazil, Russia, and India being the dominant local suppliers in their regions [2].

Network analysis, rather than analyzing country attributes such as economic, legal, political and social indicators in isolation, does so in conjunction with the resulting network structures for a complete assessment [11]. Irrespective of the increased use network analysis in the international management research, such analysis has not been applied to the study of country attractiveness and the possible implication for Foreign Direct Investment, FDI [14]. By analyzing the position each country occupies in the flow of goods, services, and capital, a complete picture of the relative attractiveness of specific countries can be ascertained, and would thus lead to better FDI decisions [11].

The existing literature reveals that using network analysis to analyze international trade and investment bring to fore very interesting revelations beyond results of the econometric analysis. Notwithstanding, this analysis has mainly been done at the world level. In the light of that, we use apply network analysis to shed light on the changes in the trade and investment network structure at the regional level with emphasis on the countries in the Belt, Road initiative with a concentration on FDI flows. We expect this will go to enrich the existing literature on network analysis application on international trade and investments at the regional level.

### **DATA AND MEASURES**

Regional agreements and especially in the case of the Belt, Road initiative do change over time and so it is imperative to have a baseline for the purpose of making an informed tracking analysis. With that in mind, we use data from 2005 which is eight years before the initiative was promulgated. However, bilateral investment data for the years 2000, 2005, 2010, and 2015 were collected from UNCTAD database and which formed the basis for the matrices generated for the ensuing analysis. The raw data was transformed into a dichotomous set of matrices and were then analyzed using the UCINET 6 program by [15] which is appropriate for the purpose of the paper with regards to the indicators explained below.

Network analysis allows us to investigate the topological properties of the complex structure of economic relations [16]. From a mathematical point of view, a network is represented by an adjacency matrix. The element of the adjacency matrix  $a_{ij}$  indicates that a link exists between nodes  $i$  and  $j$ ; that is  $a_{ij}=1$  if the investment goes to country  $j$ ; otherwise,  $a_{ij}=0$ .

In the selection of the network variables to be used, we were mindful of the varied characteristics of the countries in the initiative and also taking into account the purpose of the analysis. We use the following measures; the position of a country within a network and how that makes it attractive to investment where we use structural equivalence to measure the attractiveness of a country, how the overall structural changes in the network may well affect the future investment decisions within the network and in this regard we use centralization, network cohesion, network density, and multidimensional scaling analysis which altogether show the propensity to attract investment.

### Structural Equivalence

Two countries are said to be structurally equivalent if they have qualitatively and quantitatively identical ties to and from all countries with the network. In our case, we use convergence correlation (CONCOR) to measure this relationship. Two actors can be approximately structurally equivalent if they have the same pattern [17]. CONCOR is useful as it helps to differentiate group membership on market attractiveness.

### Network Centralization

Centralization offers a good assessment of the homogeneity of the roles of countries within any given regional integration network. Centralization is a useful indicator when tracking structural changes in a network over time [11]. In a virtually new initiative like the Belt, Road, it is expected that over time centralization will decrease as countries become economically integrated and the disparities among the richer and the poorer members begin to diminish. Thus, in the course of time, previously peripheral countries will become more central and therefore more attractive while central countries will be less so in comparison to others. Mathematically, this can be represented as follows:

$$C = \sum_{j \neq i}^N a_{ij} \quad (1)$$

where  $N$  is the total number of nodes (countries), and  $a_{ij}$  is the element in the investment matrix  $A$ , in which  $i$  is the row indicator corresponding to inward investments countries and  $j$  is the column indicator corresponding to outward investment countries. If  $a_{ij}=1$ , the two countries  $i$  and  $j$  are investment partners and if  $a_{ij}=0$ , then the two countries  $i$  and  $j$  are not investment partners.

### Cohesiveness

Cohesiveness describes the extent to which stronger ties exist between subgroups of actors within a larger network, and is a concept that is especially useful in analyzing the investment structure of a large number of countries [11]. This measure can provide insights into the upward and downward mobility of particular countries within the network. Applying this to the Belt, Road initiative countries, it helps to identify the countries within the group that has more extensive investment ties between them than with the rest of the group.

### Network Density

Network density measures the ratio of existing ties to the maximum number of all ties possible in the network [11]. For a non-dichotomous relationship, network density is the average value of all links between actors [18]. An increase in network density shows that the member countries in the block are becoming more integrated and more dependent on each other for investment.

### Multidimensional Scaling

Multidimensional scaling (MDS) is a set of data-analytic tools for deriving a graphical representation of objects in a multidimensional space based on proximity relations among them. By the graphical representation, we gain an intuitive understanding of the regularity governing the relationships among the objects [20]. Thus, as a country moves towards the central point in the spatial map, it becomes the central focus for all investments. Mathematically, this can be represented as:

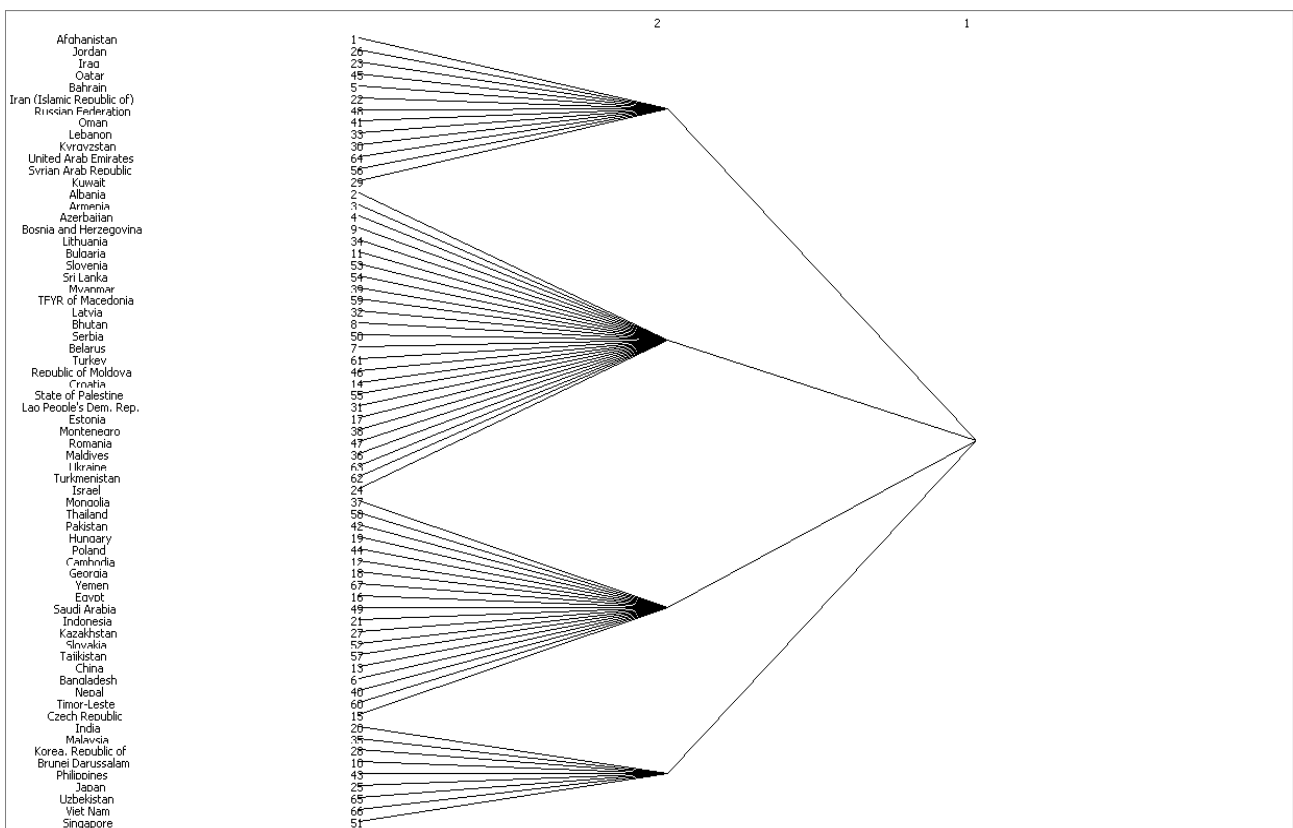
$$d_{ij} = \left[ \sum_{m=1}^M (x_{im} - x_{jm})^2 \right]^{1/2} \quad (2)$$

where  $x_{im}$  and  $x_{jm}$  denote the coordinates of object points  $i$  and  $j$  on dimension  $m$ , respectively, and  $M$  indicates the dimensionality (the number of dimensions) of the space. Once the coordinates of object points are obtained (through MDS), we can locate the objects in the space using a Cartesian coordinate system.

**FINDINGS**

The results of the structural equivalence which was measured by adopting the convergence correlation approach came out very interesting. Figure 1 shows that in 2005 the countries on the Belt, Road initiative were condensed into four subgroups with each subgroup exhibiting common characteristics in terms of geographical accessibility, language, religion, and historical trade pattern. For instance, most of the countries in the first subgroup are linked by way of their common geographical location; mostly found in West Asia region. This situation emphasizes the point that proximity influences the flow of investment between and among countries [21]. Aside proximity, some other common features exist for countries in sub group namely language and religion. Bahrain, State of Palestine, Kuwait, Iraq, Iran, Qatar, United Arab Emirates, Oman, and Jordan all do share these common characteristics and hence the propensity for them to invest between and among themselves.

There seems to be enhanced integration in 2010 and 2015 as the subgroups evolved into more diversified structures even though the core members of the various groups are present in both years, thus the major pull factors for attracting investments are at play. The structure in 2015 fully reflects the growing economic strength and mutually beneficial relationship between the decision investment structure. This may also reflect the ground gaining of the initiative especially in the West Asian and Central European regions.



**Fig-1: Year 2005 Concor**

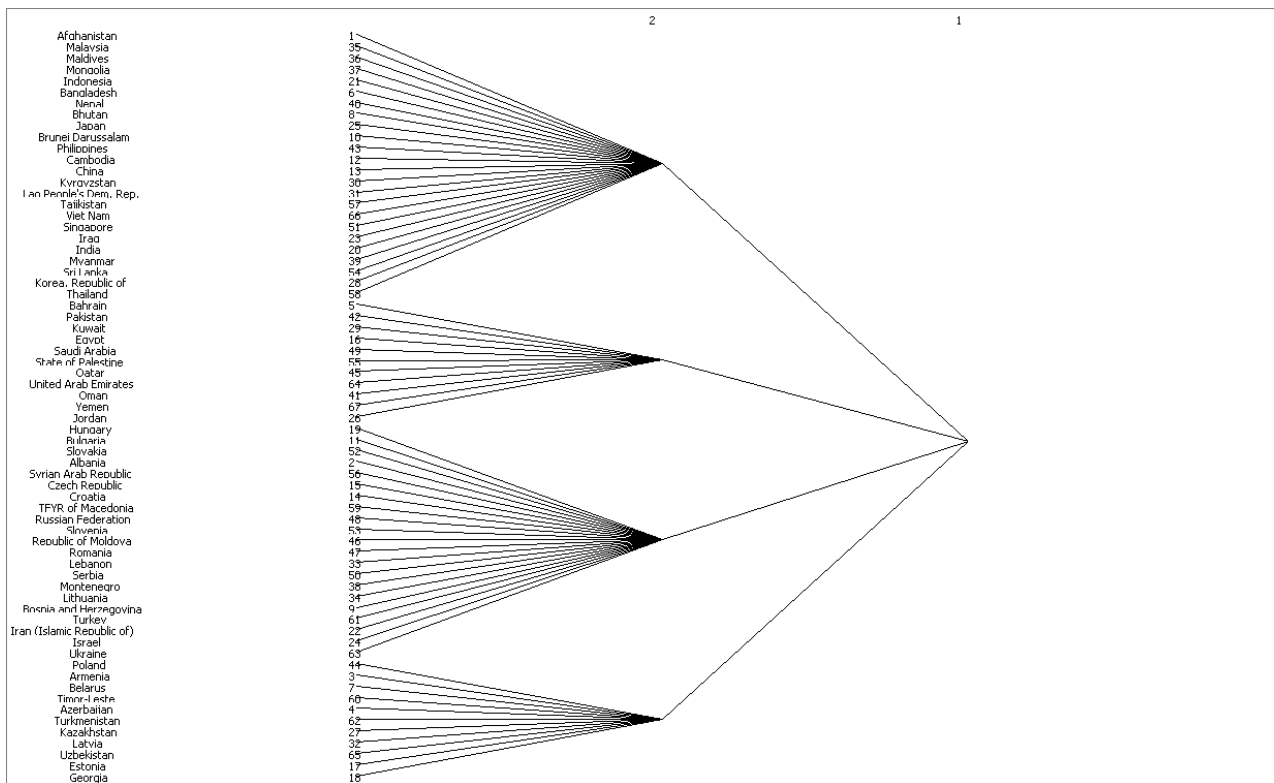


Fig-2: Year 2010 Concor

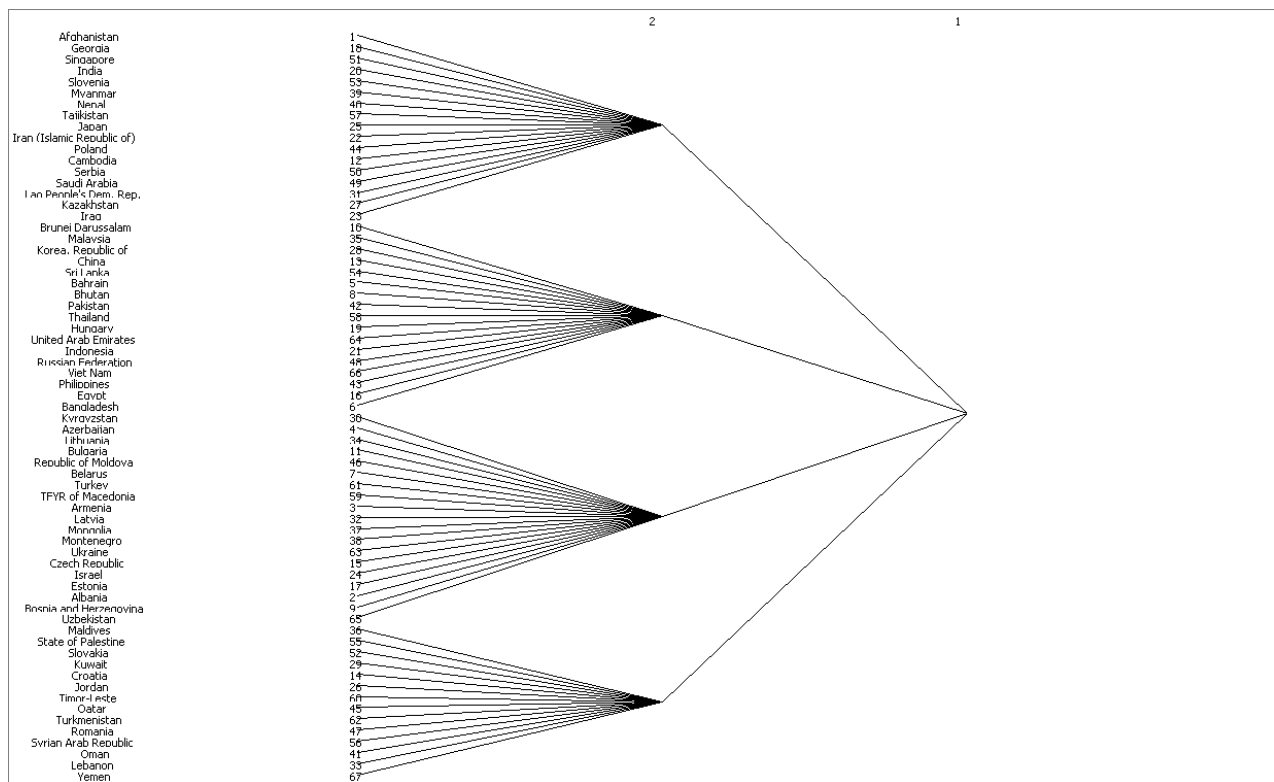


Fig-3: Year 2015 Concor

Table-1: Network Density matrix

	I	II	III	IV	R-SQUARED
I	0.300	0.112	0.008	0.087	
II	0.095	0.273	0.000	0.065	
III	0.008	0.017	0.209	0.162	
IV	0.091	0.085	0.055	0.306	<b>0.092</b>
	I	II	III	IV	R-SQUARED
I	0.310	0.148	0.093	0.061	
II	0.133	0.427	0.082	0.033	
III	0.133	0.117	0.390	0.186	
IV	0.083	0.083	0.203	0.173	<b>0.084</b>
	I	II	III	IV	R-SQUARED
I	0.414	0.143	0.102	0.000	
II	0.126	0.308	0.076	0.000	
III	0.125	0.101	0.349	0.000	
IV	0.000	0.000	0.000	0.000	<b>0.115</b>

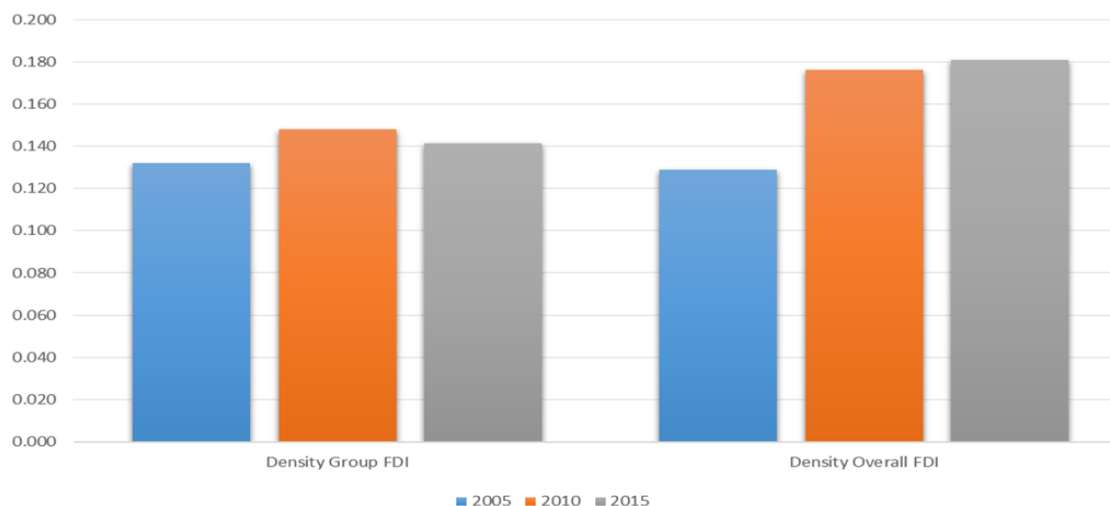
Source: Authors' calculations

After evaluating the groupings of the members in the initiative, we looked at how centralized the countries with the structures are. As stated previously, centralization offers a good assessment of the homogeneity of the roles of countries within any given regional integration network. It shows how closely related these countries in the initiative are to each other both within and outside their subgroups. It also helps to track the structural changes in the network over time.

In doing so we use the network density matrix in the assessment of the centrality or density of countries in the network; we calculate the density relation matrix between internal and external subgroups in the three years (see Table 1). The contact density value is between 0 and 1. The larger the value is, the closer the association is between subgroups. Table 1 shows that in 2005 Group I II had the lowest degree of internal contacts among countries and Group IV had the highest degree of contact among countries. The heterogeneity of the membership in subgroup III explains the low degree of internal contacts between and among them. Thus, it was not economical to direct investment within the subgroup as member countries will prefer to direct investments to countries in close proximity than to countries in the same subgroup they belong to. However, the high geographical proximity to each other in subgroup IV explains the high degree of internal contacts. On the other hand, Groups II and III had the lowest external degree of contact as there was no investment flows between countries in both subgroups. Not surprisingly though, the degree of external contact between Groups III and IV was the highest in 2005. This is mostly true because countries in Groups III and IV are mostly located in the East and South Asian regions. The prominent feature of this relationship is the presence of China's investment flows to and out of most of the countries in these regions. Overall, there was a weak degree of contact between and among countries in the Belt, Road initiative in 2005.

With improving integration, Group II had the highest degree of internal contacts while Group IV had lowest degree of internal contact. With regards to external contacts, Groups II and IV had the lowest degree of external contacts, while Groups IV and III had the highest degree of external contacts. This explained by the fact that countries in both groups in 2010 were mostly located in Central and East Europe. Countries within these regions do share common characteristics which promote the easy flow of bilateral investments. Overall, there was a decline in the level of integration between and among member countries in 2010 as against that of 2005.

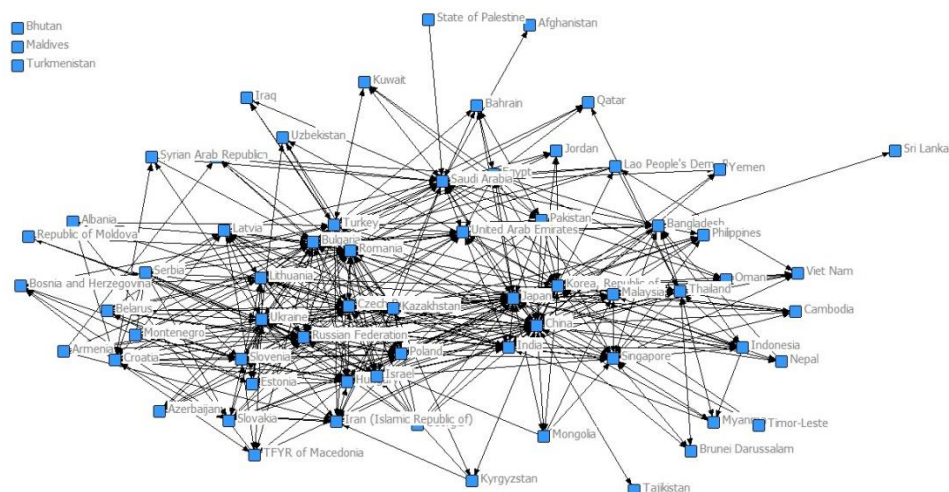
The results are significantly different in 2015. The levels internal contacts within Group I saw a significant improvement making the group with the highest degree of internal contacts in 2015. Countries within Group IV had no contact with each during the same period. Maldives, Timor-Leste, State of Palestine, Syria and Turkmenistan had no contact whatsoever which may be due to the lack of a common characteristic among them. There was an approved degree of external contact between countries in Groups I and II which happened to be the highest in 2015. The relationship between countries in Group IV and any other Group happened to be the lowest in the year. Overall, there was a significant improvement in the degree of integration of countries in the Belt, Road initiative in 2015.



**Fig-4: Density measurement**

Figure 4 shows that the group level of connectivity is increasing among countries in the initiative, moving from 0.136 in 2005 to 0.147 in 2010, indicating an increasingly close relationship between countries. It decreased however in 2015 to 0.142. This shows that the initiative may not be having an impact as might have been anticipated after the implementation of the initiative as the rate of aggregation is slower than before the implementation of the initiative. In the same light, the overall centrality (aggregation) also saw continuous increment from 2005 through to 2015. This indicates that the network status of the countries in the center is strengthening and the control in the Initiative is becoming centralized, a trend which is expected to continue with the increased Chinese influence through investments.

To further understand the contribution of membership to the network connections, a visual depiction of the investment relations network of member countries is presented in the network maps below (see Figures 5,6 and 7).



**Fig-5: 2005 Network map**

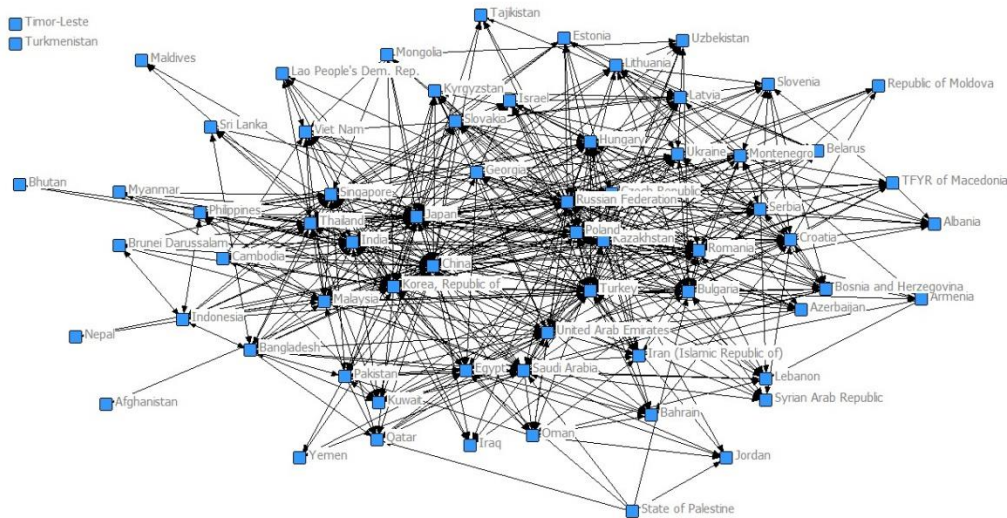


Fig-6: 2010 Network map

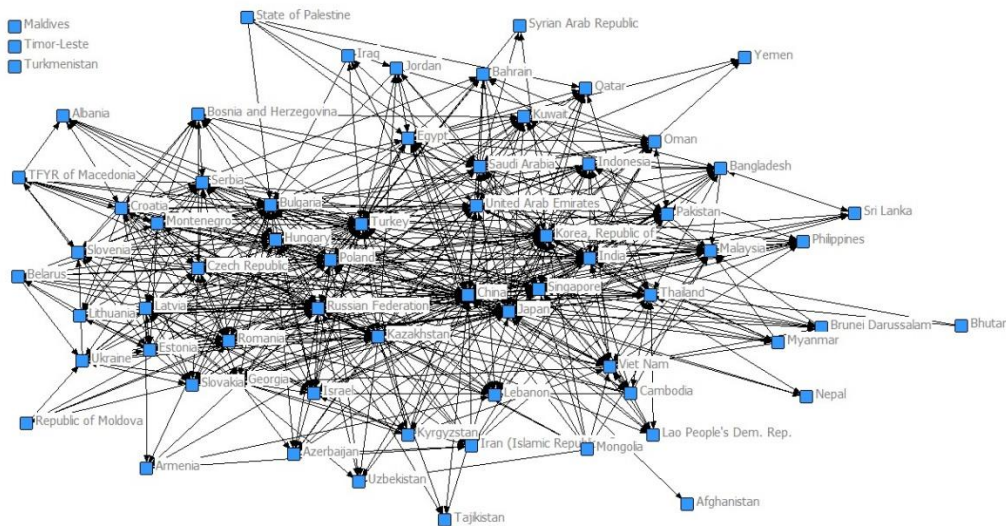


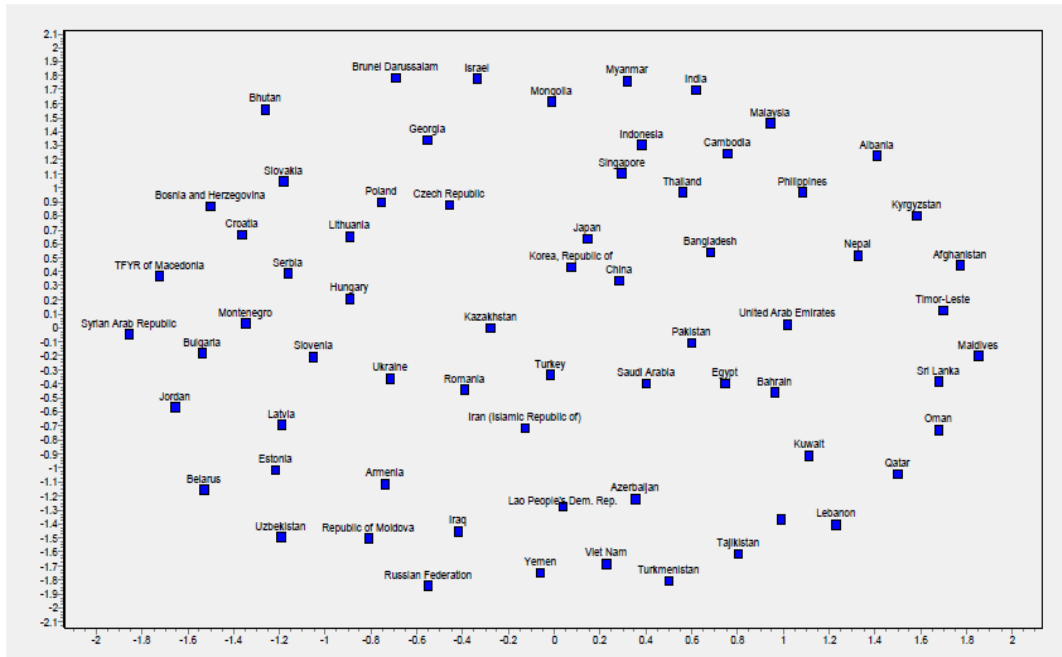
Fig-7: 2015 Network map

Figure 5 shows that in 2005, there was a less clear central position for countries in the Initiative; a lot more countries were on the peripheral. Countries such as China, Japan, Korea Republic, Saudi Arabia, and Russian Federation in the structure exerted a level of influence on the countries in the initiative of a few countries namely. These countries invested heavily in the economies of many countries in the initiative thereby exerting a significant level of influence on them and hence can be considered as the core of the network structure of countries in the initiative in 2005.

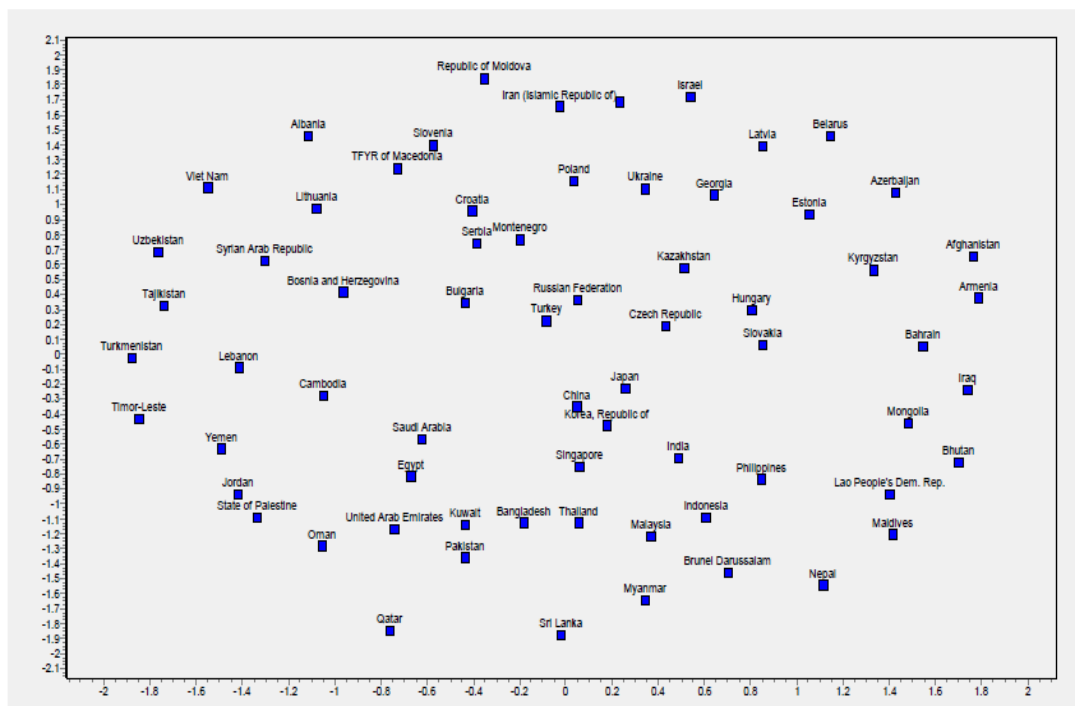
However, in 2010, Figure 6 shows an increased level of centralization in the network with less number of countries in the peripheral indicating the increase in the degree of common links. The number of contact lines to a country indicates its strength in network connectivity which defines the weight of the country in the Initiative. China, Russia, Japan, Korea, India, and Turkey were the most central countries in the network in 2010.

Figure 7 shows China assuming the core position in the network. This position suggests increasing level of influence with the implementation of various investment agreements between China and countries in the initiative.

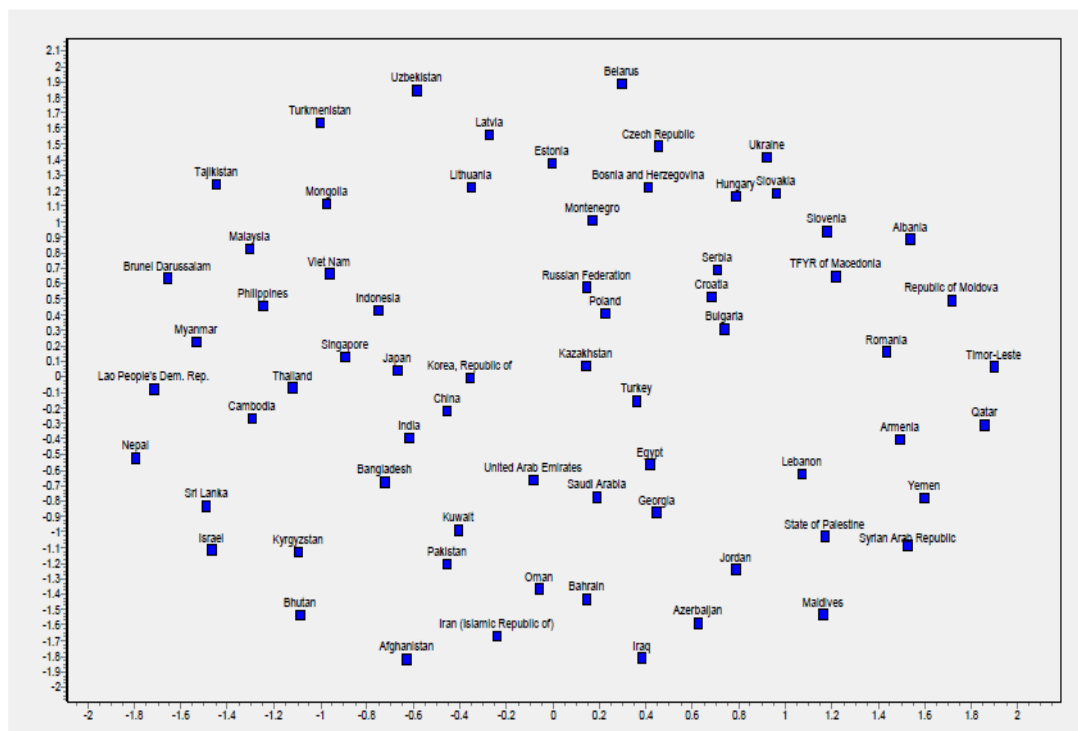




**Fig-8: 2005 Multidimensional Scaling Analysis**



**Fig-9: 2010 Multidimensional Scaling Analysis**



**Fig-10: 2015 Multidimensional Scaling Analysis**

Figure 8 shows that in 2005, China, Japan, the Korea Republic, Kazakhstan, Turkey, Saudi Arabia, and Pakistan were the countries closest to the central point of the network ; albeit none of them were at the central point. Thus, although they exerted influence on the countries in the initiative, the magnitude of which can be classified as mild.

Figure 9 shows that again China, Japan, the Korea Republic, Turkey, Russian Federation, and Czech were closest to the central point of the network. This goes to show the level of influence they exert on countries in the initiative although albeit not a total influence.

Figure 10 rather shows that in 2015, Kazakhstan was the closest country to the central point of the network with Japan, the Korea Republic, and China not too far from the central point. Turkey, however, has moved closer to the central point, which shows it growing influence on at least countries in the west Asia and Central Europe regions of the initiative. At the same time, the distribution of nodes in 2015 became stronger than that of 2010, indicating that the countries in the Initiative are becoming significantly integrated in terms of investments. It is clear the overall purpose of the Initiative is gradually becoming a reality, however, the central role expected to be played by China is yet to be seen.

## CONCLUSION AND DISCUSSIONS

Bilateral Investment and especially in international business decisions depends on certain environmental scanning and forecasting tools which ensure sound judgment. Network analysis is such tool which provides a good means for doing so. It helps to evaluate a country’s attractiveness in terms of investments. We have demonstrated through network analysis the positions of countries in the Initiative and their levels of importance.

The results also show that the broad purpose of the Initiative which is to ensure a greater level of economic integration between and among countries on the Belt, Road corridor is gradually being achieved although at a slower pace than may have been expected by framers of the Initiative with less influence being exerted by China. The balance of power with the coming into play of the Initiative is being shifted from the west to the east; as China and Russia gradually become the core of the network, the beneficial economic integration will help to achieve this underlying aim. The role and influence of countries like Japan and Korea in the coming years will be very important to underscore this power shift through trade and investment.

We in this study did not look at the magnitude of directional flow of investments between and among countries in the Initiative and how that influence the integration of countries. Again, the relationship between country-level density in a network and return on investment was not investigated. It is expected that future studies will look at these aspects of analysis in broadening and enriching FDI literature.

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