Additional insights of multinational corporation's location network in Vietnam

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ARTICLE INFO	ABSTRACT
	Multinational firms (MNCs) have increasingly dispersed their operations in different locations in response to the increased global competition. At a national level, their location decision creates an interdependent network of cities or provinces that influences inter-province relations and regional economic integration. By using sample data collected by Trade and Market Intelligence and network analysis approach, the study aims to explore (i) general structural characteristics of the FDI location network, (ii) roles, powers, and relational patterns of different provinces in the network, and (iii) resilience of the network to systemic risk in Vietnam, thereby providing some suggestions for investment promotion policies and regional planning. The study found that the network of provinces is loosely connected with only a few hubs located mostly in the southern region. In particular, neither Hanoi nor Ho Chi Minh City is the most influential node in the network. Provinces are not only connected but also structurally equivalent to many other provinces, regardless of spatial distance. These network structure characteristics suggest economic inequalities among regions and the vulnerability of the network to systemic risks. Therefore, policymakers should focus on developing more balanced regional planning and promoting province-to-province relations in order to have a tighter network of provinces and more regional economic integration.

1. Introduction

The presence of multinational corporations (MNCs) can have both positive and negative impacts on the economic development of developing countries. On one hand, MNCs can push the host nation's economic development through some means such as spillover of technology, knowledge, and skills; increased competition; and provision of better products and services at more reasonable prices (Rugraff & Hansen, 2011). On the other hand, MNCs may create a new market equilibrium and drive local companies out of the market (Blomstrom & Sjoholm, 1999). With their specialized production, they may also prevent the host economy from moving to high value-added activities (Rugraff & Hansen, 2011).

Despite these mixed impacts, MNCs have still been considered to play an important role in the economy of developing countries. Many of these countries, including Vietnam, have significantly reformed their policies and business environment to attract MNCs, such as the provision of tax incentives, or enhancement of property rights (Yehoue, 2009). However, an investment decision for MNCs is normally finalized after careful consideration of location-

specific characteristics (Bolívar et al., 2019) such as the availability of skilled and educated laborers, good infrastructures, and other supportive institutional factors, including institutions, culture or existing firms (van't Hoff & Wall, 2020). This decision then creates an interdependent network of locations regardless of geographical distance. According to social network theory, the linkages between social actors in a network provide important suggestions for not only the actors themselves but also the social groups that they belong to (Yao et al., 2020). In Foreign Direct Investment (FDI) context, a network of investment locations can have an important influence on regional, national, and international economies (Hussain et al., 2019; Saleem et al., 2023). Understanding this network's properties is a useful basis for enhancing economic integration within regions and nations, fostering FDI attraction policies (Bolívar et al., 2019) as well as, anticipating potential consequences of external challenges on network actors (Masi & Ricchiuti, 2020).

However, compared to mainstream research on the spillover effects of FDI and FDI determinants, the number of studies exploring the properties of the FDI location networks in Vietnam has been limited. Therefore, to fulfill this gap, by using a network analysis approach, the study aims to explore (i) the general structural characteristics of the FDI location network, (ii) the roles, powers, and relational patterns of different provinces in the network, and (iii) resilience of the network to systemic risk in Vietnam. The findings of the study can provide policymakers with some additional insights to make some adjustments in their investment promotion policies and regional planning.

The study is organized as follow: Section 2 reviews the related literature, Section 3 explains key network indicators and data set used for analysis, Section 4 presents results, Section 5 discusses the results and Section 6 concludes the study with limitations and future research suggestions.

2. Literature review and hypothesis development

2.1. Network perspective in FDI

A network is a structure composed of components, often called nodes or vertices, and their interactions between them, often called links or edges (Barabasi, 2016). Network analysis can reveal the core features of a network (Hevey, 2018) and visualize relational patterns, especially for small-scale or mesoscale structures (Peel et al., 2022), which makes problem-solving become simpler and more tractable (Barabasi, 2016). There has been a growing interest in applying network analysis to study complex systems in different scientific domains, such as biological, technological, and social, in order to improve our insights into life phenomena (Peel et al., 2022). Social network analysis was first applied to international trade research by Serrano and Boguna (2003), and more recently, it has been increasingly applied to study the Foreign Direct Investment (FDI) network - a collection of direct investment between countries (Li et al., 2024).

Studies on FDI networks have focused on different attributes of the network. The first focus is a hierarchical structure of the network, which is a typical characteristic of the FDI network (Bolívar et al., 2019) and can be explored through centrality measures (Bolívar et al., 2019; Hussain et al., 2019). A hierarchical or a core-periphery structure means some locations are more attractive than others in attracting FDI (Sultana & Turkina, 2020). Locations with high levels of specific advantages, such as high labor skills or advanced economies, are expected to be highly connected with other locations or hold a central position in the network. In contrast, locations with fewer advantages are poorly connected to other locations or hold peripheral positions in the network (Bolívar et al., 2019). Holding central positions in the FDI network or social network

brings locations with different competitive advantages such as control of resources, a positive signal of trust, superior access to information and learning opportunities, or expansion of knowledge base (Du et al., 2021; Sultana & Turkina, 2020). Therefore, a location that has a connection with core locations also benefits from this relational embeddedness (Yao et al., 2020).

The second focus is the relational or connectivity tendency of actors in the network, which is reflected in terms of clusters or communities and explains the polarity of the network (Hussain et al., 2019). Clusters based on the geographical proximity of firms are the simplest form of clusters (Majocchi & Presutti, 2009). The literature has found that domestic firms benefit more from knowledge and productivity spillover when they are located near FDI subsidiaries (Huynh et al., 2021). Yao et al. (2020) also found that the position of a city in a city-to-city collaboration network has a significant impact on its innovation performance.

The final important attribute of network to study is the resilience of the network to systemic risk that refers to either intentional attacks or random damages, including epidemic spread, economic crisis. This network attribute can be identified through robustness measures (Bellingeri et al., 2019). Scale-free network - a network with many tiny nodes and heavy-tailed degree distribution (Barabasi, 2016)- is highly vulnerable to intentional attacks but quite tolerant to random damages (Masi & Ricchiuti, 2020). An attack on a highly connected node in the scale-free network can quickly spread to other nodes and then lead to chain failure of the system (Masi & Ricchiuti, 2020). In contrast, homogeneous networks - fully connected networks are relatively tolerant towards attacks (Shi et al., 2019) because the effects of attacks are easily confined and controlled (Masi & Ricchiuti, 2020). However, compared to scale-free networks, homogeneous networks are more likely affected by attacks on a random node in the network. Seno-Alday (2019) found that because interconnectedness among countries in the EU trade network is stronger than that in the trade network of the Association of Southeast Asian Nations (ASEAN), the EU trade network is more likely to be broken down by random attacks on any nation in the network than ASEAN trade network.

2.2. Country context

FDI has been playing a crucial role in Vietnam's economic development. As of 2015, it accounted for 20 - 22% of total capital in the country (Huynh et al., 2021). With many law adjustment efforts to improve the business environment, such as Investment Law 2020 (General Statistics Office of Vietnam, 2022), Vietnam has become one of the most attractive FDI destinations in the group of low- and middle-income countries. During the period of 2012 and 2022, the average of FDI net inflow per GDP in Vietnam is 4.6%, while it is only 2% for low-and-middle-income countries (World Bank, 2024).

FDI inflows in Vietnam have been mostly in low-value-added areas and unevenly distributed. They are more concentrated in provinces or cities with higher levels of development (Huynh et al., 2019; Le & Dang, 2022). Among provinces and cities nationwide, Hanoi is the leading destination in terms of total registered capital. During the first two months of 2024, Hanoi received the highest total registered capital of nearly 914.4 million USD, which is 24.4 times higher than in 2023 and accounts for 21.3% of the nationwide total. However, in terms of attracting new investment projects, Ho Chi Minh City is the leading location. New investment projects in Ho Chi Minh City accounts for 35.6% of the total nationwide (Ministry of Planning and Investment, 2024).

Spillover effects of FDI vary among regions in Vietnam. Huynh et al. (2019) studied productivity spillover on domestic firms in four regions, including the north, the central, the

south, and the Mekong River delta, and only found significantly positive effects for the firms in the northern region. Huynh et al. (2021) also investigated productivity spillover on domestic firms in six regions, including the Red River Delta, North East and North West, North, and South-Central Coast, Highland, Southeast, and the Mekong River Delta. The authors found significantly positive backward spillover for all regions except the Southeast region. The authors went further to investigate FDI spillover effects on domestic firms located in the area within a 100km radius of 05 central cities (Hanoi, Hai Phong, Ho Chi Minh City, Danang, Can Tho) and found significantly negative horizontal and forward spillover for only local firms in the area surrounding 04 out of 05 cities (Hanoi, Ho Chi Minh City, Danang, Can Tho). The variation in spillover effects of FDI across regions can be explained by differences in specific characteristics of local firms and business conditions such as financial development, technology development and human capital (Huynh et al., 2021) and by differences in types of ownership of foreign subsidiaries (Huynh et al., 2019).

3. Methodology

3.1. Network analysis approach

To identify general network structure; roles, powers and relational pattern of provinces in the network, the indicators including size, degree, average shortest path, density, clustering coefficient, correlations, and modularity are estimated.

Size of the network - the simplest indicator- is the number of nodes or components in the network. *Node degree* is the number of links to that node. The higher the node degree is, the more central the node is in the network. The centrality of a node also depends on its betweenness (the extent to which a node lies between other nodes) and closeness (the average shortest distance from a node to others) (Lu et al., 2024). *Network degree* is a sum of node degrees (Scott, 2005).

Density - one of the most commonly used indicators - represents the tightness of connection among nodes in a network. Density is measured through the formula 2L/N(N-1) in which L is the network degree or number of links and N is a number of nodes in the network (Scott, 2005). The shortest path or distance between two nodes is the path that can connect the nodes with the minimum number of links. *Average shortest path length* is the average length of all shortest paths between the nodes in a network. The formula for the average shortest path length is $2\sum_{i\geq j}^{N} d(ij)/N(N+1)$ in which N is a number of nodes in the network, d(ij) is the distance between two nodes (Li et al., 2024). The shorter the path length, the more efficient information is transferred in the network.

Clustering coefficient is the probability that the neighbors of a given node link to each other and is measured through the formula C(i) = 2L(i)/$k_{(i)}$ ($k_{(i)}$–1) in which L(i) represents the number of links between the k(i) neighbors of node i, C(i) value is between 0 and 1 (Barabasi, 2016). The clustering coefficient of the whole network is the average of the clustering coefficients of all nodes in the network. The higher value of the clustering coefficient indicates a stronger clustering feature in the network (Li et al., 2024). *Correlations* between pairs of nodes in the network reflect their similarity, which helps identify the hierarchical structure of the network (Scott, 2005). Finally, *modularity* is "measure of the tendency of a network to be organized into assortative groups" (Peel et al., 2022, p. 09). To detect community in the network, the study used the maximization community function VV = GCModulMax3(A), in which A is the adjacency matrix of the network.

To evaluate network resilience, the study applied a node removal strategy in which highly connected nodes are removed one by one from the network, and changes in network efficiency are calculated. Network efficiency is calculated through the formula: $\text{Eff} = \frac{1}{N(N-1)} \sum_{i \neq j}^{N} \frac{1}{d(i,j)}$ (N is the total number of nodes; d(i,j) is the shortest path between node i and node j. Decline rate of network efficiency is defined as: R = 1-Eff(i)/Eff(0) in which Eff(i) is network efficiency when removing a node (i) and Eff(0) is initial network efficiency. The bigger the decline rate, the faster the network falls apart, and the more important the node is (Liu et al., 2016).

3.2. Construction of network for the study

Sample data was collected from the Trade and Market Intelligence Section's website. The dataset for Vietnam contains 2,141 MNCs from 59 countries. However, to reduce heterogeneity in the sample data, the study included only MNCs of which subsidiaries employ a number of employees of 1,000 and above. Therefore, the selected dataset includes only 313 MNCs from 29 countries located in 38 provinces. From this dataset, the study constructed an unweighted adjacency matrix of provinces based on MNCs ownership linkages. A graph of this adjacency matrix is visualized and isolated nodes are removed because the estimation of network indicators is only meaningful for a connected network. The network of provinces for the final analysis consists of 19 nodes and 37 links (Figure 1).

Figure 1

Projected Network of Provinces
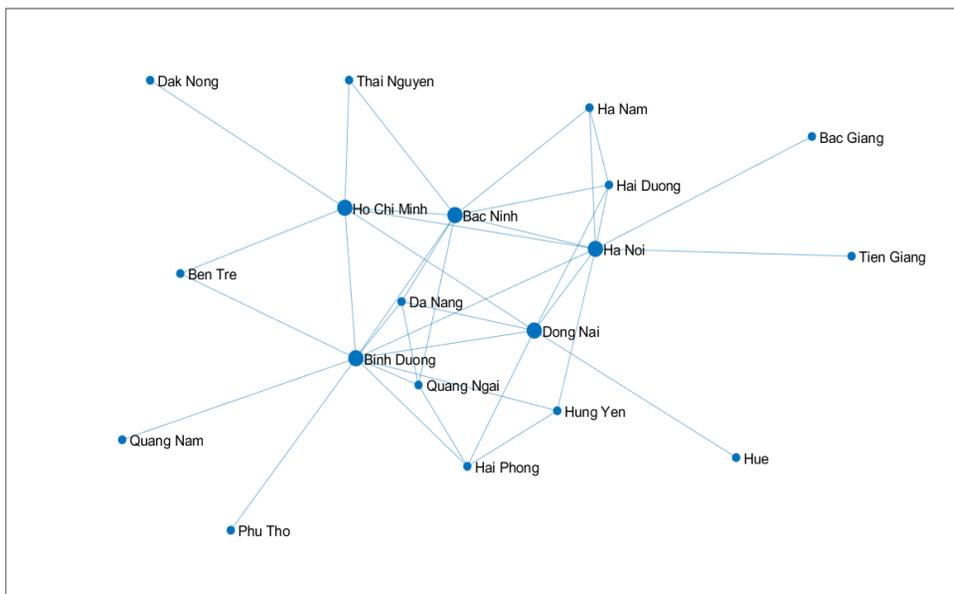
Source. The researcher's data analysis

3.3. Network software for analysis

The study used Matlab (2023) software to estimate and visualize the network of provinces.

4. Results

4.1. General structural characteristics of the network

The general structural characteristics of the network can be identified through connectivity level and degree distribution. One-third of nodes in the network have a degree of 1

(Figure 2). Network density and clustering coefficient are pretty low (less than 0.3 and 0.5, respectively), while the average shortest path is as high as the average degree (see Table 1 for more details). These numbers indicate hierarchical structure and weak clustering feature of the network, and low connectivity between provinces in the network.
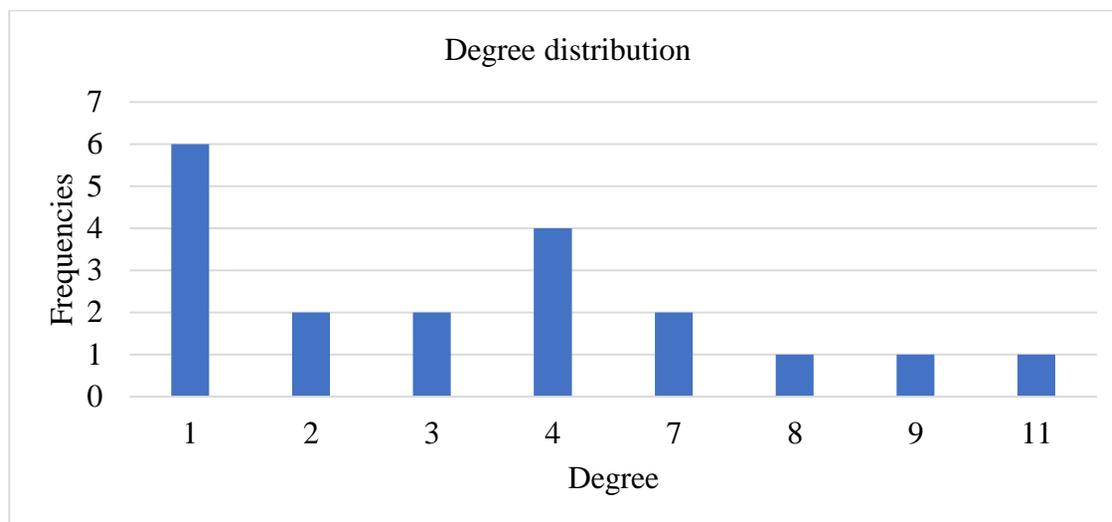
Table 1

General Network Indicators

No.	Network indicator	Value
1	Average Degree	3.89
2	Density	0.22
3	Clustering coefficient	0.40
4	Average shortest path	3.69

Source. Data analysis result of the research

Figure 2

Degree Distribution of the Network

Source. Data analysis result of the research

4.2. Roles, powers and relational patterns of provinces in the network

Roles, powers, and relational patterns of provinces in the network are indicated through centrality, correlations, and modularity measures.

4.2.1. Centrality

Binh Duong has the highest degree in the network, followed by Hanoi, Bac Ninh, Dong Nai, and Ho Chi Minh City, respectively. However, the clustering coefficient of these core nodes is all less than 0.5 (see Table 2 for details). This means that although these nodes (provinces) seem to hold a central position in the network, there are still structural holes around them.

4.2.2. Modularity

Although the network has a weak clustering feature, the study was still able to separate the network into 4 clusters (see Table 2 for details). Between clusters, cluster 4 and 3 are much bigger than the other two groups. Within clusters, clusters 3 and 1 are more similar in terms of

geographical proximity than the other two groups. Specifically, while more than 80% of provinces in cluster 3 are located in the northern region of Vietnam, 75% of provinces in cluster 1 are located in the southern region of Vietnam. Moreover, among 04 clusters, only cluster 3 has two hubs, which are the second and third highest-degree nodes (Hanoi and Bac Ninh) in the network.

Table 2

Centrality and Modularity

ID	Province	Region	Degree	Betweenness	Clustering coefficient	Modularity
1	'Bac Giang'	North	1	0.00	0.00	3
2	'Bac Ninh'	North	8	21.00	0.36	3
3	'Ben Tre'	South	2	0.00	1.00	1
4	'Binh Duong'	South	11	54.07	0.25	4
5	'Danang'	Central	4	1.07	0.67	4
6	'Dak Nong'	South	1	0.00	0.00	1
7	'Dong Nai'	South	7	25.08	0.29	2
8	'Ha Nam'	North	3	0.00	1.00	3
9	'Hanoi'	North	9	44.57	0.28	3
10	'Hai Duong'	North	4	1.57	0.67	3
11	'Hai Phong'	North	4	1.83	0.50	4
12	'Ho Chi Minh'	South	7	28.40	0.33	1
13	'Hue'	Central	1	0.00	0.00	2
14	'Hung Yen'	North	3	1.17	0.67	4
15	'Phu Tho'	North	1	0.00	0.00	4
16	'Quang Nam'	Central	1	0.00	0.00	4
17	'Quang Ngai'	Central	4	1.25	0.67	4
18	'Thai Nguyen'	North	2	0.00	1.00	1
19	'Tien Giang'	South	1	0.00	0.00	3

Source. Data analysis result of the research

4.2.3 Correlations

The study calculated correlation between all pairs of nodes in the network. The correlation of the correlation was then calculated and repeated 50 times until all values in the correlation matrix reached a value of 1 (the exact same pattern of affiliations) and -1 (completely different pattern of affiliations) (see Appendix 1 for correlation coefficient matrix).

In pairwise comparison, the correlation matrix indicates that one province holds an equivalent position to many provinces in the network. Within cluster comparison, among 5 core nodes (nodes with degrees higher than an average degree), only Bac Ninh and Hanoi do not hold equivalent positions to other lower-degree nodes. Particularly, although modularity 2 has only 02 nodes (Dong Nai and Hue), these two nodes are not only geographically distant but also structurally different.

4.3. Network resilience

Figure 3 indicates that network efficiency declines rapidly as the number of removed nodes increases and the network collapses after removing 05 nodes. Removing the first highest-degree node makes network efficiency decrease by 22%. The decline rate experienced the most dramatic change when removing the fourth node (Dong Nai), and the least change when removing the third node (Bac Ninh).

Figure 3

The Decline Rate of Network Efficiency
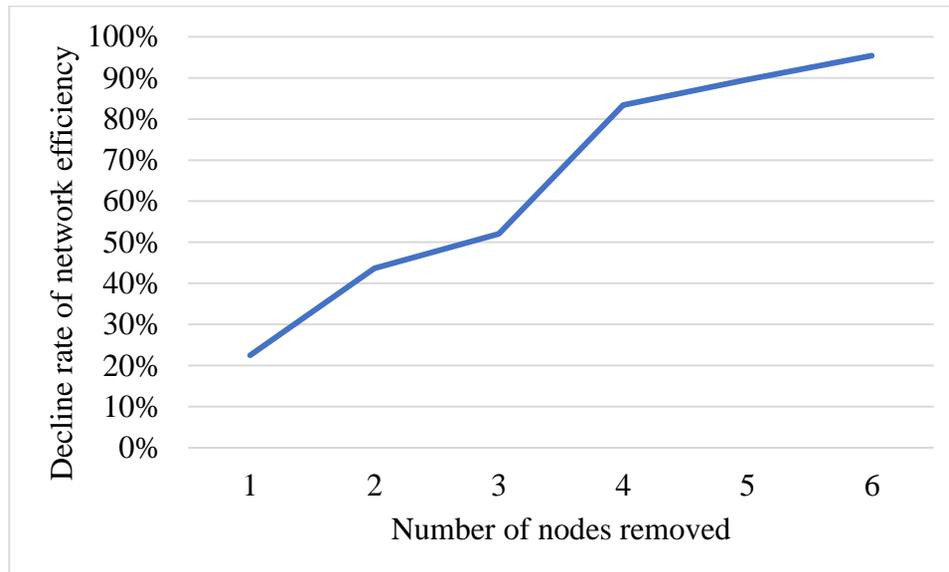
Source. Data analysis result of the research

5. Discussion

Low network density with skewed degree distribution indicates that the network of provinces as a result of investment of MNCs in Vietnam is loosely connected with only a few hubs located mostly in the southern region. This finding is consistent with previous studies about the hierarchical structure of FDI location networks irrespective of national context. This also supports findings about regional economic inequalities in Vietnam identified by some scholars such as Kim (2023). Moreover, low network density or connectivity also indicates inefficiency of information flow within the network.

In terms of the role and power of provinces in the network, centrality analysis reveals an interesting result. Although Ho Chi Minh City has the highest number of MNCs, it does not hold the most powerful position in the network. Binh Duong is the most powerful province in the network, even though its number of MNCs is just slightly greater than one-half that of Ho Chi Minh City. This finding is contradictory to some previous studies. For example, Bolívar et al. (2019) found that countries with high GDP are more likely to hold central positions in the FDI network. However, in this study, although Binh Duong and Dong Nai are not at the top of provinces and cities that contribute the most to regional GDP (Vo & Vo, 2023), they are among the few strong nodes in the network. This result also implies that although Ho Chi Minh and Hanoi are considered to be the two biggest FDI attractors in the government's regional planning (Kim, 2023), Binh Duong and Dong Nai may appear to be more effective in promoting regional

economic integration. In other words, MNCs in Binh Duong and Dong Nai seem to be playing an important role in regional economic contagion than MNCs in other big provinces/cities.

In terms of relational patterns between provinces, modularity results show a tendency of geographically distant connections among provinces in the same cluster. This finding is consistent with other FDI network findings. Mehmood et al. (2023) found that distant connections dominate economic ties in intercity networks. MNCs are more likely to look for economic proximity and effective collaboration with local government when geographical proximity increases (Bettarelli & Resmini, 2022). Correlation results indicate high similarity between pairs of provinces regardless of their geographical distance. This may suggest a lack of location-specific differentiations and potential competition among provinces in terms of foreign direct investment attractiveness, especially among those whose node degree is not very different. However, high structural similarity among provinces may signify, to some extent, low adaptation or monitoring costs for MNCS if they want to diversify their operations in various provinces in Vietnam (Alcaraz et al., 2020).

Core-periphery structure with low clustering coefficients suggests that the overall FDI province network in Vietnam is highly vulnerable to systemic risk (Masi & Ricchiuti, 2020). If MNCs in Binh Duong and Dong Nai suffer from random destructions, this could significantly damage FDI attractiveness and lead to chain failure of the FDI network at national level. At sub-groups of the network, having two high-degree nodes makes cluster of 05 provinces in northern region (Hanoi, Bac Ninh, Bac Giang, Ha Nam, Hai Duong) and 01 southern province (Tien Giang) more resilient to systemic risk than others.

6. Conclusion

6.1. Theoretical contributions

Due to increased competition, multinational firms have increasingly dispersed their operations around the world (van't Hoff & Wall, 2020). Their selection of production location is influenced by their corporate strategies (Mehmood et al., 2023) and different locational variables such as culture, infrastructure, labor, and institutions (Bettarelli & Resmini, 2022; van't Hoff & Wall, 2020). Within a nation, this location decision naturally creates a network of provinces and cities that are connected with each other through owner-subsidiary links (Mehmood et al., 2023). This connection could influence the relationship between provinces/cities, promote regional cooperation (Mehmood et al., 2023) as well as facilitate systemic risk sharing (Masi & Ricchiuti, 2020).

By investigating the MNCs network of 38 provinces in Vietnam, the study found that the network is loosely connected with very few hubs that are located mostly in the south. Provinces and cities in the network are not only structurally similar but also likely connected to form clusters irrespective of their geographical distance. For example, Tien Giang is in the same cluster with Hanoi, Bac Ninh, and Ha Nam, while Danang, Binh Duong, and Hung Yen belongs to the same cluster. This structure not only indicates some level of economic inequality among regions but also limits the efficiency of information flow, knowledge, and risk sharing in the network. With these findings, the study contributes additional evidence to the prevalent literature on the core-peripheral structure of the FDI network and the tendency of geographically distant connections among FDI destinations, especially in the Vietnam context. Moreover, by plotting the network, the study enriches visual presentations about relational patterns between provinces and unbalanced regional economic development in Vietnam.

6.2. Practical implications

The study provides two policy suggestions for FDI attraction. First, at the provincial level, central provinces in the network should continue to improve their locational advantages, while peripheral provinces should strengthen their relational ties with core provinces to gain economic contagion. Peripheral provinces should also identify and emphasize their local differentiated advantages in their investment promotion policies. Second, at the national level, the government should pay attention to filling structural holes around core provinces by identifying potential pairs of provinces through MNCs linkages such as Danang and Hai Phong, or Danang and Phu Tho, and promoting sharing, learning or relation between them. However, because of provinces' highly structural similarity, the government should play more roles in promoting and monitoring FDI inflows among provinces to avoid unexpected competition among them. By taking advantage of current linkages among provinces and their positions in the network, it is also important for the government to identify hub provinces and develop an industrial clustering for the central region to narrow down the regional development gap.

6.3. Limitations and future research suggestions

The study has some limitations. First, the study focused only on big MNCs subsidiaries from one database; therefore, it may miss some connections between provinces, especially those created by smaller subsidiaries. Second, because the data used in the study is cross-sectional, the dynamics of roles, powers, and relational patterns between provinces are not captured. Moreover, there are different methods to detect community and structural equivalence in the network. Therefore, the findings and suggestions provided by the study should be considered to be directional only. Future research can use another database and statistical method to calculate network indicators. Longitudinal datasets should be used to measure changes in network indicators over time so as to have a better picture of the connectivity and efficiency of the overall network as well as the importance of each province in the network. Moreover, because the FDI network has an important role in regional and national economic development, future research can correlate network characteristics with macroeconomic variables such as GDP growth, city/region innovation, or locational variables such as culture and institution in order to have more insights for urban development programs.

References

Alcaraz, J., Salamanca, E., & Regalado-Pezúa, O. (2020). Ethnic networks and multinational firms' location decisions. *Review of International Business and Strategy*, *30*(2), 279-298. https://doi.org/10.1108/RIBS-11-2019-0152

Barabasi, A. L. (2016). *Network science*. http://networksciencebook.com/

Bellingeri, M., Bevacqua, D., Scotognella, F., & Cassi, D. (2019). The heterogeneity in link weights may decrease the robustness of real-world complex weighted networks. *Scientific Reports*, *9*, 1-12. https://doi.org/10.1038/s41598-019-47119-2

Bettarelli, L., & Resmini, L. (2022). The determinants of FDI: A new network-based approach, *Applied Economics*, *54*(45), 5257-5272. https://doi.org/10.1080/00036846.2022.2041184

Blomstrom, M., & Sjoholm, F. (1999). Technology transfer and spillovers: Does local participation with multinationals matter? *European Economic Review*, *43*(4/6), 915-923. https://doi.org/10.1016/S0014-2921(98)00104-4

Bolívar, L. M., Casanueva, C., & Castro, I. (2019). Global foreign direct investment: A network perspective. *International Business Review*, *28*(4), 696-712. https://doi.org/10.1016/j.ibusrev.2019.01.007

Du, J., Xu, Y., Voss, H., & Wang, S. (2021). The impact of home business network attributes on Chinese outward foreign direct investment. *International Business Review*, *30*(4), 1-13. https://doi.org/10.1016/j.ibusrev.2020.101779

General Statistics Office of Vietnam. (2022). *Disbursement of public investment capital, foreign direct investment, expecting the last months of 2022*. https://www.gso.gov.vn/en/data-and-statistics/2022/10/disbursement-of-public-investment-capital-foreign-direct-investment-expecting-the-last-months-of-2022/

Hevey, D. (2018). Network analysis: A brief overview and tutorial. *Health Psychology and Behavioral Medicine*, *6*(1), 301-328. https://doi.org/10.1080/21642850.2018.1521283

Hussain, O. A., Zaidi, F., & Rozenblat, C. (2019). Analyzing diversity, strength and centrality of cities using networks of multinational firms. *Network and Spatial Economics*, *19*, 791-817. https://doi.org/10.1007/s11067-018-9428-8

Huynh, H. T. N., Nguyen, P. V., Trieu, H. D. X., & Tran, K. T. (2021). Productivity spillover from FDI to domestic firms across six regions in Vietnam. *Emerging Markets Finance and Trade*, *57*(1), 59-75. https://doi.org/10.1080/1540496X.2018.1562892

Huynh, H. T. N., Tran, K. T., Nguyen, P. V., Le, N. T. T., & Trieu, H. D. X. (2019). Estimating inward regional FDI spillover in Vietnamese manufacturing firms: Ownership structure and firm characteristics. *Journal for Global Business Advancement*, *12*(4), 542-563. https://doi.org/10.1504/JGBA.2019.103316

Kim, H. M. (2023). Foreign direct investment and urban growth in Vietnam: Spatial, economic, and demographic perspectives. *Asian Geographer*, *41*(2), 167-184. https://doi.org/10.1080/10225706.2023.2244946

Le, N. T., & Dang, T. T. (2022). An integrated approach for evaluating the efficiency of FDI attractiveness: Evidence from Vietnamese provincial data from 2012 to 2022. *Sustainability*, *14*(20), 1-25. https://doi.org/10.3390/su142013140

Li, B., Shi, Z., & Guo, W. (2024). The global foreign direct investment network: Evolution and influencing factors. *Kybernetes*, *53*(3), 841-861. https://doi.org/10.1108/K-05-2022-0774

Liu, J., Xiong, Q., Shi, W., Shi, X., & Wang, K. (2016). Evaluating the importance of nodes in complex networks. *Physica A: Statistical Mechanics and its Applications*, *452*, 209-219. https://doi.org/10.1016/j.physa.2016.02.049

Lu, S., Chen, N., Zhou, W., & Li, S. (2024). Impact of the belt and road initiative on trade status and FDI attraction: A local and global network perspective. *International Review of Economics & Finance*, *89*(Part A), 1468-1495. https://doi.org/10.1016/j.iref.2023.09.003

Majocchi, A., & Presutti, M. (2009). Industrial clusters, entrepreneurial culture and the social environment: The effects on FDI distribution. *International Business Review*, *18*(1), 76-88. https://doi.org/10.1016/j.ibusrev.2008.12.001

Masi, G. D., & Ricchiuti, G. (2020). From FDI network topology to macroeconomic instability. *Journal of Economic Interaction and Coordination*, *15*, 133-158. https://doi.org/10.1007/s11403-019-00275-0

Matlab. (2023). *Release highlights - MATLAB and simulink*. https://www.mathworks.com/products/new_products/release2023b.html

Mehmood, M. Y., Haqqani, S. J., Zaidi, F., & Rozenblat, C. (2023). Economic hubs and the domination of inter-regional ties in world city networks. *Social Network Analysis and Mining, 13*(125), 1-12. https://doi.org/10.1007/s13278-023-01134-4

Ministry of Planning and Investment. (2024). *FDI attraction situation in Vietnam and Vietnam's overseas investment in the first two months of 2024.* https://www.mpi.gov.vn/en/Pages/2024-3-1/FDI-attraction-situation-in-Vietnam-and-Vietnam-s-sh2gfb.aspx

Peel, L., Peixoto, T. P., & De Domenico, M. (2022). Statistical inference links data and theory in network science. *Nature Communications, 13*, 1-15. https://doi.org/10.1038/s41467-022-34267-9

Rugraff, E., & Hansen, M. W. (2011). *Multinational corporations and local firms in emerging economies.* Amsterdam University Press.

Saleem, M. A., Zaidi, F., & Rozenblat, C. (2023). World city networks and multinational firms: An analysis of economic ties over a decade. *Network and Spatial Economics, 23*, 559-580. https://doi.org/10.1007/s11067-023-09587-y

Scott, J. (2005). *Social network analysis.* Sage Publication.

Seno-Alday, S. (2019). Varieties of regional integration, international trade, networks and risk. *The World Economy, 42*(9), 2790-2815. https://doi.org/10.1111/twec.12831

Serrano, M. A., & Boguna, M. (2003). Topology of the world trade web. *Physical Review E, 68*(10), 1-4. https://doi.org/10.1103/PhysRevE.68.015101

Shi, D., Lu, L., & Chen, G. (2019). Totally homogeneous networks. *National Science Review, 6*(5), 962-969. https://doi.org/10.1093/nsr/nwz050

Sultana, N., & Turkina, E. (2020). Foreign direct investment, technological advancement, and absorptive capacity: A network analysis. *International Business Review, 29*(2), 1-13. https://doi.org/10.1016/j.ibusrev.2020.101668

Trade and Market Intelligence Section. (2020). *Investment map for better foreign investment attraction and targeting.* https://www.investmentmap.org/affiliates/by-affiliate

van't Hoff, M., & Wall, R. (2020). Business districts: The spatial characteristics of FDI within cities. *European Planning Studies, 28*(2), 273-295. https://doi.org/10.1080/09654313.2019.1651830

Vo, T. H., & Vo, T. (2023). *Vietnam's key economic zones: Performance and investments.* https://www.vietnam-briefing.com/news/vietnam-key-economic-zones.html/

World Bank. (2024). *Foreign direct investment, net inflows (% of GDP).* https://data.worldbank.org/indicator/BX.KLT.DINV.WD.GD.ZS

Yao, L., Li, J., & Li, J. (2020). Urban innovation and intercity patent collaboration: A network analysis of China's national innovation system. *Technological Forecasting and Social Change, 160*, 1-16. https://doi.org/10.1016/j.techfore.2020.120185

Yehoue, E. B. (2009). Clusters as a driving engine for FDI. *Economic Modelling, 26*(5), 934-945. https://doi.org/10.1016/j.econmod.2009.03.006