A Network-Theoretic Analysis of India's Foreign Direct Investment Landscape (2023)

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Abstract

Abstract: Traditional analysis of Foreign Direct Investment (FDI) often relies on ranked lists and bilateral totals, which fail to capture the complex web of indirect relationships and structural interdependencies that define the global economic landscape. This paper addresses this limitation by modeling India's 2023 FDI ecosystem as a complex network. By aggregating multi-source data and applying a robust analytical framework adapted from the Bank of Portugal, we construct a **directed network whose structure is determined by an underlying symmetric proximity matrix**, representing the economic proximity between India and its key investment partners. The network is systematically filtered using a percentile threshold and a Minimum Spanning Tree (MST) backbone, augmented with structurally significant edges, to reveal a clear and interpretable topology. This network-centric approach enables the identification of key hub and intermediary countries, visualizes economic clusters, and provides a quantitative assessment of the roles different nations play within India's investment network. The findings offer a richer, relational understanding of India's economic integration and highlight the structural importance of its key partners beyond simple inflow volumes.

1. Introduction

1.1 Background and Motivation

Foreign Direct Investment (FDI) is a critical catalyst for India's economic growth, serving as a primary channel for capital infusion, technological advancement, and integration into the global economy. Initiatives like 'Make in India' are intrinsically linked to the nation's ability to attract and sustain stable, long-term foreign investment. However, conventional methods of analyzing FDI—typically through simple rankings or bilateral totals—provide a limited, one-dimensional perspective. Such approaches fail to capture the complex web of relationships, indirect influences, and the systemic roles that countries play within the broader investment network. Understanding this underlying structure is paramount for effective economic policy and strategic decision-making.

1.2 Problem Statement

Raw FDI data, often presented in static lists and tables, obscures the true structure of international capital flows. It does not reveal how investment from one country may be intermediated through another, nor does it quantify the strategic importance of a country beyond its direct investment value. This project addresses the need for a structural and relational understanding of India's FDI network, moving beyond simple totals to uncover the topology of economic interdependence.

1.3 Research Objectives

The primary objectives of this study are four-fold:

1. To clean, standardize, and aggregate multi-source FDI data for the calendar year 2023 into a single, coherent dataset.

*The views expressed in this paper are those of the author and do not necessarily reflect the views of NITI Aayog.

2. To construct a mathematically rigorous network model representing the economic proximity between India and its key investment partners.

3. To visualize this complex network to identify structural patterns, economic clusters, and the roles of key players.

4. To quantitatively analyze the network using centrality and structural metrics to determine the influence and function of each country within the system.

1.4 Scope of Analysis

This study's scope is a static, cross-sectional analysis focused on the FDI network for the **calendar year 2023**. The analytical boundary is defined to include a core set of economic entities: **India**, its **Top 10 FDI partners**, and the **Top 3 bilateral partners** for each of those primary partners. This focused approach allows for a detailed examination of India's primary economic ecosystem, with the specific data sources and limitations detailed in the subsequent section.

2. Data

The analysis presented in this report is built upon a composite dataset constructed for the **calendar year 2023** (January 1st to December 31st). The data collection process involved aggregating official statistics from multiple national sources, followed by a rigorous standardization process where country names were matched against a master list, **missing country-pairs were zero-filled**, and all entities were augmented with 3-letter ISO codes for universal compatibility[1].

2.1 Host Country Data (India)

To establish a baseline for India's investment flows, both inward and outward FDI data were meticulously compiled.

Inward FDI (Equity Inflow): Data for country-wise FDI equity inflow into India was sourced from the official newsletters of the **Department for Promotion of Industry and Internal Trade (DPIIT)**, Ministry of Commerce and Industry. To align with the 2023 calendar year, data from four fiscal quarters were aggregated:

- Q4 of F.Y. 2022-23 (January – March 2023)
- Q1 of F.Y. 2023-24 (April – June 2023)
- Q2 of F.Y. 2023-24 (July – September 2023)
- Q3 of F.Y. 2023-24 (October – December 2023)

Outward FDI (Equity): Data for India's outward direct investment was sourced from the **Reserve Bank of India (RBI)**'s official "Data on Overseas Investment". Monthly statistics for outward FDI equity were aggregated for the period of January 2023 to December 2023 to generate the annual total.

2.2 Partner Country Data

The selection of India's key partners was guided by official government reporting. The **Top 10 FDI partners** were identified as the leading source countries for FDI equity inflows as listed in the DPIIT's FDI Factsheet for October-December 2023. These countries are: Mauritius, Singapore, USA, Netherlands, Japan, United Kingdom, UAE, Cayman Islands, Germany, and Cyprus.

A critical step in the data processing pipeline was the standardization of all monetary values. Data for partner countries, originally reported in their respective local currencies, were converted to a common unit, the U.S. Dollar (USD), to ensure comparability. This conversion was performed using the 2023 annual average exchange rates, sourced from the International Monetary Fund's (IMF) International Financial Statistics (IFS) database[2]. The specific rates applied in this study are detailed in Table 2.

[1] Country codes correspond to the ISO 3166-1 alpha-3 standard maintained by the International Organization for Standardization.

[2] International Monetary Fund, International Financial Statistics (IFS), "Official Exchange Rate (LCU per US$, period average)", accessed August 2025.

For each of these partner countries, an effort was made to collect both their total inward and outward FDI data for 2023 from their respective official statistical agencies or central banks, as shown in Table 1.

Table 1: Official Data Sources for Partner Countries

Country	**Official Data Source(s)**
Mauritius	Bank of Mauritius (BoM)
Singapore	Singapore Department of Statistics (SingStat)
USA	U.S. Bureau of Economic Analysis (BEA)
Netherlands	De Nederlandsche Bank (DNB) & Statistics Netherlands (CBS)
Japan	Ministry of Finance (MOF)
United Kingdom	Office for National Statistics (ONS)
Germany	Deutsche Bundesbank
Cyprus	Central Bank of Cyprus

Table 2: Currency Conversion Rates (2023 Annual Average vs. USD)

Currency	**ISO Code**	**Value of 1 Unit in USD**
Mauritian Rupee	MUR	\$0.02193
Singapore Dollar	SGD	\$0.74470
Euro	EUR	\$1.08000
Japanese Yen	JPY	\$0.00713
British Pound	GBP	\$1.24390

2.3 Data Limitations and Methodological Considerations

Several important considerations and limitations should be noted, as they influence the scope and interpretation of the analysis.

Data Unavailability: Despite extensive searches, comparable, country-wise FDI data for the 2023 calendar year could not be sourced for two of the Top 10 partners: the **United Arab Emirates (UAE)** and the **Cayman Islands**. Consequently, while they are recognized as top investors into India, they had to be excluded from the subsequent bilateral network analysis involving partner-to-partner flows.

Measurement Mismatch: A primary methodological consideration is the difference in FDI measurement. India's available data, for both inward and outward flows, is strictly **FDI equity based**. For the partner countries, however, granular equity-only data was not consistently available. Therefore, their data represents **total FDI flow**, which typically includes equity, reinvested earnings, and intra-company loans. This distinction is crucial for interpreting the absolute values in the network.

Temporal Alignment: Every effort was made to ensure all data conforms to the **2023 calendar year**. However, as reporting standards can differ (fiscal vs. calendar year), minor temporal misalignments may exist in the data from some partner countries where the reporting period was not explicitly defined.

3. Methodology

The analytical framework employed in this study is adapted from the network analysis methodology for FDI flows developed by researchers at the Bank of Portugal. This approach, presented at the 2020 IFC-BoP-ECB conference[3], provides a robust, theoretically-grounded method for transforming complex bilateral investment data into an interpretable network structure.

[3]Lima, F., Pinheiro, F., Silva, J. F., & Matos, P. (2020). *Foreign direct investment – using network analysis to understand the position of Portugal in a global FDI network*. Presentation at the IFC Conference on external statistics, Lisbon, Portugal.

The core principle is to model the global FDI landscape as a mathematical graph, $G = (V, E)$. While the **final visualization is a directed graph** to distinguish between inward and outward capital flows, the **underlying structure is determined using a symmetric, undirected framework** to identify the strongest bilateral partnerships, allowing for a richer interpretation.

3.1 Data Transformation and Proximity Matrix Construction

Raw FDI data is inherently asymmetric; the investment from country A to country B is rarely equal to the investment from B to A ($f_{AB} \neq f_{BA}$). To **analyze the strength of bilateral partnerships irrespective of flow direction**, the asymmetric raw data was first transformed into a symmetric matrix using the following steps, consistent with the BoP methodology:

Symmetric Engagement Metric (W_{ij}): First, a single, symmetric measure of the total bilateral engagement between any two countries, *i* and *j*, was calculated. This was achieved by summing the absolute values of the flows in both directions:

$$W_{ij} = |f_{ij}| + |f_{ji}|$$

Here, $|f_{ij}|$ represents the absolute value of the FDI flow from country *i* to *j*. This value, W_{ij}, captures the total economic volume of the partnership and was also used to identify the Top 3 partners for each of India's Top 10 partners.

Proximity Matrix (Φ_{ij}): Next, this engagement metric was converted into a measure of economic "distance" or "proximity." A strong investment relationship (a large W_{ij}) implies close proximity. This inverse relationship was modeled using the formula:

$$\Phi_{ij} = \frac{1}{W_{ij}} = \frac{1}{|f_{ij}| + |f_{ji}|}$$

The resulting N×N **Proximity Matrix**, Φ, is symmetric ($\Phi_{ij} = \Phi_{ji}$) and encodes the economic closeness of all country pairs. A smaller value indicates a stronger relationship. Pairs with zero total investment were assigned an infinite distance.

3.2 Graph Filtering and Visualization Pipeline

A complete network, where every country is connected to every other, is too dense to be visually interpretable. To distill the most significant relationships and reveal the underlying structure of the network, a multi-stage filtering and construction pipeline was implemented.

Percentile Thresholding: To reduce noise and focus on the most impactful connections, a **75th percentile threshold** was chosen after considering alternatives such as absolute or degree-based cutoffs. This adaptive, data-driven method retains the top 25% of investment relationships, as measured by total bilateral engagement volume (W_{ij}), balancing network sparsity with information retention.

Minimum Spanning Tree (MST) Backbone: The filtered data was then used to construct a **Minimum Spanning Tree (MST)**. An MST is a sub-graph that connects all nodes in the network using the smallest possible sum of edge weights. In this context, it forms the "skeleton" of the FDI network by identifying the most efficient set of connections that links the entire economic system.

Strategic Edge Addition: While the MST provides a clean backbone, it can omit other highly significant secondary relationships. To create a more comprehensive and realistic final graph, the MST was augmented by strategically adding back two types of crucial edges:

- The **top 10 strongest connections** (those with the smallest proximity values) that were not already included in the MST.
- A set of **forced structural edges** to guarantee that a priori known important relationships—namely the links between India and its Top 10 partners, and between those Top 10 partners and their own Top 3 partners—were present in the final visualization.

The final output of this pipeline is a **directed multigraph** where edge directionality is preserved to show capital flow.

3.3 Quantitative Centrality Analysis

Beyond visualization, the final constructed graph was subjected to quantitative analysis using standard centrality measures from graph theory. These metrics help to objectively determine the importance and role of each country within the network. The following metrics were calculated:

- **Degree Centrality:** Measures the number of direct investment links a country has, indicating its level of direct engagement.
- **Betweenness Centrality:** Identifies how often a country lies on the shortest path between two other countries, highlighting its role as a crucial intermediary or "bridge" for capital flows.
- **Closeness Centrality:** Calculates the average shortest path distance from a country to all other countries in the network, indicating how quickly it can interact with others.
- **Eigenvector Centrality:** Measures a country's influence based on its connections to other highly influential countries. A high score means a country is a hub in an important neighborhood.

3.4 Global Network Metrics

To characterize the overall topology of the FDI network, three global metrics were computed:

- **Network Density:** Measures the ratio of actual edges in the network to the total number of possible edges, indicating the overall connectedness of the system.
- **Average Shortest Path Length:** Calculates the average number of steps along the shortest paths for all possible pairs of network nodes, indicating the efficiency of capital flow.
- **Global Clustering Coefficient:** Measures the degree to which nodes in a graph tend to cluster together, indicating the presence of tightly-knit economic blocs or communities.

4. Results and Discussion

This section presents the findings obtained by applying the network analysis methodology to the 2023 FDI dataset. We first examine the visual structure of the network before delving into a quantitative analysis of country-specific roles and the overall network topology.

4.1 The Visual Structure of India's FDI Network

Figure 1 displays the constructed FDI network. The visual encoding is designed to highlight key structural features: India, as the network's focal point, is colored crimson and is the largest node. The Top 10 FDI partners are colored dark blue, distinguishing them from other secondary partners in light blue. The edges are styled to convey capital flow directionality relative to India: teal lines represent inward FDI to India, orange lines represent outward FDI from India, and dashed gray lines denote partner-to-partner relationships.

The network's primary observable characteristic is a distinct **hub-and-spoke topology**, with India positioned firmly at the center. This visually confirms India's central role within its immediate investment ecosystem. Strong, direct investment corridors are evident, particularly the thick teal lines indicating significant inward investment from key partners like **Singapore, the United States, and the Netherlands**. Visually, a notable cluster of interconnected European economies—including the **United Kingdom, Netherlands, Germany, Switzerland, and Luxembourg**—is apparent, suggesting a tightly integrated regional bloc that acts as a significant source and conduit of capital.

4.2 Quantitative Analysis: Centrality of Key Players

To move beyond visual interpretation, the structural importance of each country was quantified using centrality measures, with the results summarized in Table 3.

The results underscore India's pivotal position, with the second-highest Closeness (0.6786) and a high Eigenvector (0.4339) centrality, confirming its role as a primary hub. However, the analysis also reveals more nuanced

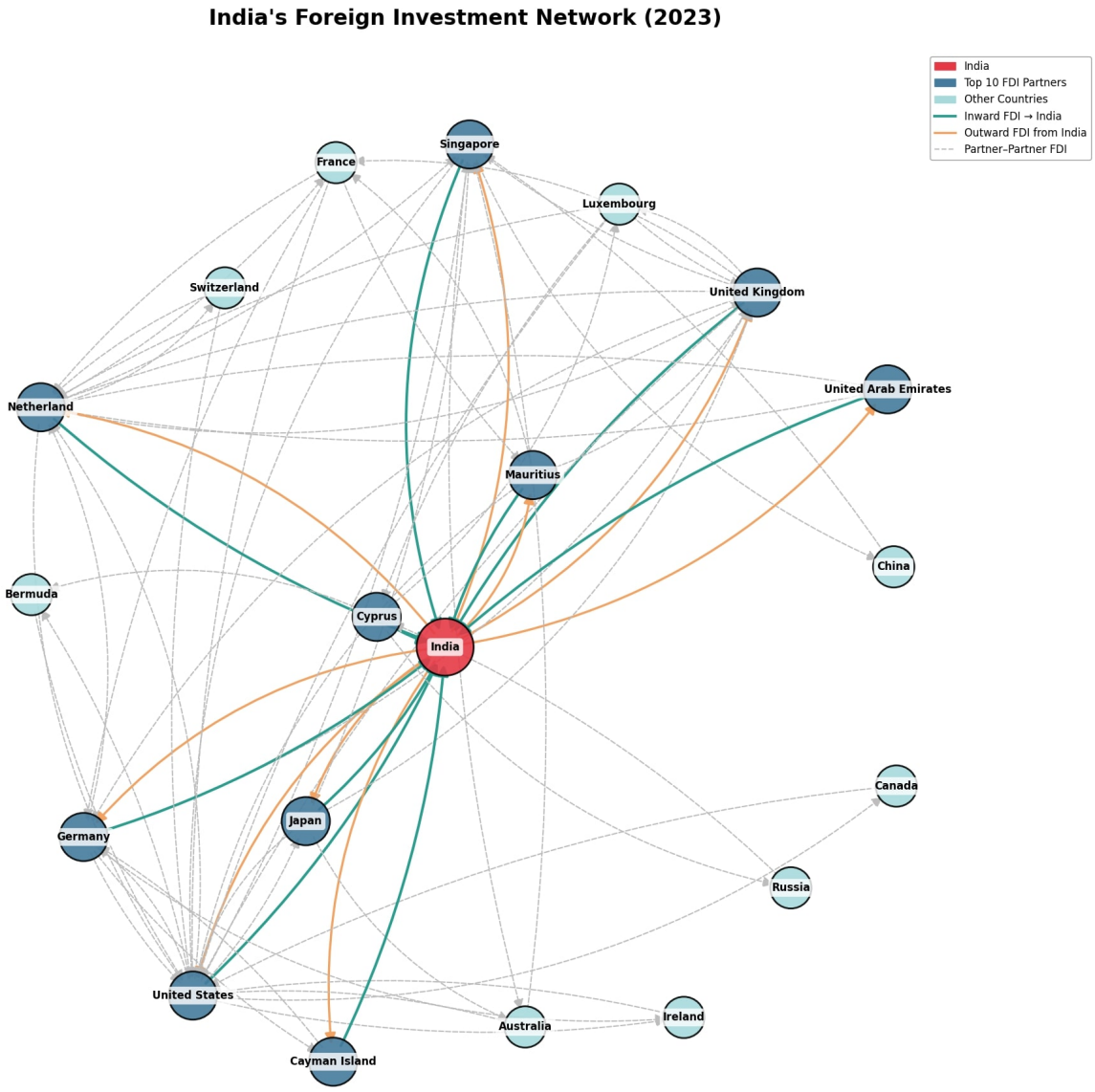

Figure 1: India's Foreign Investment Network (2023). The network is constructed using an MST backbone with strategic edge augmentation. The legend explains the color and style encoding for nodes and edges.

roles played by its partners. The **United States emerges as the most structurally important node in the network**, ranking first in Degree (1.1579), Closeness (0.76), Betweenness (0.3644), and Eigenvector (0.4968) centrality. This indicates that the U.S. is not only the most connected and influential country but also the most critical **intermediary** for capital flows within this ecosystem.

Other key players include **Singapore, the Netherlands, and the United Kingdom**, which all exhibit high centrality scores across multiple measures, significantly above the network average. Their high Betweenness scores, in particular, highlight their function as crucial gateways, channeling capital from other parts of the world. In contrast, countries like Mauritius and Cyprus, while being significant sources of investment, show lower centrality scores, suggesting they function more as direct, specialized conduits rather than broad structural hubs.

4.3 Overall Network Topology

The global metrics describe the network's overall character, as detailed in Table 4. The network has a **low density (0.197)**, indicating that it is sparse and specialized rather than densely interconnected. This suggests that FDI relationships are selective and not randomly formed.

The most striking feature is the very low **Average Shortest Path Length of 2.292**. This is a classic indicator of

Table 3: Centrality Metrics for Countries in the FDI Network (2023)

Country	**Degree**	**Closeness**	**Betweenness**	**Eigenvector**
Singapore	0.5789	0.5758	0.1600	0.2989
China	0.1053	0.3725	0.0000	0.0555
United States	1.1579	0.7600	0.3644	0.4968
Netherland	0.7895	0.5938	0.1617	0.3636
United Kingdom	0.6842	0.5429	0.1738	0.3198
India	1.0000	0.6786	0.2509	0.4339
Canada	0.1053	0.4419	0.0000	0.0922
Germany	0.5789	0.5429	0.0512	0.2842
Switzerland	0.1579	0.3800	0.0000	0.0675
Australia	0.2105	0.3800	0.0000	0.0876
Ireland	0.1579	0.4634	0.0000	0.1450
Japan	0.3684	0.5000	0.0288	0.1728
Luxembourg	0.3158	0.3878	0.1159	0.0616
Bermuda	0.1579	0.4872	0.0054	0.0944
Cyprus	0.3158	0.2923	0.1084	0.0118
Russia	0.1053	0.2289	0.0000	0.0022
France	0.3684	0.4318	0.0078	0.1469
United Arab Emirates	0.2105	0.4524	0.0000	0.1480
Cayman Island	0.2105	0.4318	0.0000	0.1333
Mauritius	0.3158	0.4318	0.0074	0.1078
Average	*0.3947*	*0.4688*	*0.0718*	*0.1762*

a **"small-world" network**, meaning that any country in the network can connect to any other in just over two steps on average. This points to a highly efficient system for capital transmission. Finally, the high **Global Clustering Coefficient (0.530)** reveals a strong tendency for countries to form tightly-knit communities. This suggests the presence of distinct economic blocs, where the partners of a country are also likely to be partners with each other.

Table 4: Global Network Structure Metrics (2023)

Metric	**Value**
Network Density	0.197
Average Shortest Path Length	2.292
Global Clustering Coefficient	0.530

5. Conclusion

This study successfully applied a network-theoretic framework to analyze India's 2023 FDI landscape, yielding insights not visible from traditional analysis. The findings reveal a distinct **hub-and-spoke network** with **small-world properties**, indicating an efficient but centralized investment structure with India at its core.

The quantitative analysis demonstrates that while countries like Singapore are dominant sources of direct capital inflow, the **United States emerges as the most structurally critical player**, serving as both the most connected hub and the primary intermediary for capital flows. European nations like the Netherlands and the United Kingdom also function as vital gateways, underscoring the importance of regional economic blocs. This highlights a key policy implication: engagement strategies should consider not only the volume of investment from a partner but also its structural role within the global network.

The analysis is constrained by its static, single-year scope and a measurement mismatch between India's equity-based data and partners' total FDI data. Future research should pursue a dynamic, longitudinal analysis to track the evolution of these relationships, conduct a sectoral-level breakdown to identify industry-specific networks, and incorporate trade data to build a more comprehensive, multi-layered model of India's economic integration.

References

[1] Lima, F., Pinheiro, F., Silva, J. F., & Matos, P. (2020). *Foreign direct investment – using network analysis to understand the position of Portugal in a global FDI network*. Presentation at the IFC Conference on external statistics, Lisbon, Portugal.

[2] Government of India, Department for Promotion of Industry and Internal Trade. (2024). *Fact Sheet on Foreign Direct Investment (FDI) from April, 2000 to December, 2023*. Retrieved from https://dpiit.gov.in/

[3] Hagberg, A. A., Schult, D. A., & Swart, P. J. (2008). *Exploring network structure, dynamics, and function using NetworkX*. In G. Varoquaux, T. Vaught, & J. Millman (Eds.), Proceedings of the 7th Python in Science Conference (SciPy2008) (pp. 11–15). Pasadena, CA.

Appendices

A Master Country List and ISO-3 Codes

The following table lists the countries considered during the data standardization process and their corresponding ISO 3166-1 alpha-3 codes used in the analysis. This comprehensive list ensures consistency in country naming throughout the data processing pipeline.

Table 5: Standardized Country List and ISO-3 Codes

Country	Code	Country	Code	Country	Code
Albania	ALB	Guatemala	GTM	Oman	OMN
Algeria	DZA	Guernsey	GGY	Pakistan	PAK
Anguilla	AIA	Guyana	GIN	Palau	PLW
Argentina	ARG	Honduras	HND	Panama	PAN
Armenia	ARM	Hong Kong	HKG	Papua New Guinea	PNG
Australia	AUS	Hungary	HUN	Paraguay	PRY
Austria	AUT	Iceland	ISL	Peru	PER
Azerbaijan	AZE	IFSC	-	Philippines	PHL
Bahamas	BHS	India	IND	Poland	POL
Bahrain	BHR	Indonesia	IDN	Portugal	PRT
Bangladesh	BGD	Iran	IRN	Puerto Rico	PRI
Barbados	BRB	Iraq	IRQ	Qatar	QAT
Belarus	BLR	Ireland	IRL	Romania	ROU
Belgium	BEL	Isle Of Man	INL	Russia	RUS
Belize	BLZ	Israel	ISR	Rwanda	RWA
Benin	BEN	Italy	ITA	Saint Vincent	VCT
Bermuda	BMU	Japan	JPN	Samoa	WSM
Bhutan	BTN	Jersey	JEY	Saudi Arabia	SAU
Bolivia	BOL	Jordan	JOR	Senegal	SEN
Botswana	BWA	Kazakhstan	KAZ	Serbia	SRB
Brazil	BRA	Kenya	KEN	Seychelles	SYC
British Indian Ocean Ter.	IOT	Kuwait	KWT	Sierra Leone	SLE
British Virgin Islands	VGB	Kyrgyz Republic	KGZ	Singapore	SGP
Brunei Darussalam	BRN	Lao People's Dem. Rep.	LAO	Slovakia	SVK
Bulgaria	BGR	Latvia	LVA	Slovenia	SVN
Burkina Faso	BFA	Lebanon	LBN	Somalia	SOM
Cambodia	KHM	Liberia	LBR	South Africa	ZAF
Canada	CAN	Libya	LBY	South Korea	KOR
Cayman Island	CYM	Liechtenstein	LIE	Spain	ESP
Channel Island	-	Lithuania	LTU	Sri Lanka	LKA
Chile	CHL	Luxembourg	LUX	State Of Palestine	PSE
China	CHN	Macau	MAC	Sudan	SDN
Colombia	COL	Macedonia	MKD	Swaziland	SWZ
Congo	-	Madagascar	MDG	Sweden	SWE
Cook Island	COK	Malawi	MWI	Switzerland	CHE
Costa Rica	CRI	Malaysia	MYS	Syria	SYR
Croatia	HRV	Maldives	MDV	Taiwan	TWN
Curacao	CUW	Mali	MLI	Tajikistan	TJK
Cyprus	CYP	Malta	MLT	Tanzania	TZA
Czech Republic	CZE	Marshall	MHL	Thailand	THA
Denmark	DNK	Mauritius	MUS	Togo	TGO
Djibouti	DJI	Mexico	MEX	Trinidad & Tobago	TTO
Dominican Republic	DOM	Moldova	MDA	Tunisia	TUN
Ecuador	ECU	Monaco	MCO	Turkey	TUR
Egypt	EGY	Mongolia	MNG	Turks And Caicos Islands	TCA

Table 5 – continued from previous page

Country	Code	Country	Code	Country	Code
Estonia	EST	Montenegro	MNE	Uganda	UGA
Ethiopia	ETH	Morocco	MAR	Ukraine	UKR
Finland	FIN	Mozambique	MOZ	United Arab Emirates	ARE
France	FRA	Myanmar	MMR	United Kingdom	GBR
Gabon	GAB	Namibia	NAM	United States	USA
Georgia	GEO	Nepal	NPL	U.S. Virgin Islands	VIR
Germany	DEU	Netherland	NLD	Uruguay	URY
Ghana	GHA	New Caledonia	NCL	Uzbekistan	UZB
Gibraltar	GIB	New Zealand	NZL	Vanuatu	VUT
Greece	GRC	Nigeria	NGA	Venezuela	VEN
Guam	GUM	Northen Mariana Islands	MNP	Vietnam	VNM
		Norway	NOR	Zambia	ZMB
				Zimbabwe	ZWE

B Top 3 Bilateral Partners for Top 10 Countries

The following table shows the result of the bilateral partner identification process, based on the total bidirectional FDI flow (W_{ij}). This data was used to define the forced structural edges in the final network visualization, ensuring that the most significant relationships for India's primary partners were included.

Table 6: Top 3 Bilateral FDI Partners for India's Key Partners (2023)

Top 10 Country	Identified Top 3 Bilateral Partners
Mauritius	France, United States, United Kingdom
Singapore	China, United States, India
United States	Canada, Germany, Netherland
Netherland	United Kingdom, Switzerland, United States
Japan	United States, United Kingdom, Australia
United Kingdom	Luxembourg, France, Germany
Germany	United Kingdom, Netherland, Ireland
Cyprus	Russia, Luxembourg, Bermuda

C Pruned Proximity Matrix (Φ) Snippet

The table below presents a snippet of the pruned proximity matrix (Φ_{ij}) after the 75th percentile threshold was applied. The values represent the calculated "economic distance" ($1/W_{ij}$) between country pairs, where smaller values indicate stronger total investment relationships. Infinite values (∞) represent connections that were filtered out. This matrix formed the basis for constructing the Minimum Spanning Tree.

Table 7: Snippet of the Pruned Proximity Matrix (Post-Thresholding)

Country	India	USA	UK	Singapore	Netherland	Germany	Japan	Mauritius	Cyprus
India	0.0000	0.0001	0.0008	0.0000	0.0006	0.0048	0.0053	0.0146	0.1187
USA	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0065	∞
UK	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0298	0.0002
Singapore	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	∞	0.0165
Netherland	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	∞	0.0005
Germany	0.0048	0.0000	0.0000	0.0001	0.0000	0.0000	0.0007	0.0079	0.0011
Japan	0.0053	0.0000	0.0002	0.0000	0.0004	0.0007	0.0000	∞	∞
Mauritius	0.0146	0.0065	0.0298	∞	∞	0.0079	∞	0.0000	∞
Cyprus	0.1187	∞	0.0002	0.0165	0.0005	0.0011	∞	∞	0.0000

D Comparison of Network Pruning Methodologies

The selection of a pruning method is a critical step in network construction. The following table, adapted from the project notebook, compares four alternative methodologies that were considered. The Percentile Threshold was ultimately chosen for its adaptability and robustness in identifying relatively significant relationships across the dataset.

Table 8: Comparative Analysis of Network Pruning Methods

Method	**Complexity**	**Data-Driven**	**Economic Interpretation**
Absolute	O(1)	No	Clear monetary threshold
Percentile	O(n log n)	Yes	Relative significance
Degree-based	$O(n^2)$	Partial	Attention constraints
Density-based	$O(n^2)$	Yes	Topological control