NETWORK OF THE TRANSATLANTIC SLAVE TRADE:

A Data-Driven Analysis of Historical Connections

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01. INTRODUCTION

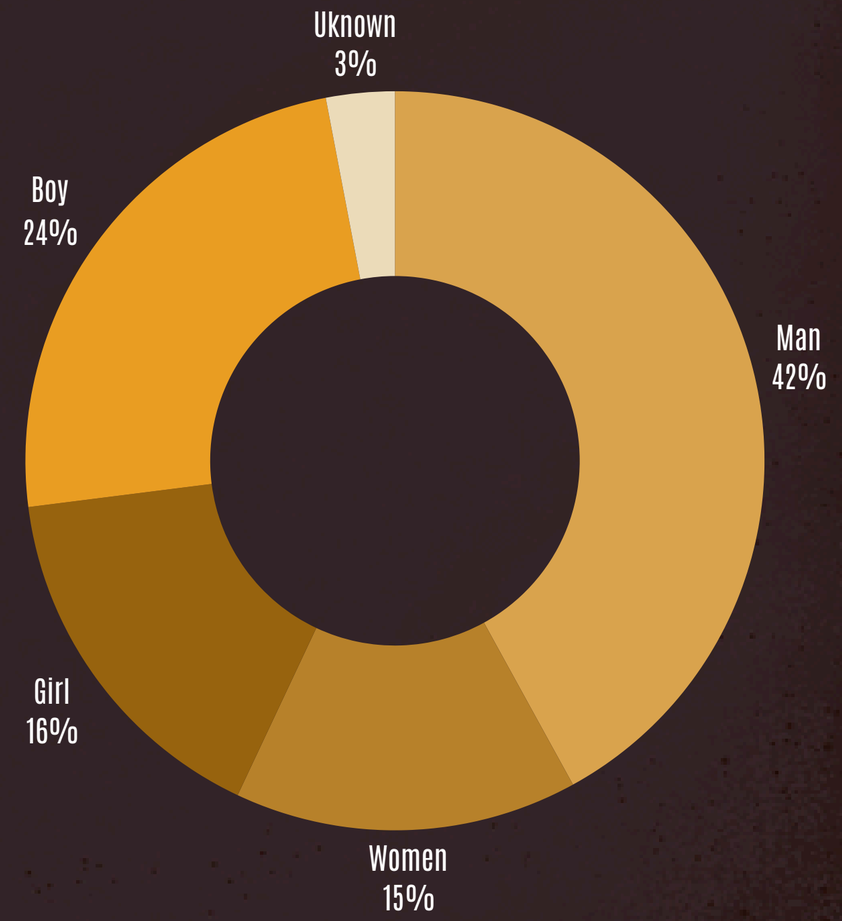
DATASET[1]

VOYAGES - 36.242

FROM 1514 TO 1866

AVERAGE DURATION : 274 DAYS

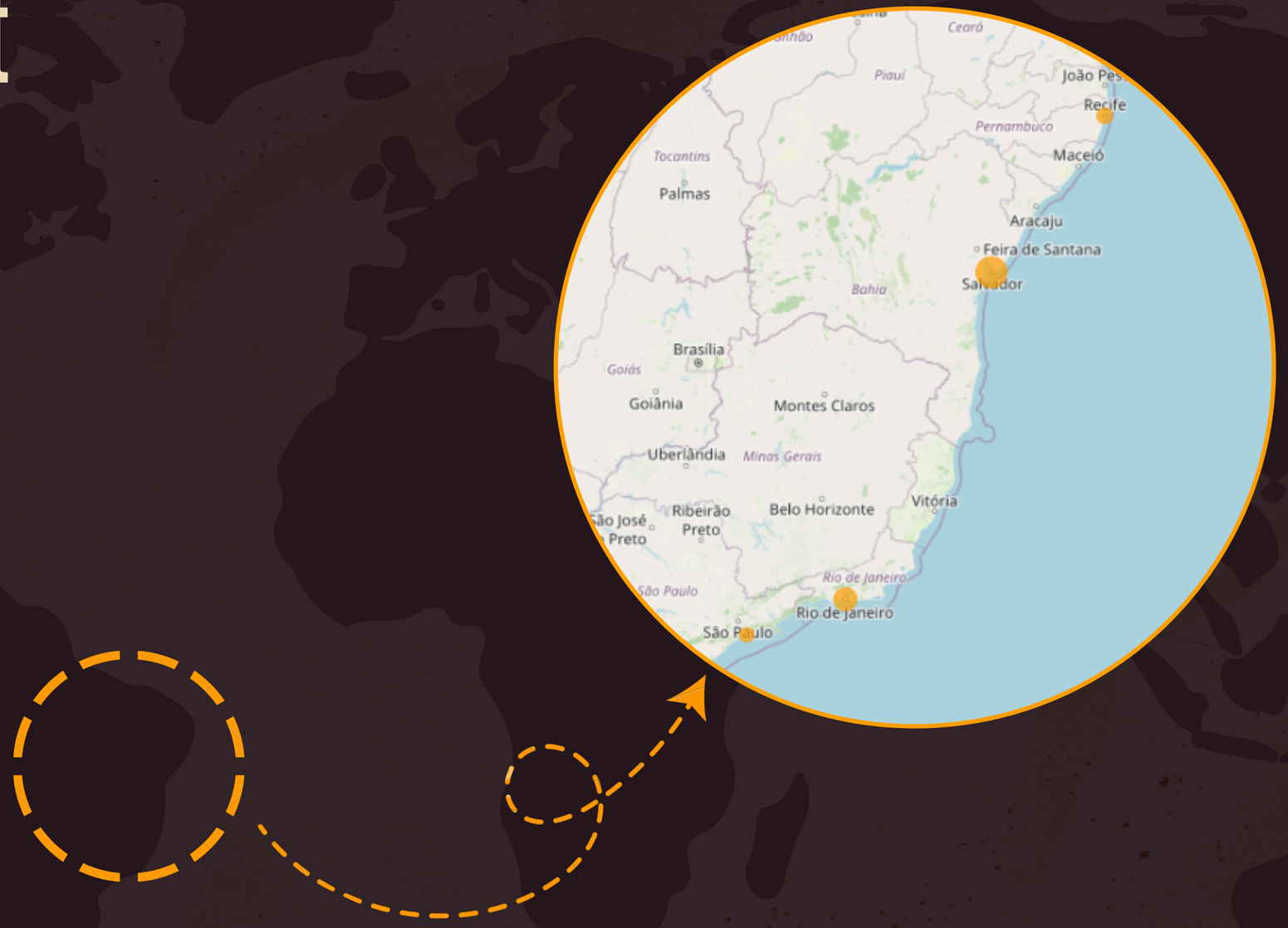
SLAVES - 67.460



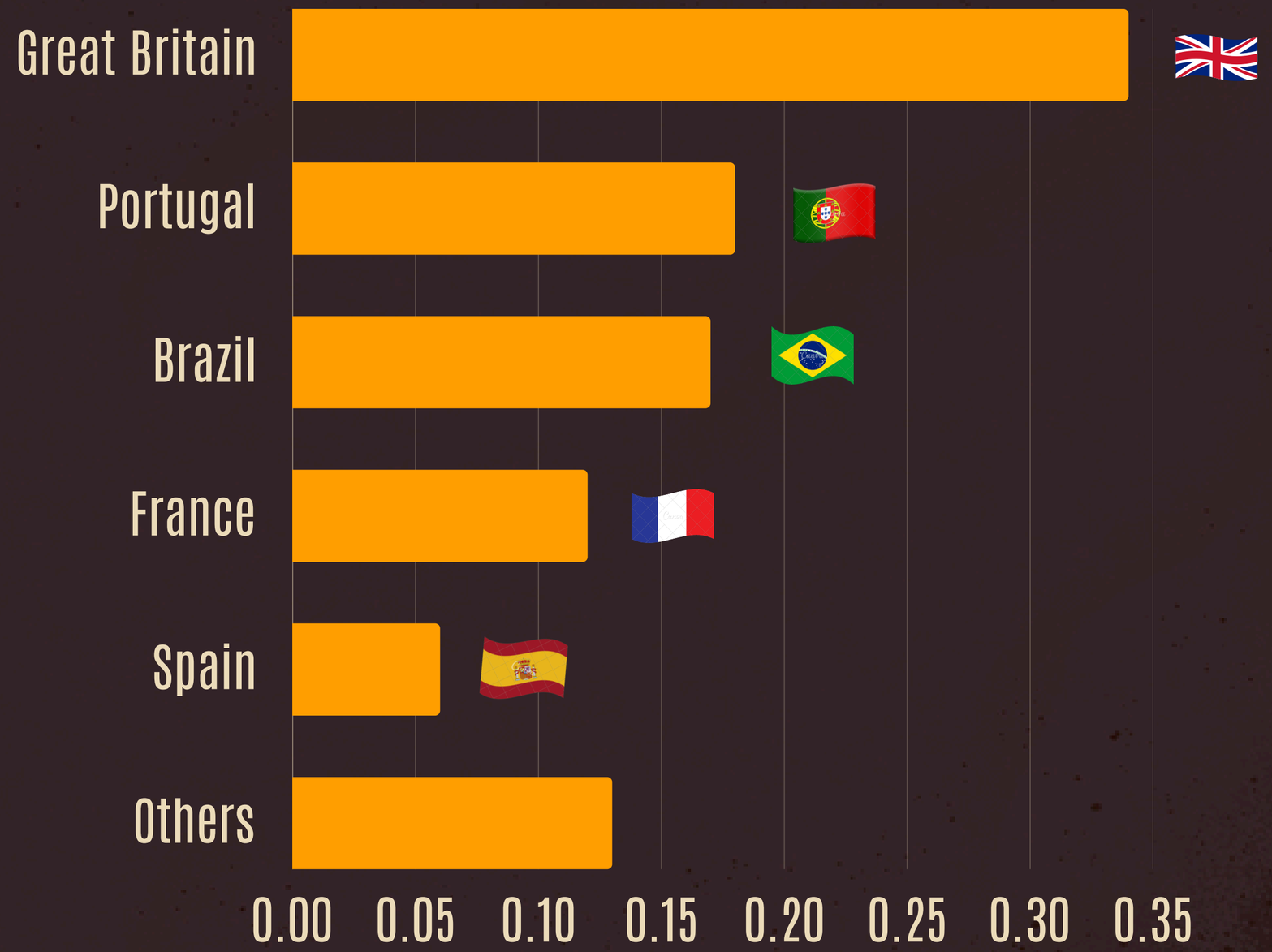
[1] https://www.slavevoyages.org/

Departure port

Departure port



FLAGS OF VESSELS



Slave purchase place and arrival port

THE RESEARCH QUESTION

How did the slave trade expand over the years ?

- What are the central nodes?
- How resilient is the network across the historical periods?
- How did the the network structure change over time?

02. THE NETWORK

133.142 nodes

- Ship
- Slaves
- Departure port
- Arrival port
- Slave purchase place
- Vessel captain
- Vessel owner

442.049 edges

 # voyages

Departure port ➤ *Arrival port*

Departure port ➤ *Slave purchase place* ➤ *Arrival port*

Ship ➤ *Departure port*

Ship ➤ *Slave purchase place*

Ship ➤ *Arrival port*

Ship ➤ *Slaves*

Ship ➤ *Vessel owner*

Vessel captain ➤ *Ship*

Slave ➤ *Slave purchase place*

HISTORICAL PERIODS

1514-1600

Early Transatlantic Slave Trade

1601-1700

Expansion of European Colonies

1701-1800

Peak of the Transatlantic Slave Trade

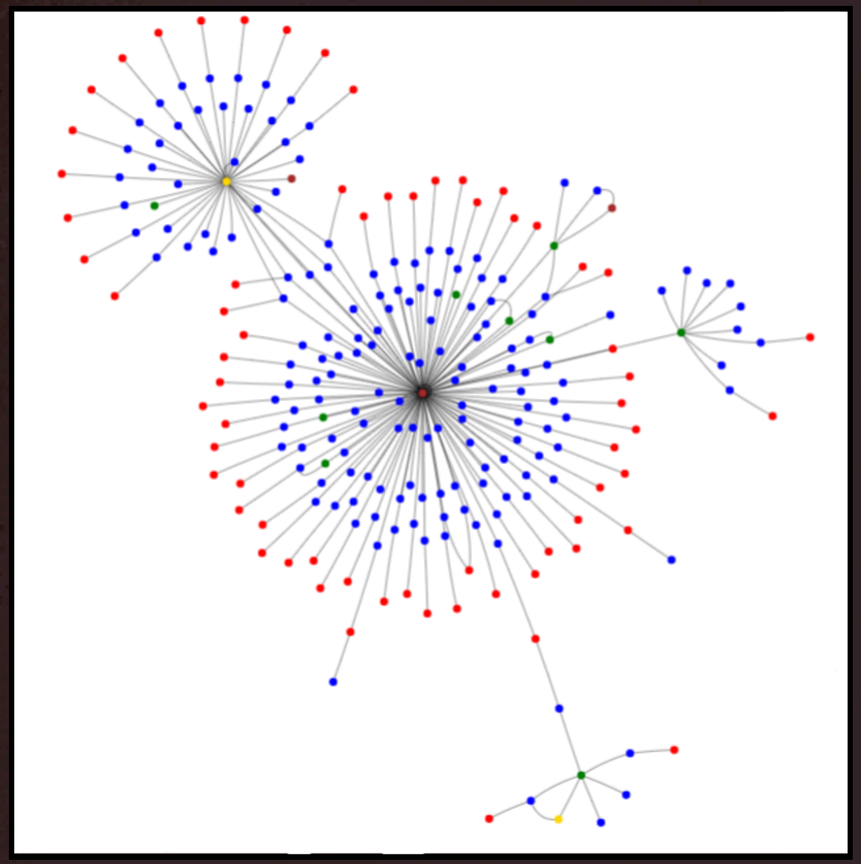
1801-1830

Abolitionist Movements Begin

1831-1866

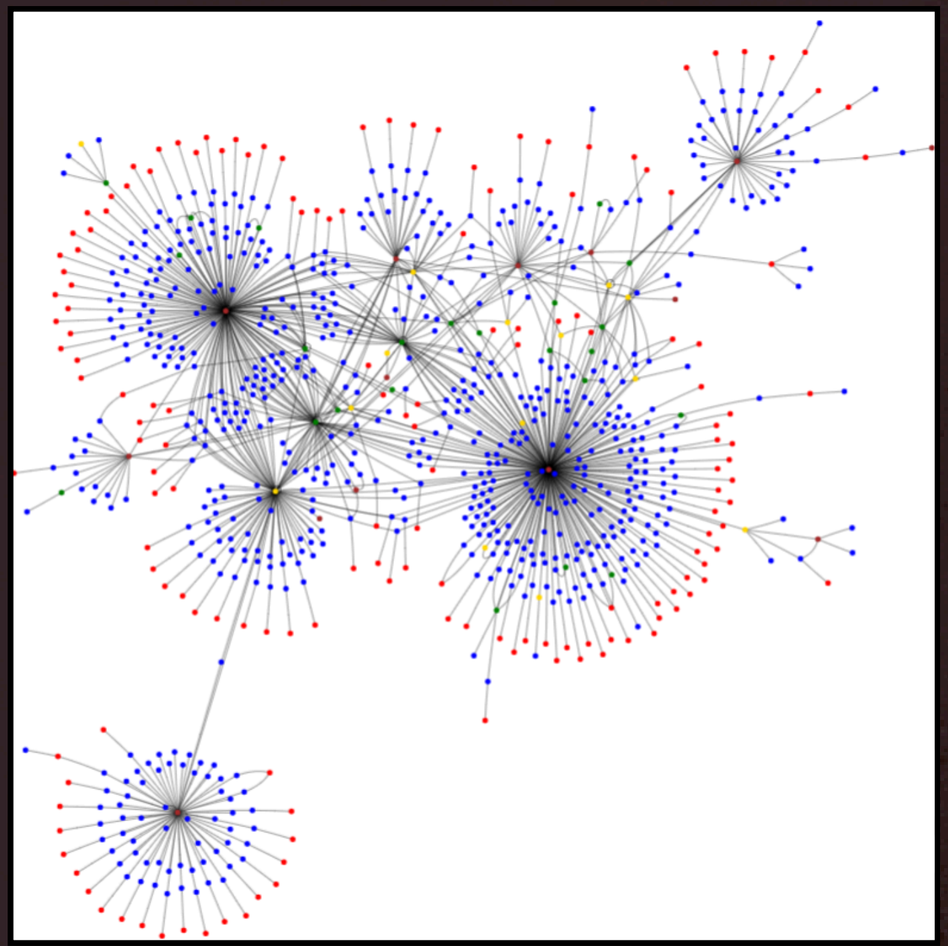
Post-Abolition and Illegal Trade

Early Transatlantic Slave Trade (1514-1600)



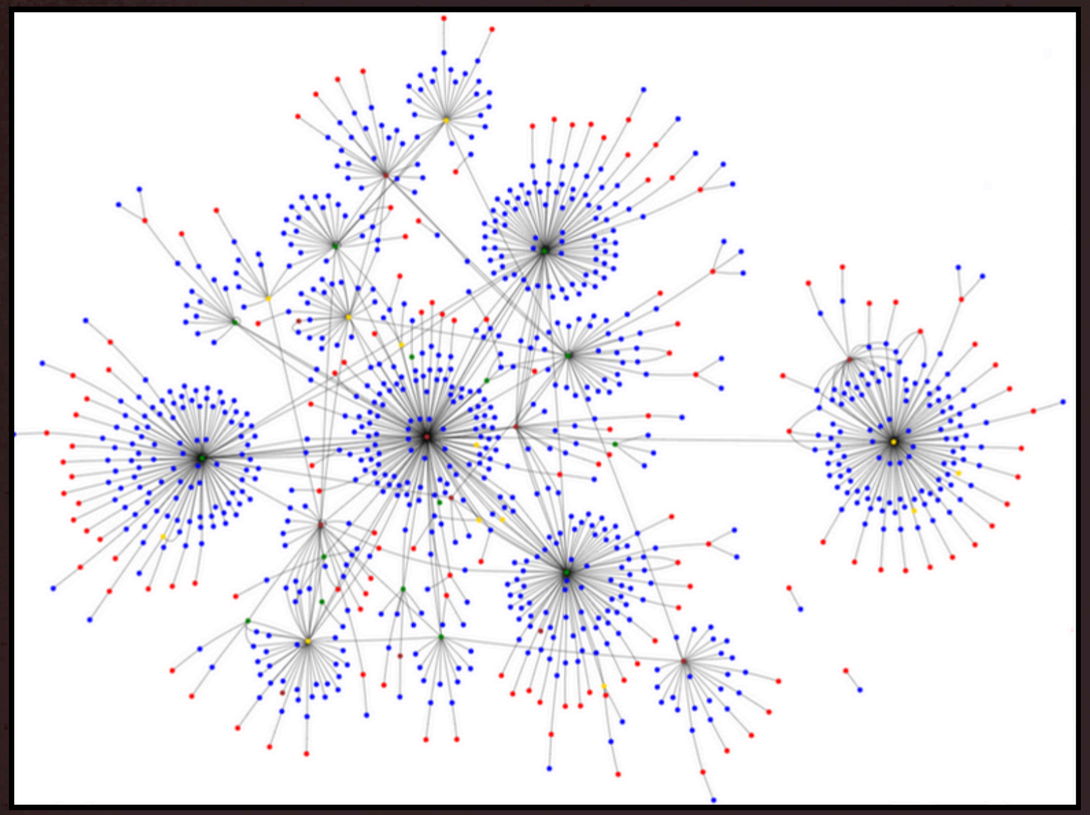
Nodes: 1689, Edges: 4536

Expansion of European Colonies (1601-1700)



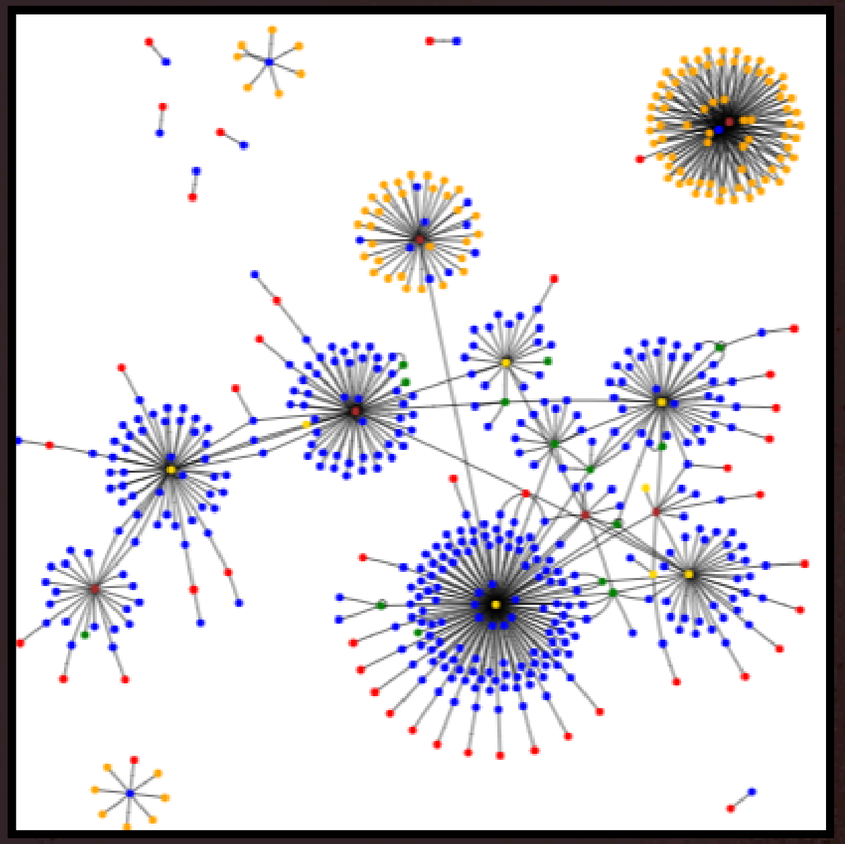
Nodes: 6232, Edges: 20618

Peak of the Transatlantic Slave Trade (1701-1800)



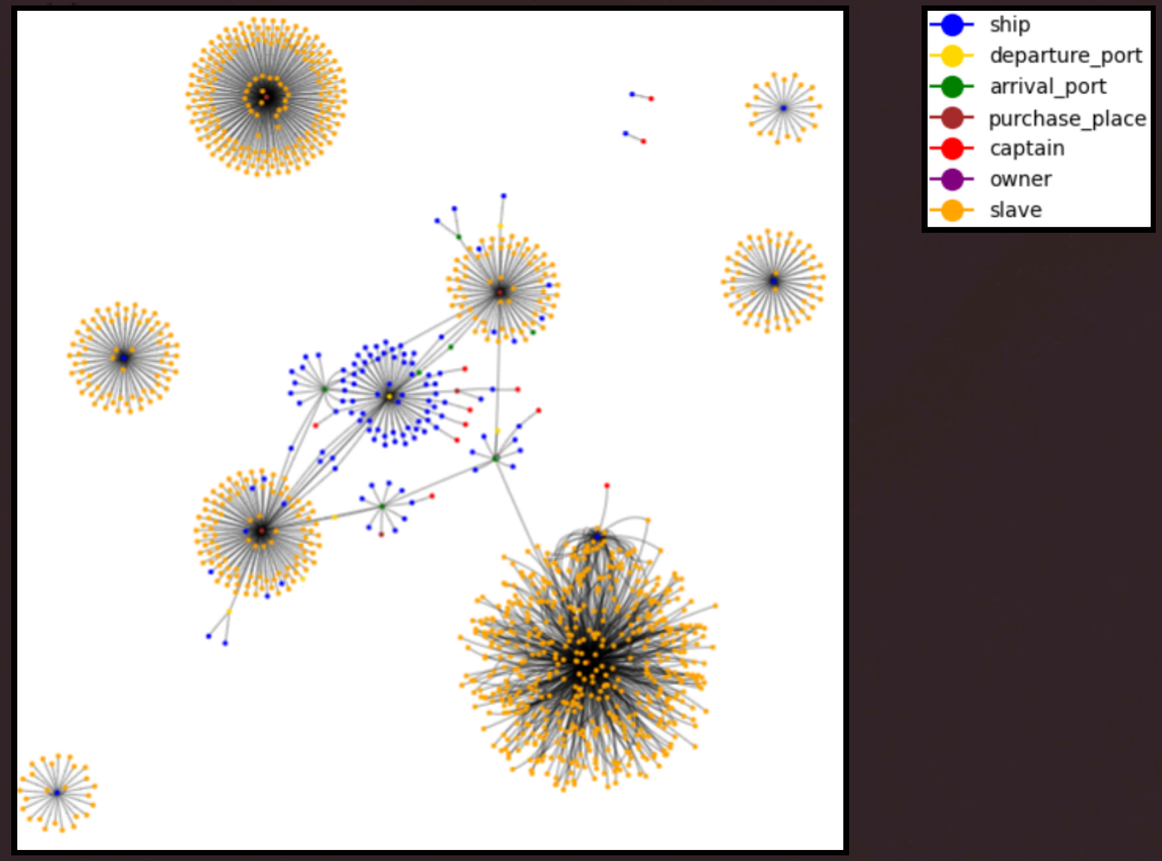
Nodes: 32535, Edges 133157

Abolitionist Movements Begin (1801-1830)



Nodes: 39301, Edges: 128312

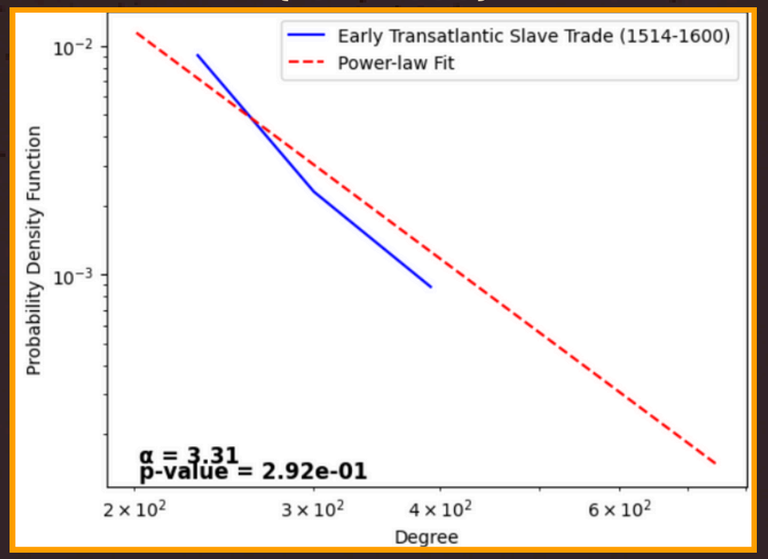
Post-Abolition & Illegal Trade (1831-1866)



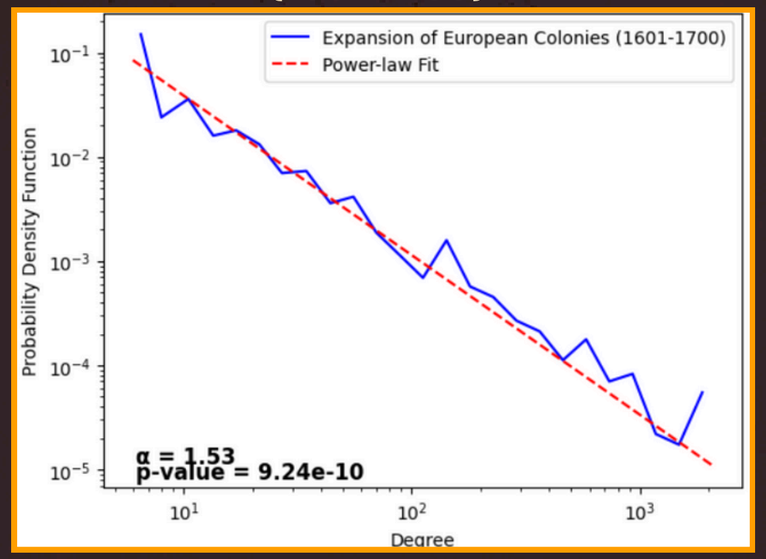
Nodes: 44209, Edges: 133412

Degree Distribution vs Power-law Fit

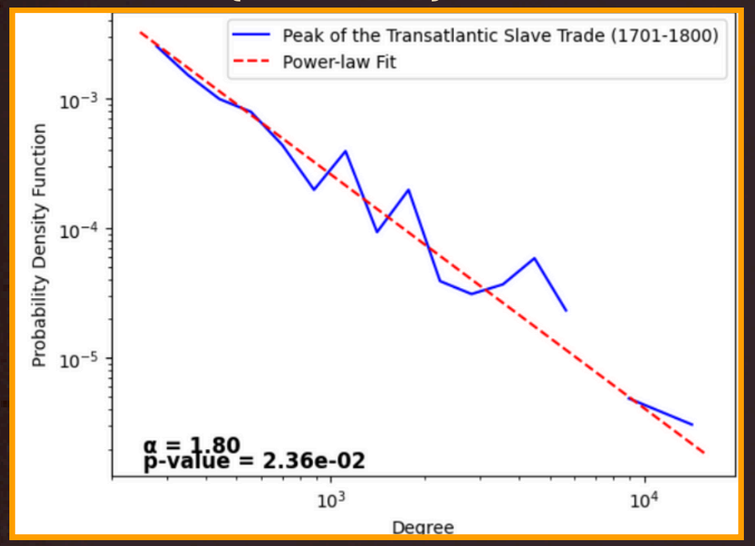
(1514-1600)



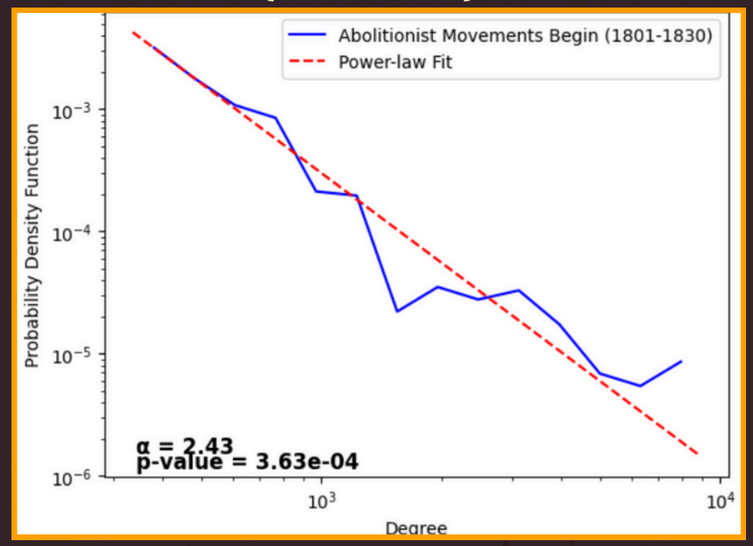
(1601-1700)



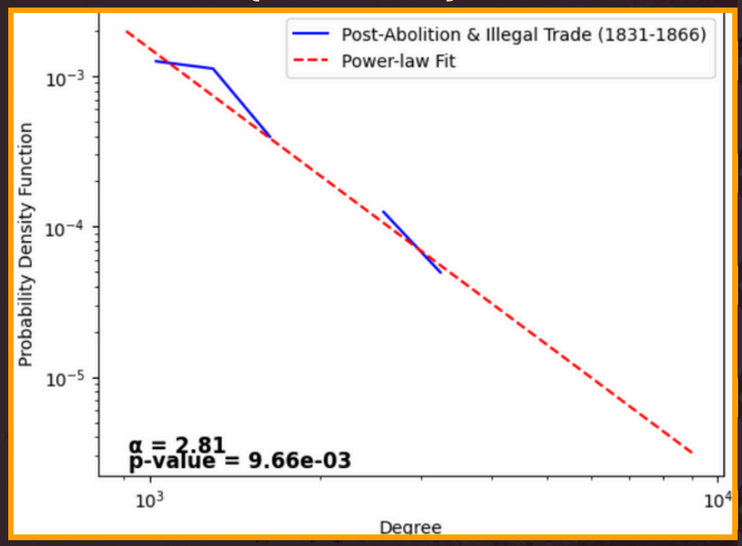
(1701-1800)



(1801-1830)



(1831-1866)

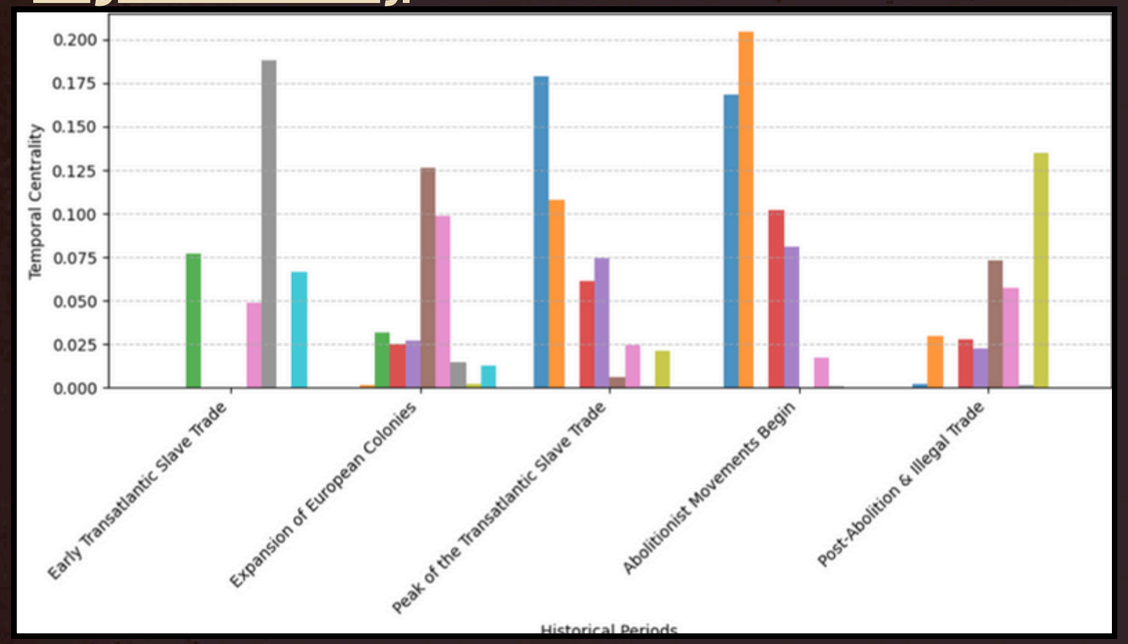


03. BASIC NETWORK METRICS

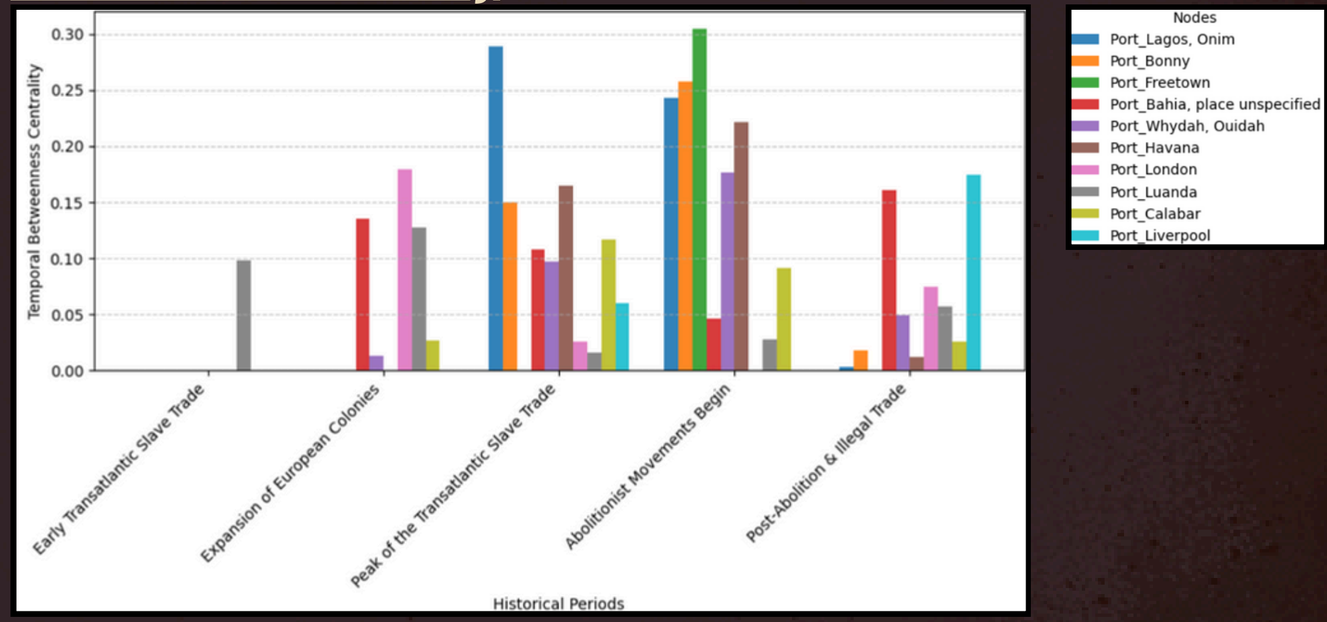
Temporal centrality

Tracks node importance over time with decay

Degree centrality

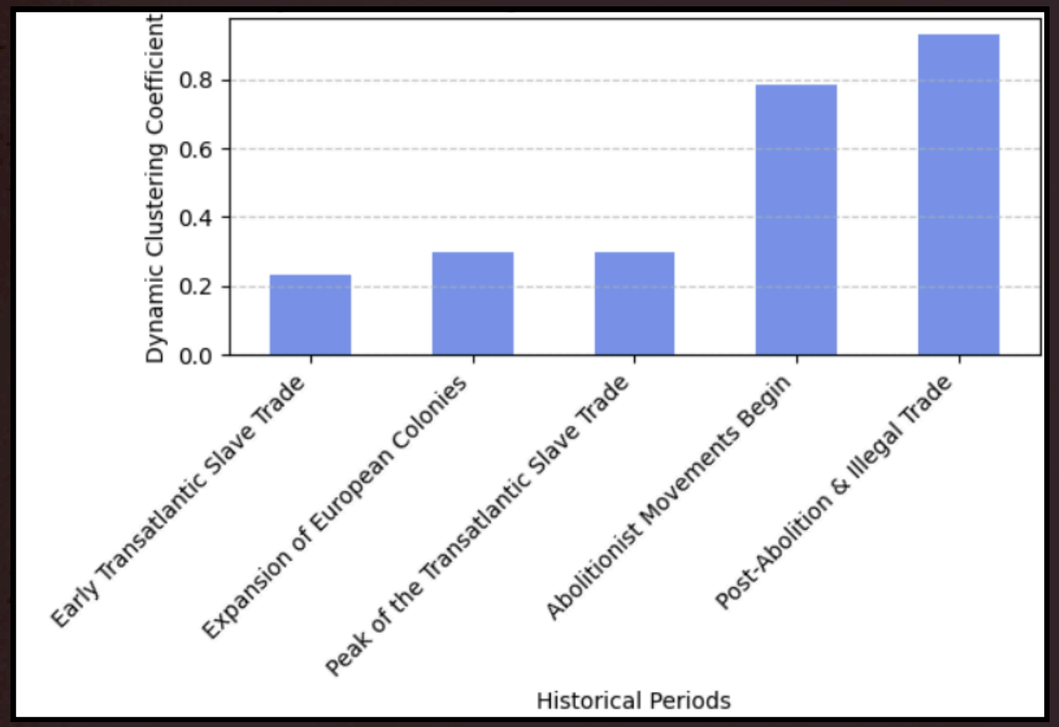


Betweeness centrality



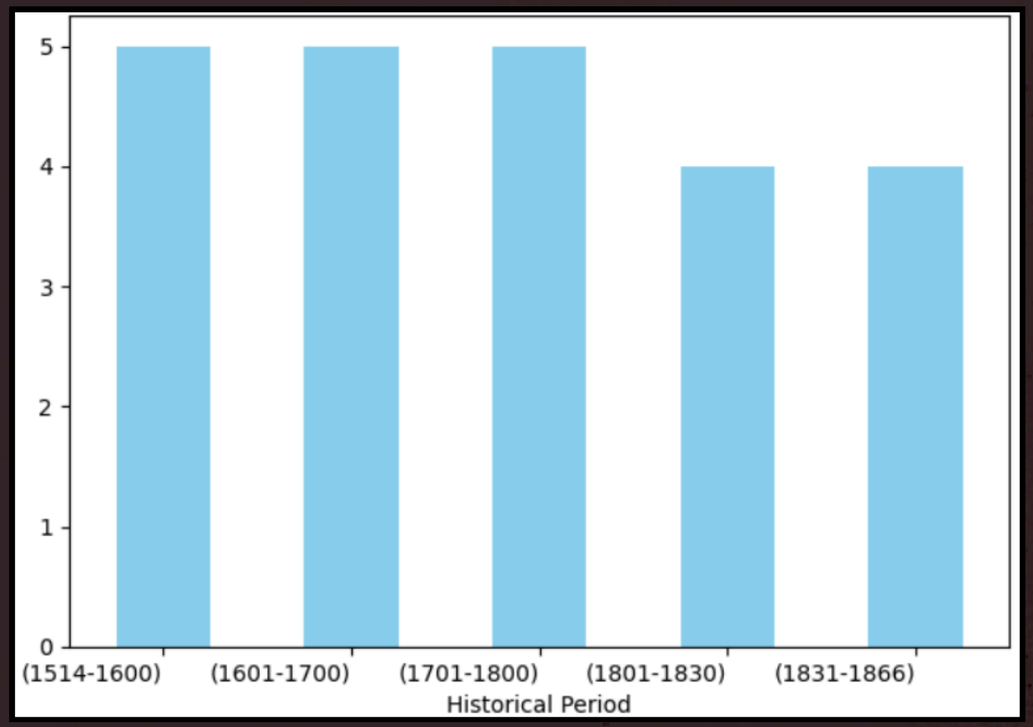
Dynamic clustering coefficient

Measures how clusters evolve over time



Temporal effective diameter

Measures the maximum connection distance, showing influence over time.



illegal trade networks tend to form hidden, high-clustering structures

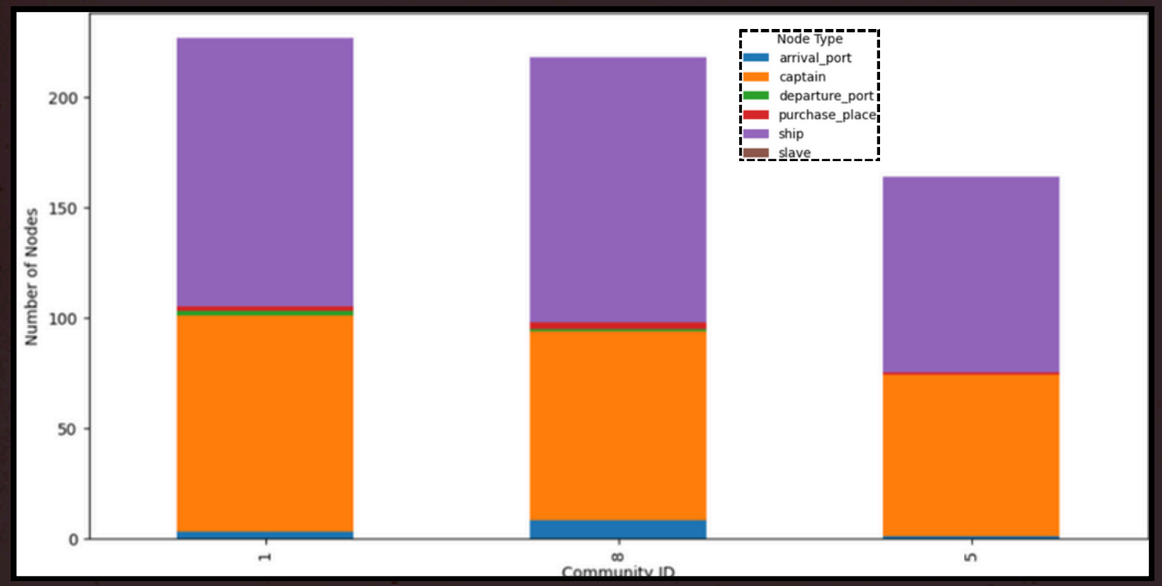
04. COMMUNITY DETECTION

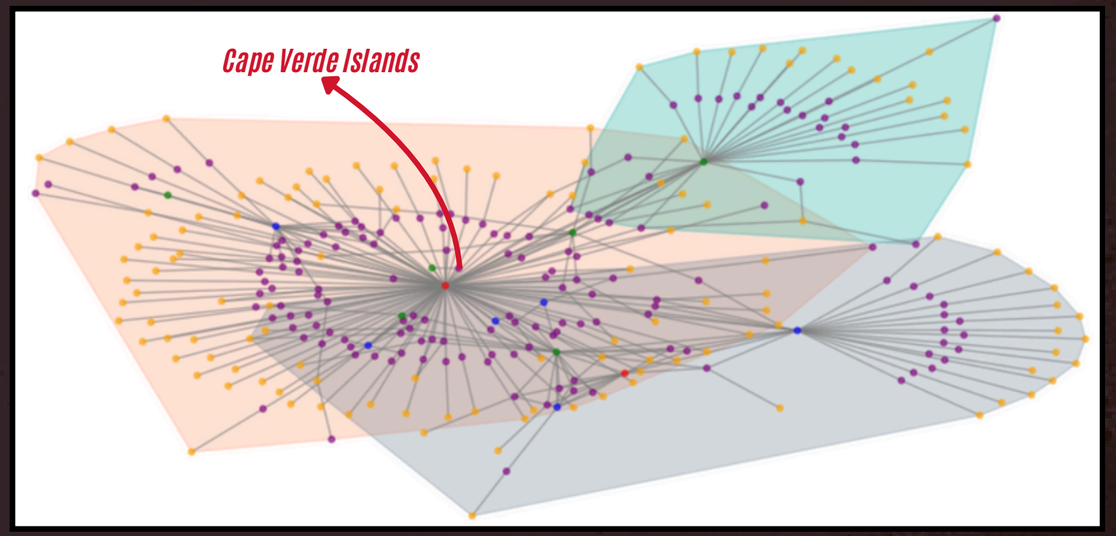
Community Detection in the transatlantic slave trade

- *Helps identify clusters within the transatlantic slave trade network, such as groups of ports, ships, or captains that worked together frequently.*
- *Helps to understand the organization and structure of the network across different time periods.*

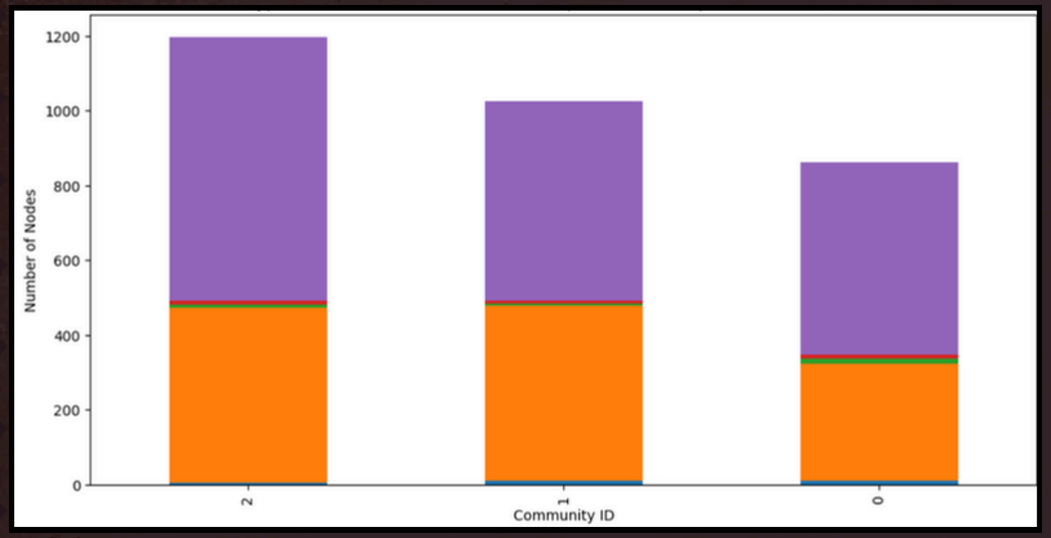
*We used the **Louvain method** for community detection, which optimizes the modularity of the network to find dense clusters of nodes.*
For each historical period, we extracted the relevant subgraph and applied the community detection algorithm.

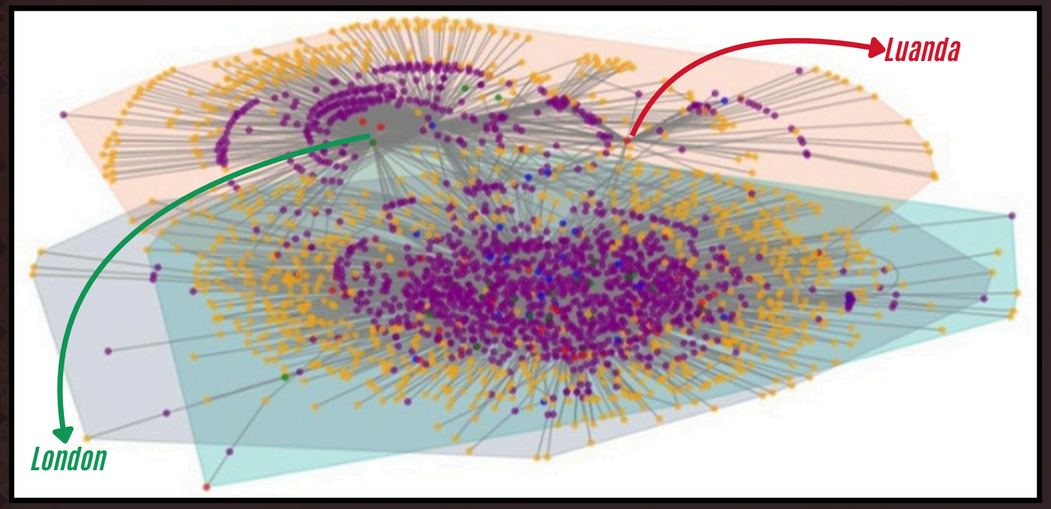
Early Transatlantic Slave Trade (1514-1600)



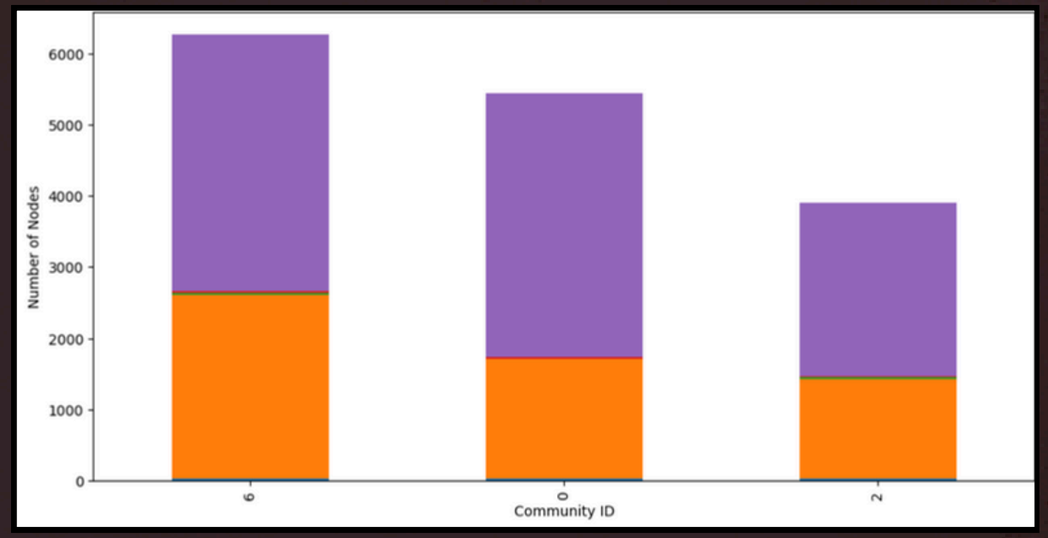


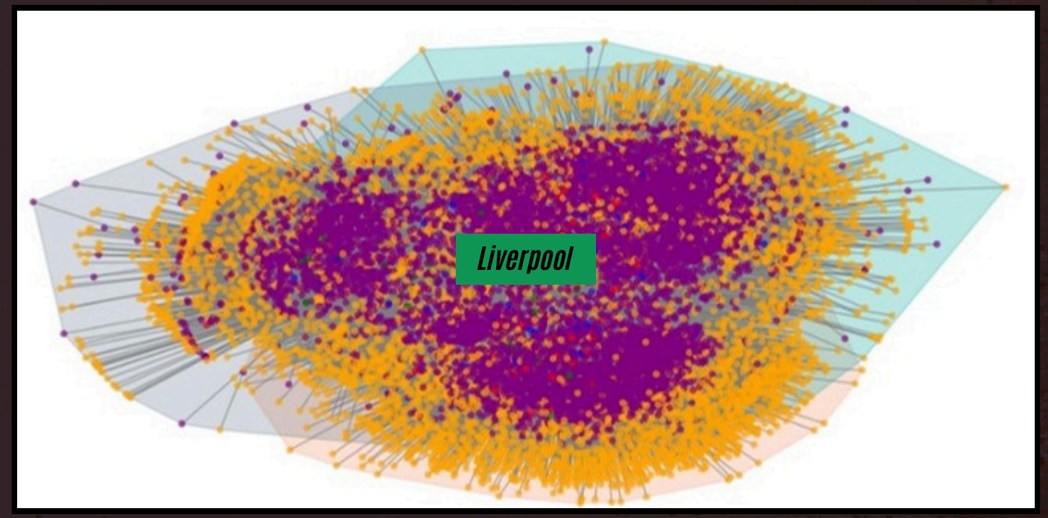
Expansion of European Colonies (1601-1700)



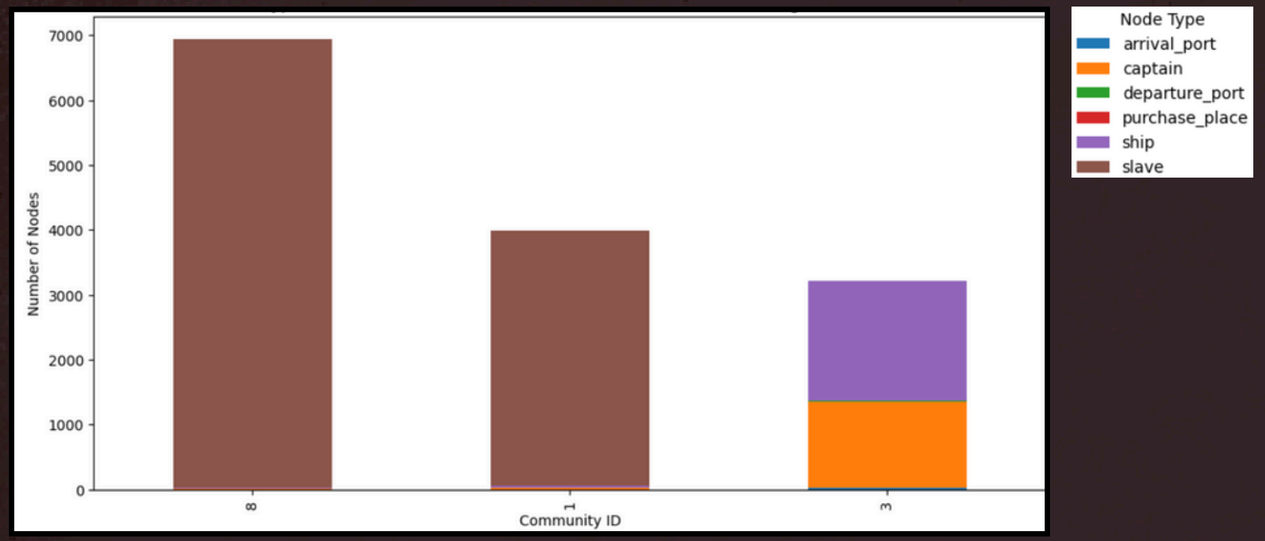


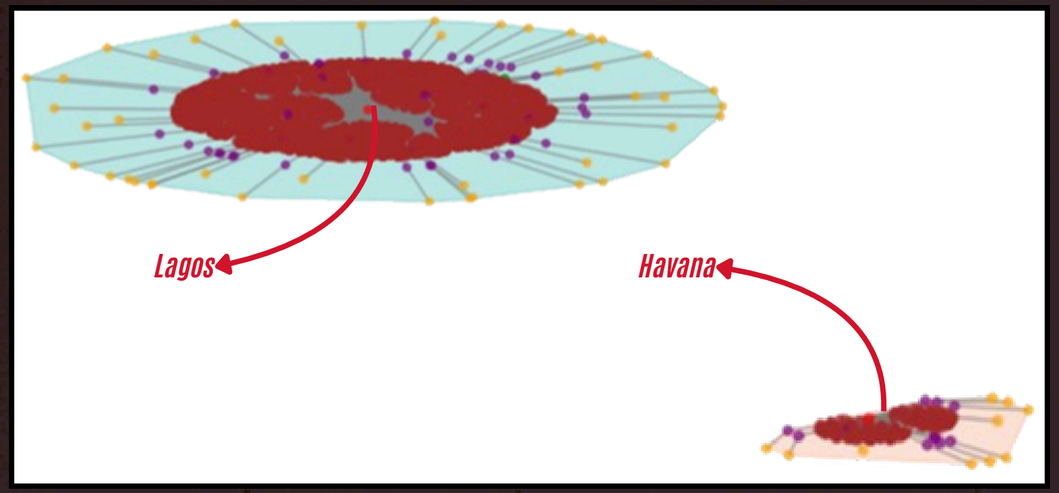
Peak of the Transatlantic Slave Trade (1701-1800)



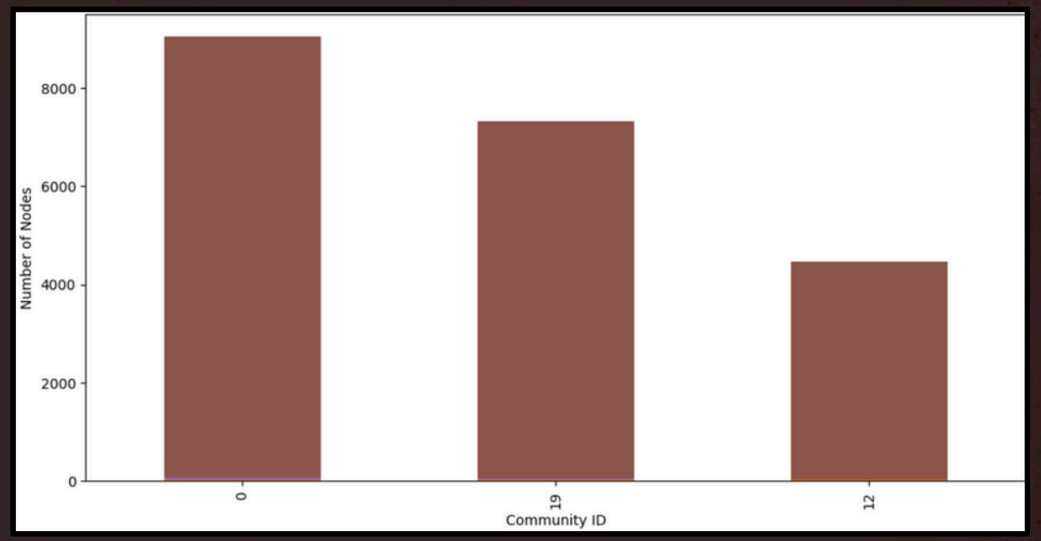


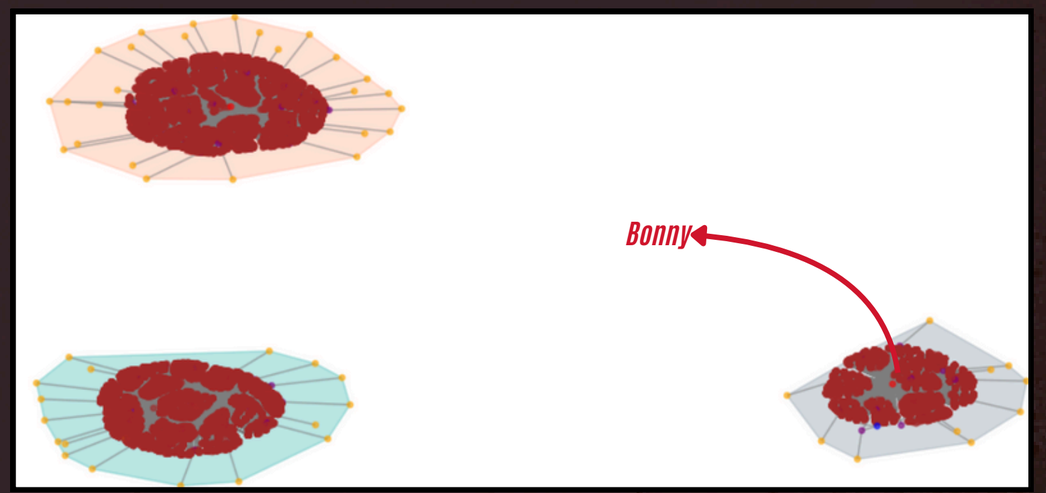
Abolitionist Movements Begin (1801-1830)





Post-Abolition & Illegal Trade (1831-1866)





Period	Nodes	Edges	Community	Modularity score
Early Transatlantic Slave Trade (1514-1600)	*1689*	*4536*	*15*	*0.56*
Expansion of European Colonies (1601-1700)	*6232*	*20618*	*23*	*0.62*
Peak of the Transatlantic Slave Trade (1701-1800)	*32535*	*133157*	*15*	*0.63*
Abolitionist Movements Begin (1801-1830)	39301	*128312*	42	*0.87*
Post-Abolition & Illegal Trade (1831-1866)	44209	133412	94	0.88

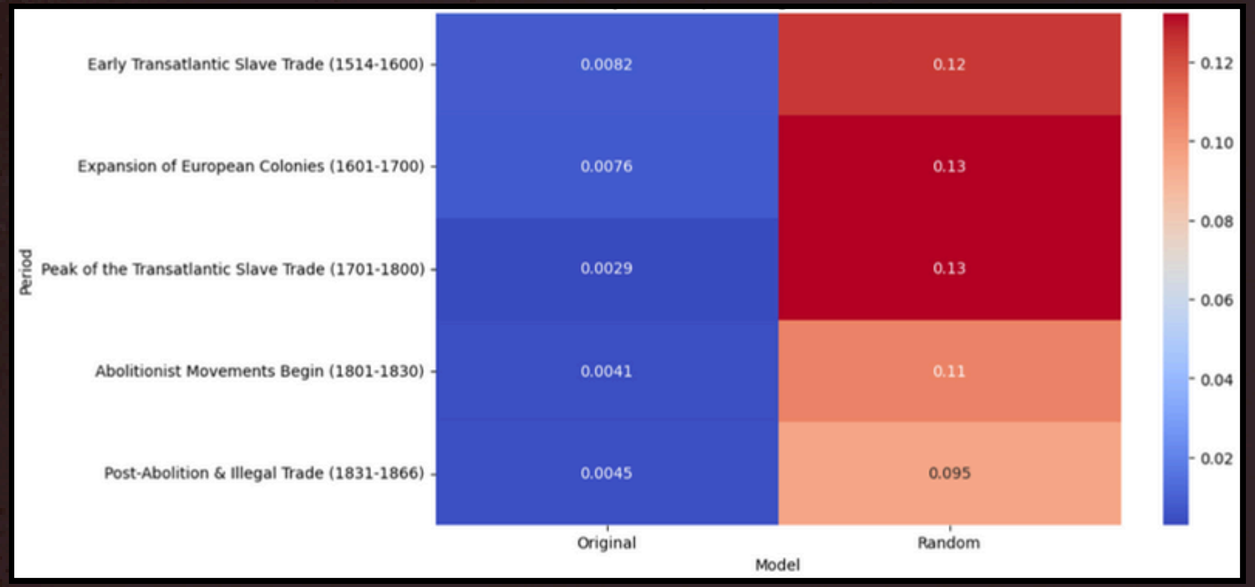
05. NULL MODEL COMPARISON

Null model comparisons help assess the structural properties of dynamic networks by creating randomized versions of the original network.

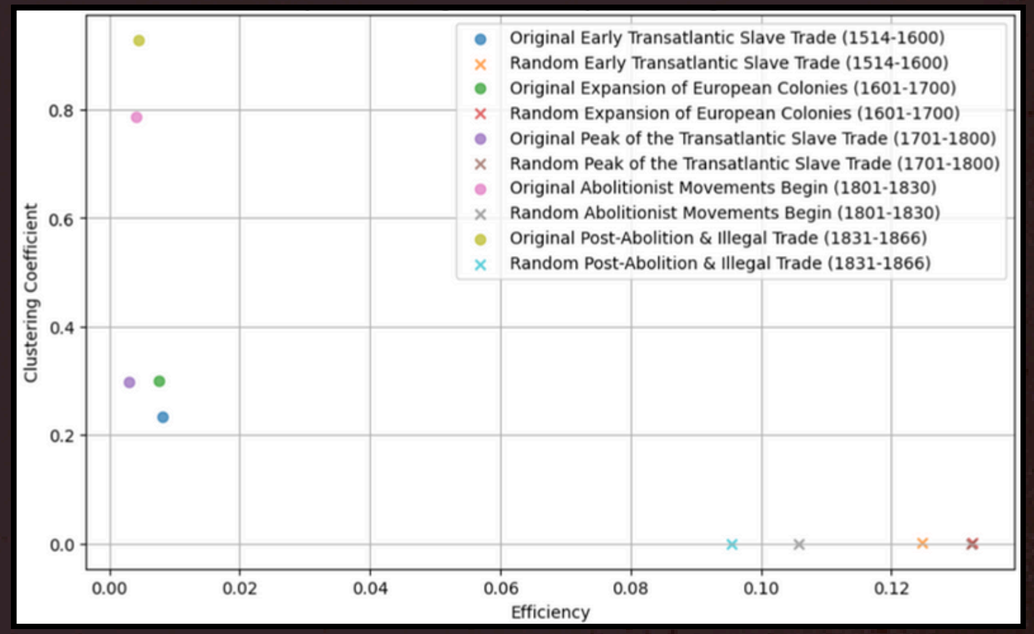
This allows us to determine whether its characteristics—such as efficiency, clustering coefficient, and degree distribution—deviate from random expectations.

Period	Model	Efficiency	Clustering Coefficient
Early Transatlantic Slave Trade	original	**0.008**	**0.234**
	random	**0.125**	**0.001**
Expansion of European Colonies	original	**0.008**	**0.299**
	random	**0.132**	**0.001**
Peak of the Transatlantic Slave Trade	original	**0.003**	**0.298**
	random	**0.132**	**0.0001**
Abolitionist Movements Begin	original	**0.004**	**0.786**
	random	**0.106**	**0.0001**
Post-Abolition and Illegal Trade	original	**0.005**	**0.929**
	random	**0.095**	**0.0001**

Efficiency heatmap for original vs random networks



Efficiency vs Clustering Coefficient by Period

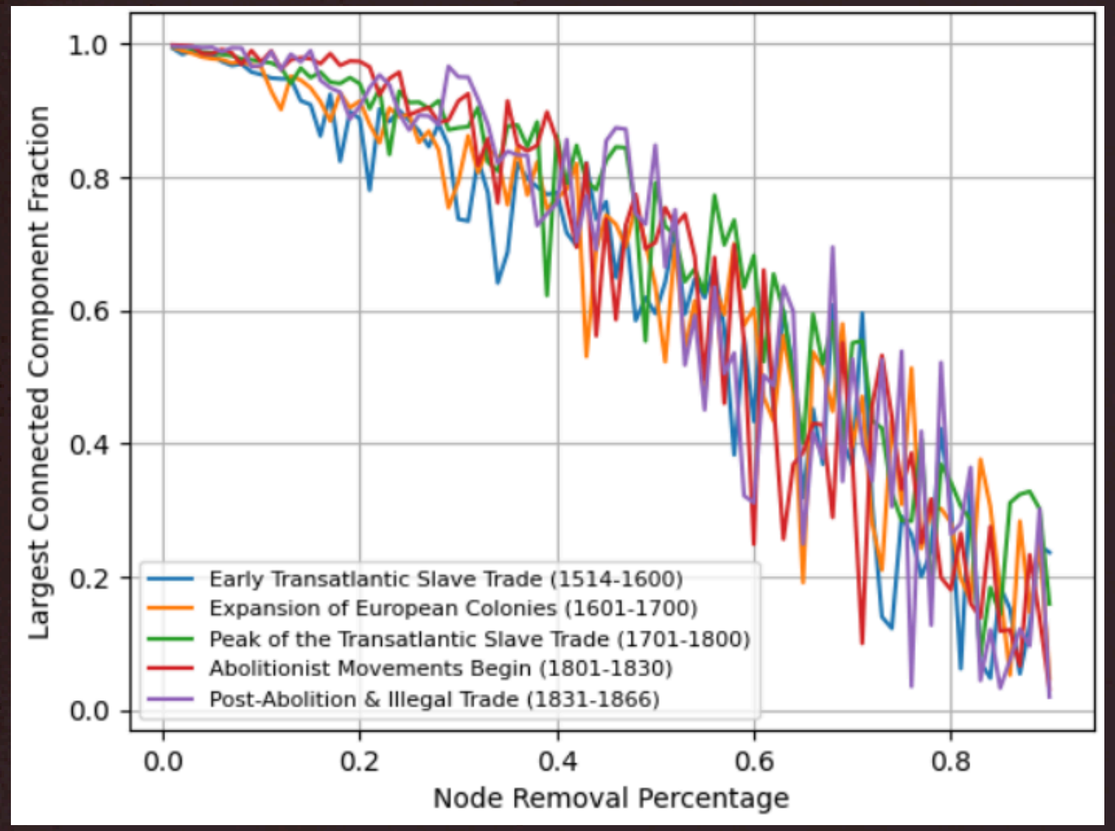


06. DYNAMIC SIMULATION

SITE PERCOLATION

Random removal

Percolation threshold

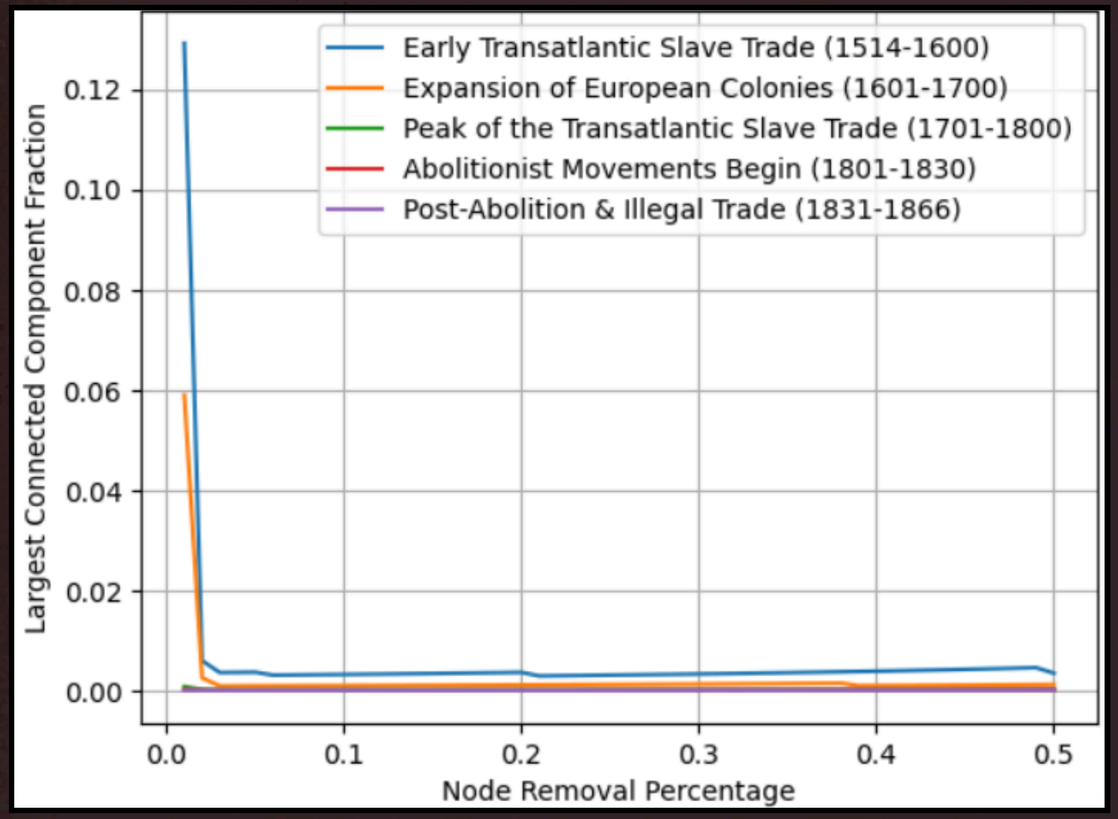


Period	LCC size before	P_c	LCC size after
Early Transatlantic Slave Trade	0.955	0.71	0.709
Expansion of European Colonies	0.959	0.42	0.755
Peak of the Transatlantic Slave Trade	0.972	0.38	0.699
Abolitionist Movements Begin	0.976	0.59	0.662
Post-Abolition and Illegal Trade	0.959	0.75	0.853

SITE PERCOLATION

Degree centrality

Percolation threshold

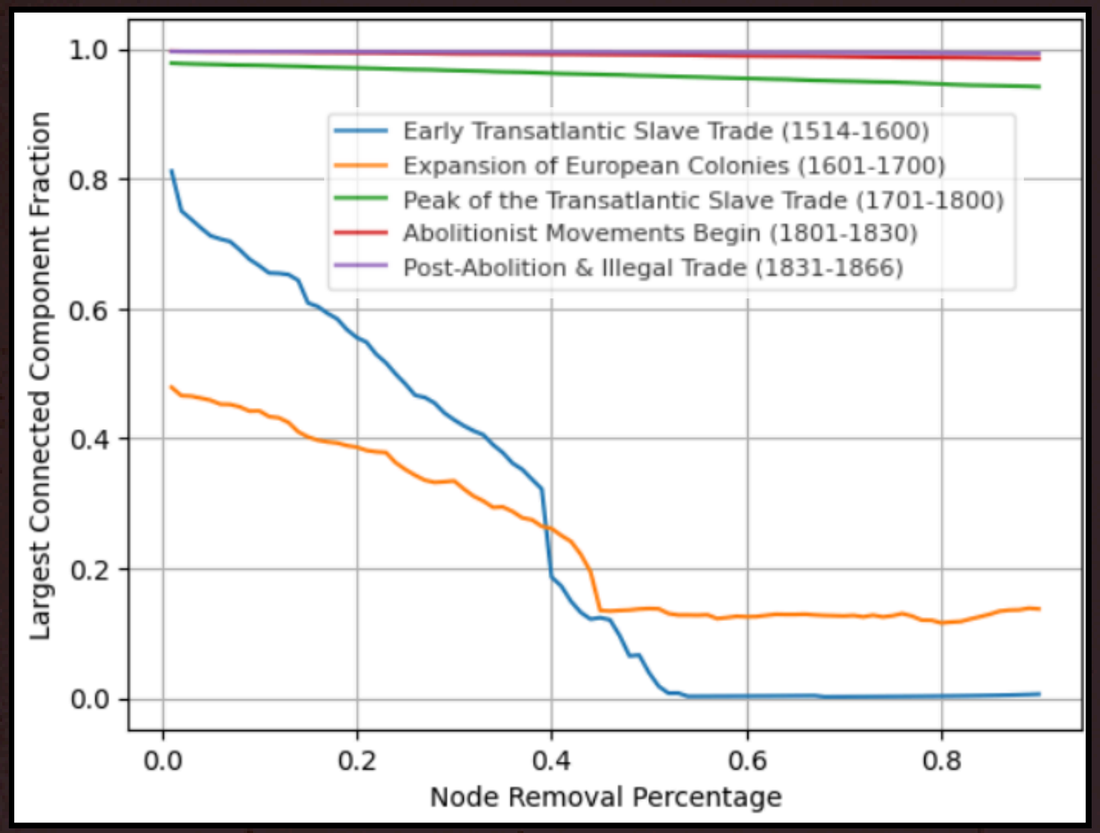


Period	LCC size before	P_c	LCC size after
Early Transatlantic Slave Trade	0.998	0.01	0.130
Expansion of European Colonies	0.997	0.01	0.060
Peak of the Transatlantic Slave Trade	0.993	0.01	0.001
Abolitionist Movements Begin	0.998	0.01	0.0002
Post-Abolition and Illegal Trade	0.997	0.02	0.0001

SITE PERCOLATION

Betweeness centrality

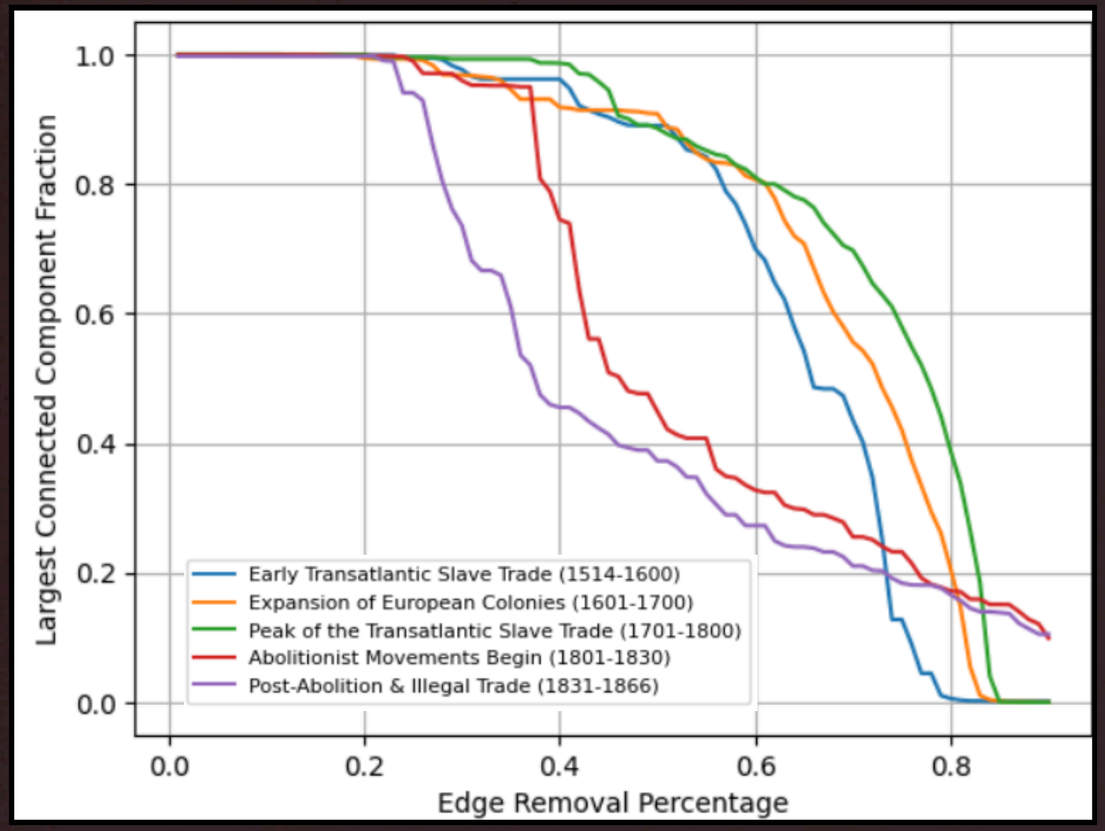
Percolation threshold



Period	LCC size before	P_c	LCC size after
Early Transatlantic Slave Trade	0.667	0.39	0.006
Expansion of European Colonies	0.545	0.44	0.050
Peak of the Transatlantic Slave Trade	0.992	0.80	0.962
Abolitionist Movements Begin	0.995	0.87	0.985
Post-Abolition and Illegal Trade	0.996	0.76	0.986

BOND PERCOLATION

Percolation threshold



Period	LCC size before	P_c	LCC size after
Early Transatlantic Slave Trade	0.998	0.73	0.001
Expansion of European Colonies	0.996	0.81	0.0006
Peak of the Transatlantic Slave Trade	0.999	0.83	0.0002
Abolitionist Movements Begin	0.999	0.37	0.099
Post-Abolition and Illegal Trade	0.996	0.35	0.105

CONCLUSION

Central Nodes

- Early periods (1514-1600) saw European departure ports such as San Lucar and African purchase places like Cape Verde Islands playing a central role.
- As the trade expanded (1601-1700), hubs like London and Luanda emerged as crucial nodes.
- During the peak of the trade (1701-1800) and Abolitionist movements (1801-1830), ports like Lagos and Bonny became dominant.
- Post-abolition (1831-1866), illegal trade routes restructured the network, with Liverpool and Havana maintaining influence.

Expansion of the Trade and Structural Changes

Over time, the network transitioned from a tightly-knit structure with fewer nodes to a highly decentralized and fragmented system. The number of nodes and edges increased significantly, indicating a broader geographic reach and a more complex organization. The highest level of connectivity was observed during the peak period (1701-1800), after which fragmentation increased due to abolitionist efforts, leading to localized and illegal trading networks.

Resilience of the Network

The scale-free properties of the network suggest that the system was highly resilient. Our dynamic simulation confirmed that the trade was robust against random disruptions, as removing small, low-degree nodes did not significantly impact connectivity. However, the trade was vulnerable to targeted attacks on high-degree hubs, indicating that interventions on key ports could have significantly disrupted operations.

Structural Differences from Random Networks

Comparing the historical network to random models revealed that the real-world network had lower efficiency but higher clustering, emphasizing how geographical, political, and economic constraints might have shaped its structure. This further supports the idea that the trade was not an optimally connected system but rather one shaped by historical conditions.


THANK
YOU!