DOCTORAL DISSERTATION PRESENTATION

NICOLAS VICTOR NOAK

22 MAY 2025

Committee

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Prof. Dr. Søren Salomo, TU Berlin

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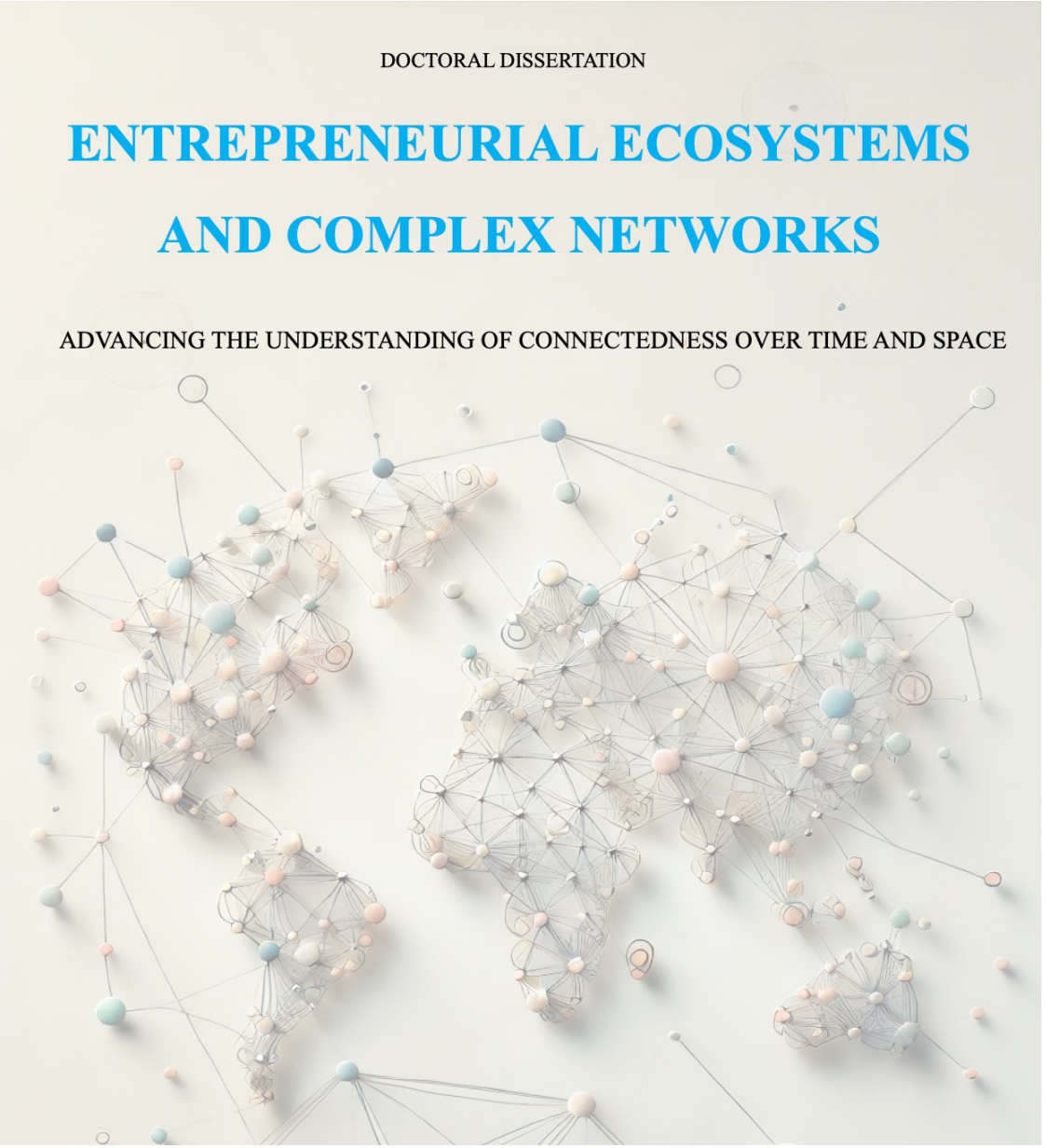
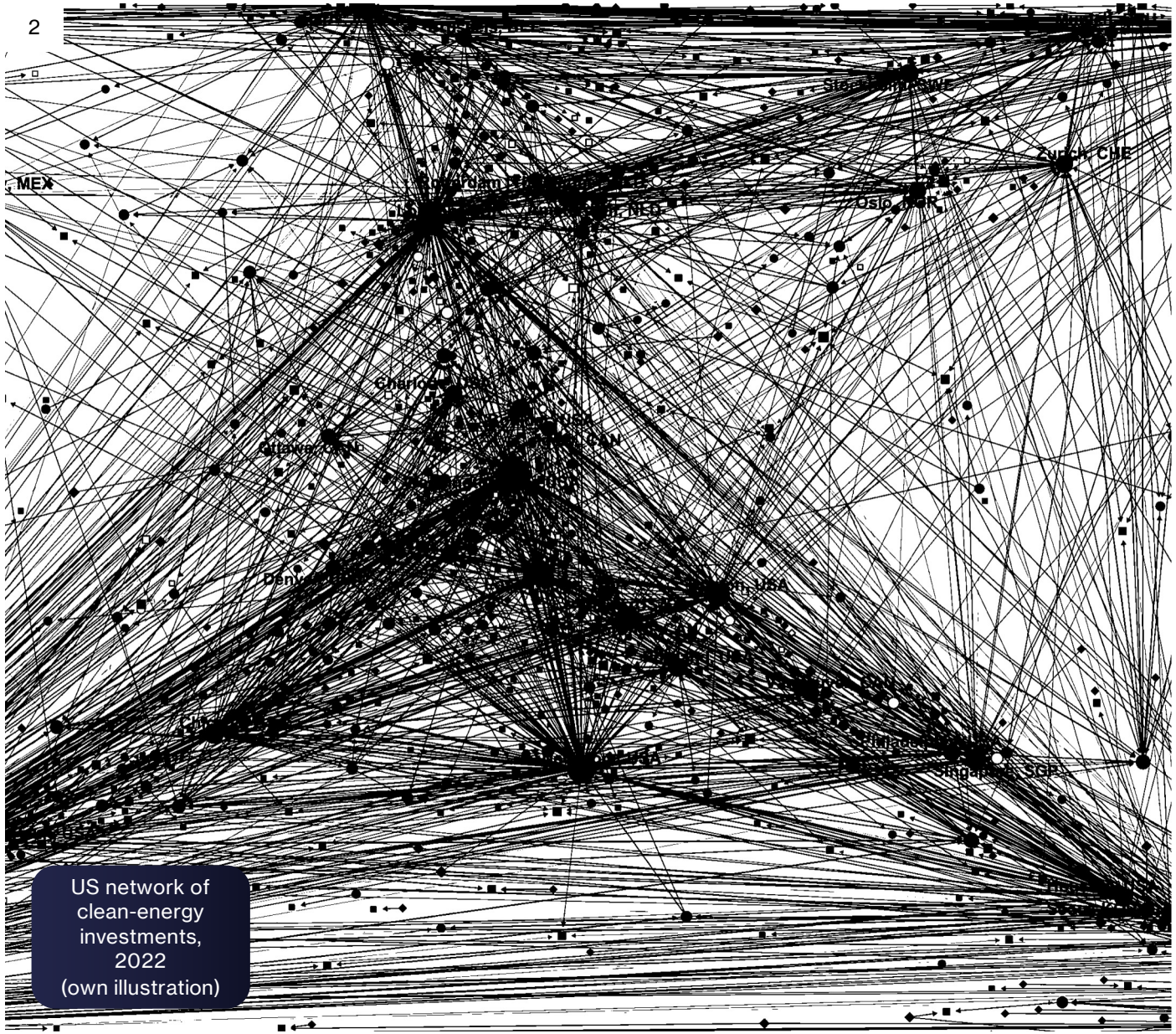




US network of clean-energy investments, 2022 (own illustration)

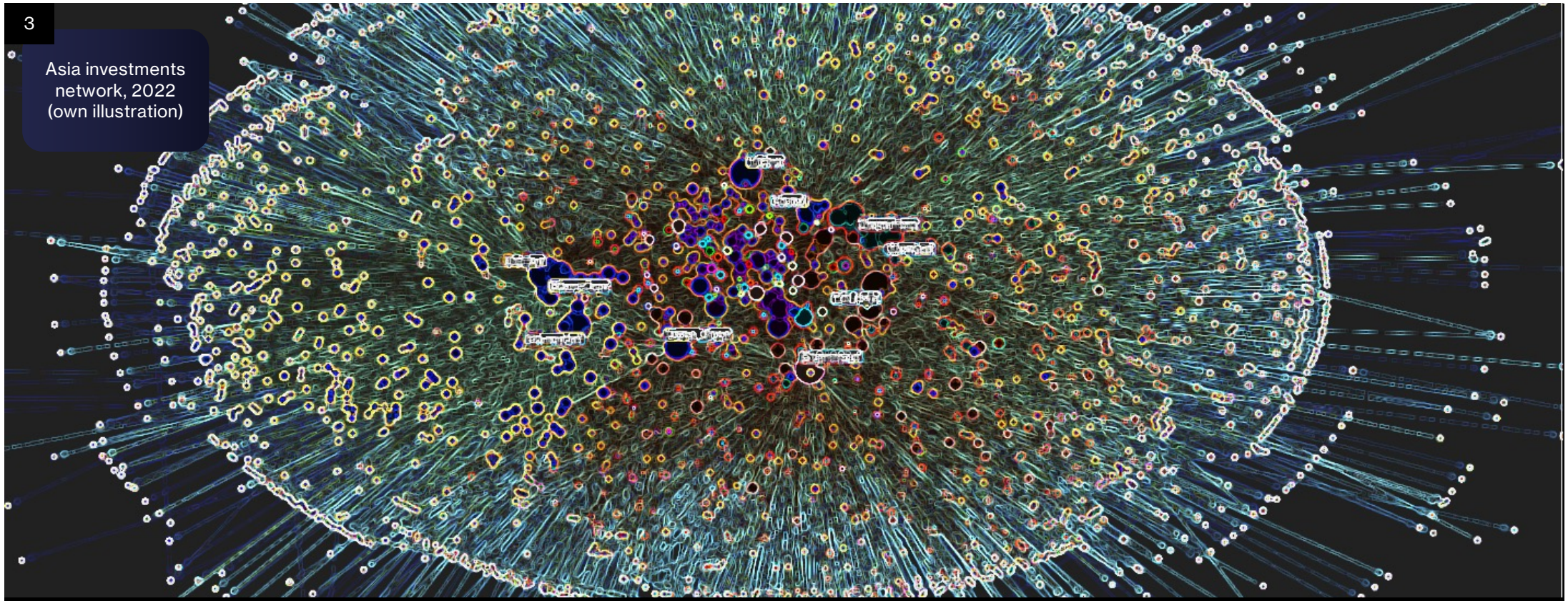
Agenda

Chapter 1: Introduction & Objectives

Chapter 2: Theory & Concepts

Chapter 3: Paper Overview & Methods

Chapter 4: Insights & Contribution



Asia investments network, 2022 (own illustration)

CHAPTER 1: INTRO

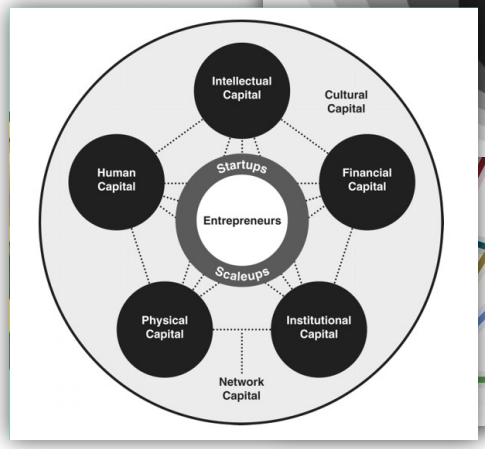
Entrepreneurial Ecosystems (EEs)

DIVERSE ACTORS AND FACTORS
Entrepreneurs, investors, universities, finance and culture, legal frameworks (Stam, 2015; Audretsch et al., 2019)

CORE TO ECONOMIC DEVELOPMENT
EEs drive innovation, competitiveness, and regional growth globally – important policy priority
(Feld, 2020; Florida et al., 2020; Acs et al., 2017)

COMPLEX INTERDEPENDENCIES
Networks are a crucial factor for EE functioning
(Stam & van de Ven, 2021)

Networks constitute the system



EEs contribute to economic activity

Sources: Feld, 2020; Startup Genome, 2024

Research Relevance

FRAGMENTED EMPIRICAL EVIDENCE

Several competing conceptual and theoretical understandings

(Alaassar et al., 2022; Roundy et al., 2018a; Wurth et al., 2021)

METHODOLOGICAL SHORTCOMING

Traditional methods insufficient for capturing EE complexity

(Autio et al., 2018; Cao & Shi, 2021)

Focus on (descriptive) case studies and isolated elements limit comparability

CALL FOR INNOVATION

Strong urgency for methodological advancements
(Spigel et al., 2020; Obschonka & Audretsch, 2020).

Econometric and survey-based tools fail to capture EE complexity and relational dynamics

Network Science as a Promising Area

ROOTED IN RELATIONAL THINKING

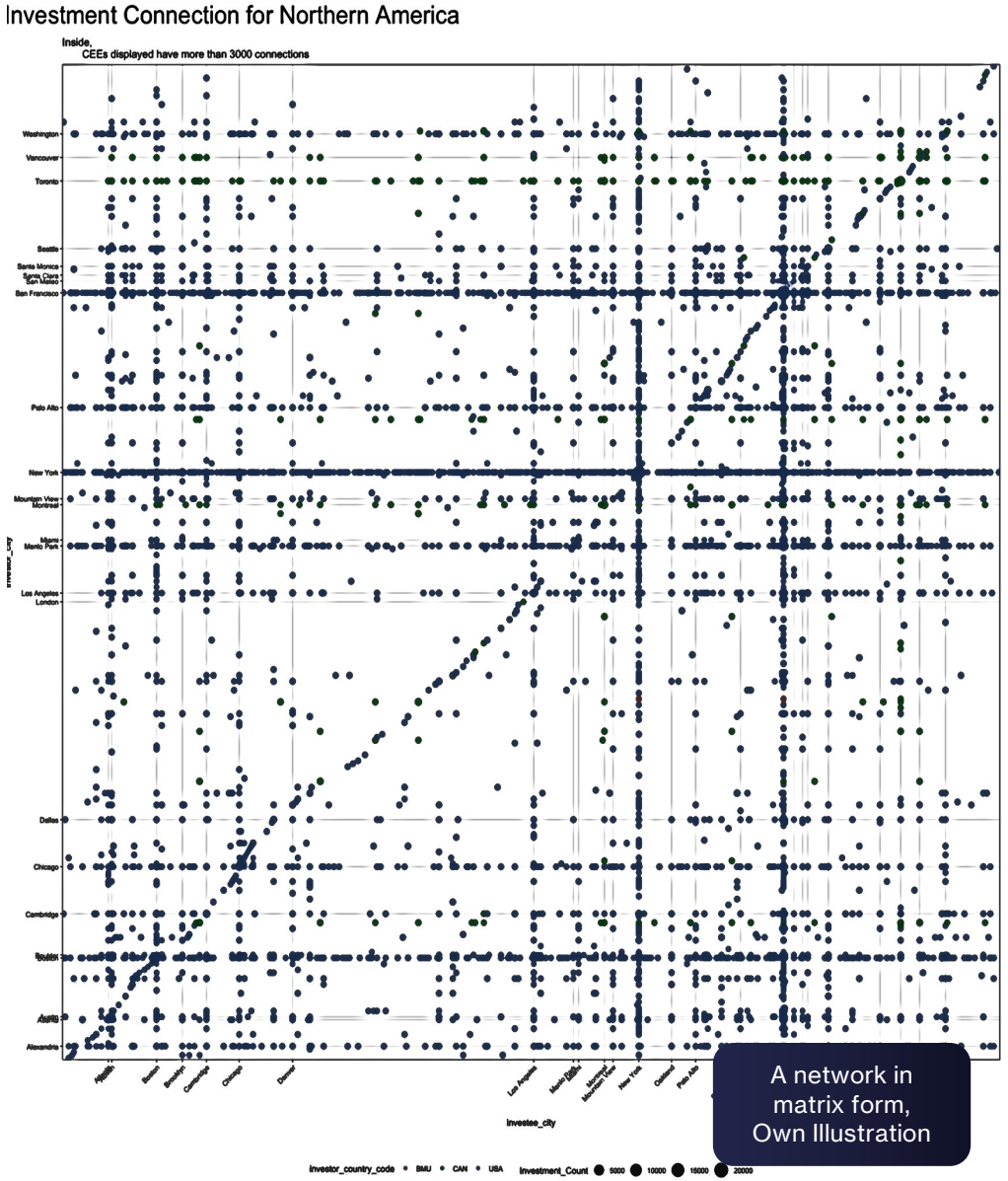
Powerful for assessing connections among actors/entities (Barabási & Pósfai, 2016; Newman, 2018)

RESOURCE FLOW ANALYSIS

Captures flows of resources, information, capital critical for entrepreneurship (Sorenson & Stuart, 2001; Hoang & Antoncic, 2003)

TOOL FOR ANALYZING COMPLEXITY

Quantitative and visual tools for evaluating EEs as Complex Adaptive Systems (Estrada, 2012; Thurner et al., 2018)



A network in matrix form, Own Illustration

Network Science in EE Research

EARLY INTEREST, LATE ADOPTION IN EE RESEARCH

Network approaches discussed early in entrepreneurship but empirical studies scarce – espeically in EE research (Hoang & Antoncic, 2003; Hoang & Yi, 2015)

DATA ACCESSIBILITY BARRIER

Historically limited by data scarcity and lack of technical prowess and computational means (Fernandes & Ferreira, 2022; Jack, 2010)

EMERGING RELATIONAL FOCUS

Recent emphasis on interdependencies and structural dynamics in EE research (Mason & Brown, 2014; Spigel, 2017)

Global network of inter-EE flows
own illustration

RESEARCH QUESTION

How can we leverage and adapt tools from network science to advance the methodological repertoire for understanding entrepreneurial ecosystems?

Elaborate on and channel data analytic thinking

Introduce “hands-on” tools for research & policy

Paper Overview

Small Bus Econ
https://doi.org/10.1007/s11187-025-01029-y

RESEARCH ARTICLE

Exploring spatial network structures in entrepreneurial ecosystems: a network and clustering analysis of global venture funding flows

Nicolas Victor Noak · Lance Christian

Accepted: 26 February 2025

Abstract This study examines the interconnectedness of entrepreneurial ecosystems (EEs) through a comprehensive geospatial network analysis of global investment flows. Addressing the critical need to explore EEs beyond their local boundaries, we investigate how EEs interact across regional, national, and international levels. Utilizing data from Crunchbase, which details 556,612 investment interactions among 5488 city-regions globally from 2000 to 2022, our analysis employs network topology analysis and hierarchical clustering to elicit similarities and differences in the financial interconnectedness. Our findings reveal significant variability in how EEs are connected, with distinct patterns emerging among clusters. We highlight the role of external linkages in shaping the structure EEs, challenging the inward-focused perspective commonly held in current literature. Notably, our research uncovers the extensive reach and complexity of EEs' financial interactions, illustrating both concentrated and dispersed network embeddedness. The study contributes to the entrepreneurial ecosystem literature in three ways. First, we extend the analysis of EEs to consider their spatial interconnectedness and complex network structures. Second, we introduce network topology analysis as a robust method for understanding the complexities of EE connectivity. And third, through hierarchical clustering of EEs by their network metrics, we show that EE vary greatly in their relational structures. These insights not only enrich our understanding of EEs but also inform policy implications, suggesting avenues for fostering stronger, more resilient entrepreneurial environments through strategic network facilitation and international cooperation.

Plain English Summary This study looks at how entrepreneurial ecosystems (EEs) connect with each other globally by analyzing investment flows from all over the world. We go beyond just looking at local interactions to understand how EEs interact on regional, national, and international levels. We used data from Crunchbase, which includes details on 556,612 investments across 5,488 city-regions from the year 2000 to 2022. Our approach involves using network topology analysis and hierarchical clustering to figure out how these financial connections vary among EEs. Our results show there is a lot of variation in how these ecosystems connect, and we found

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Resilience and Vulnerability of Entrepreneurial Ecosystems: The Role of Networks

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"We can't stop the money from trickling out,
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Research Paper

Entrepreneurial Ecosystems and Trans-Local Ties: Exploring the Global Funding Network of the Renewable Energy Sector Over Time and Space

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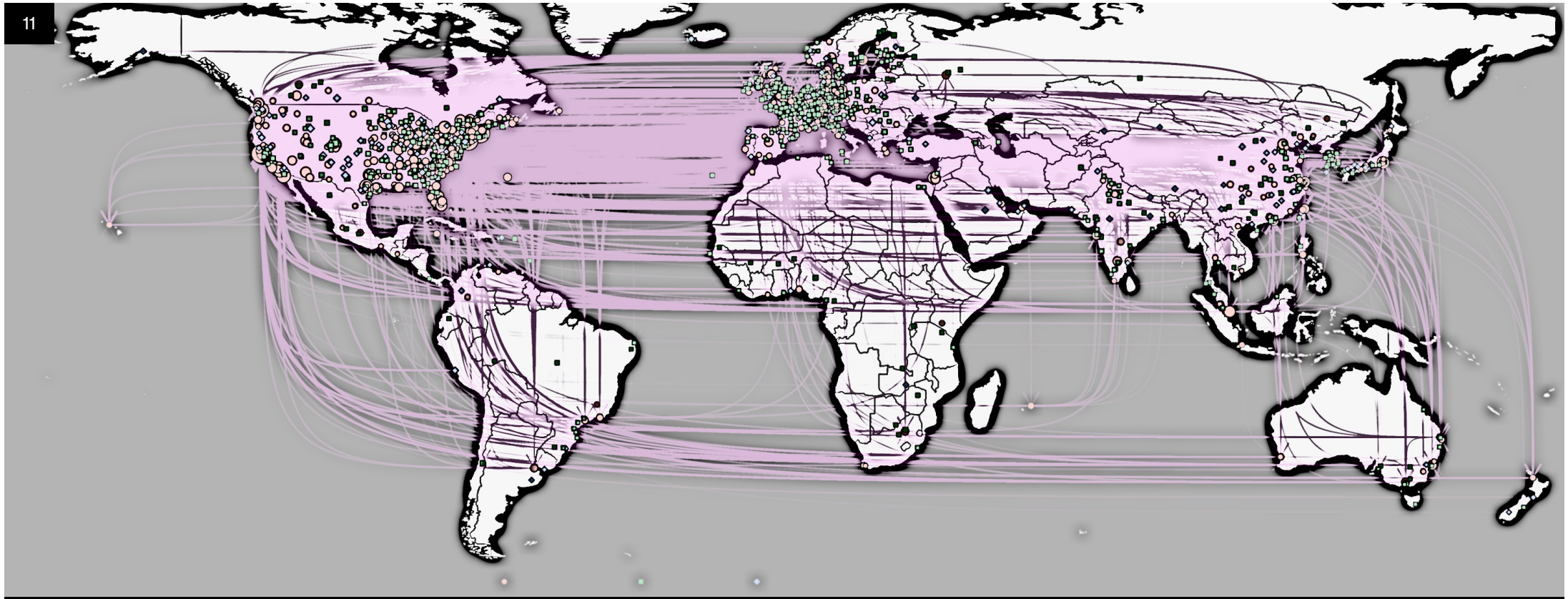
Objectives

1 **INNOVATION**
Introduce advanced network methods to EE analysis.

2 **APPLICATION**
Apply network science methods to real-world EE data.

3 **EVALUATION**
Assess the methodological contribution to EE research.



CHAPTER 2: THEORETICAL FRAMEWORKS

Entrepreneurial Ecosystems – Theoretical Framework

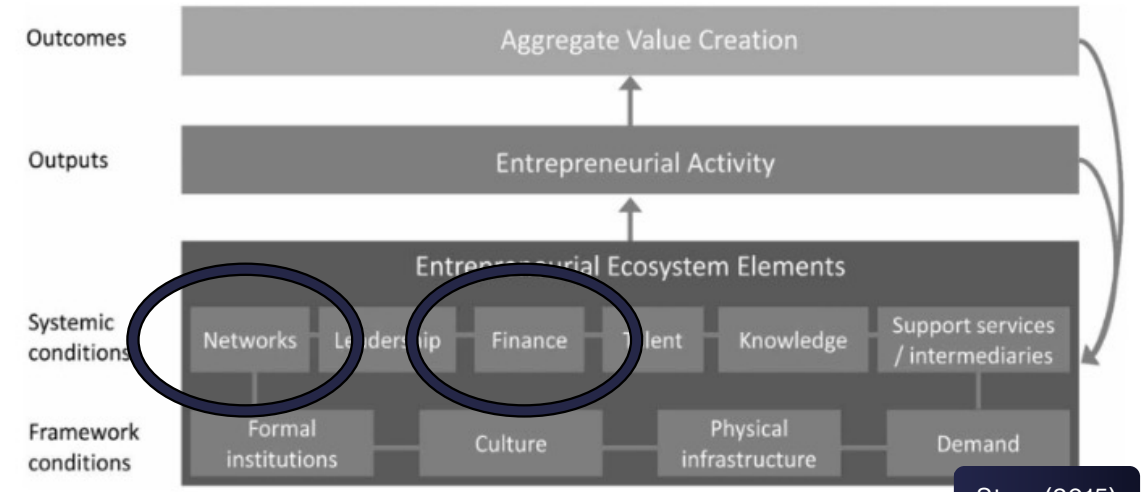
"a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship."

(Stam, 2015)

ROOTED IN ECOLOGICAL ANALOGY
Ecosystems provide "life-sustaining" configurations and services to its participants (DeFries & Nagendra, 2017; Kuckertz, 2019)

SYSTEM-LEVEL FOCUS
Interconnected actors and factors enabling productive entrepreneurship (Stam & van de Ven, 2021)

FOCUS ON ENTREPRENEURSHIP
Different from clusters or regional innovation systems (Audretsch & Belitski, 2017)



Stam (2015)

Networks as well as ***Finance*** are crucial elements of EEs

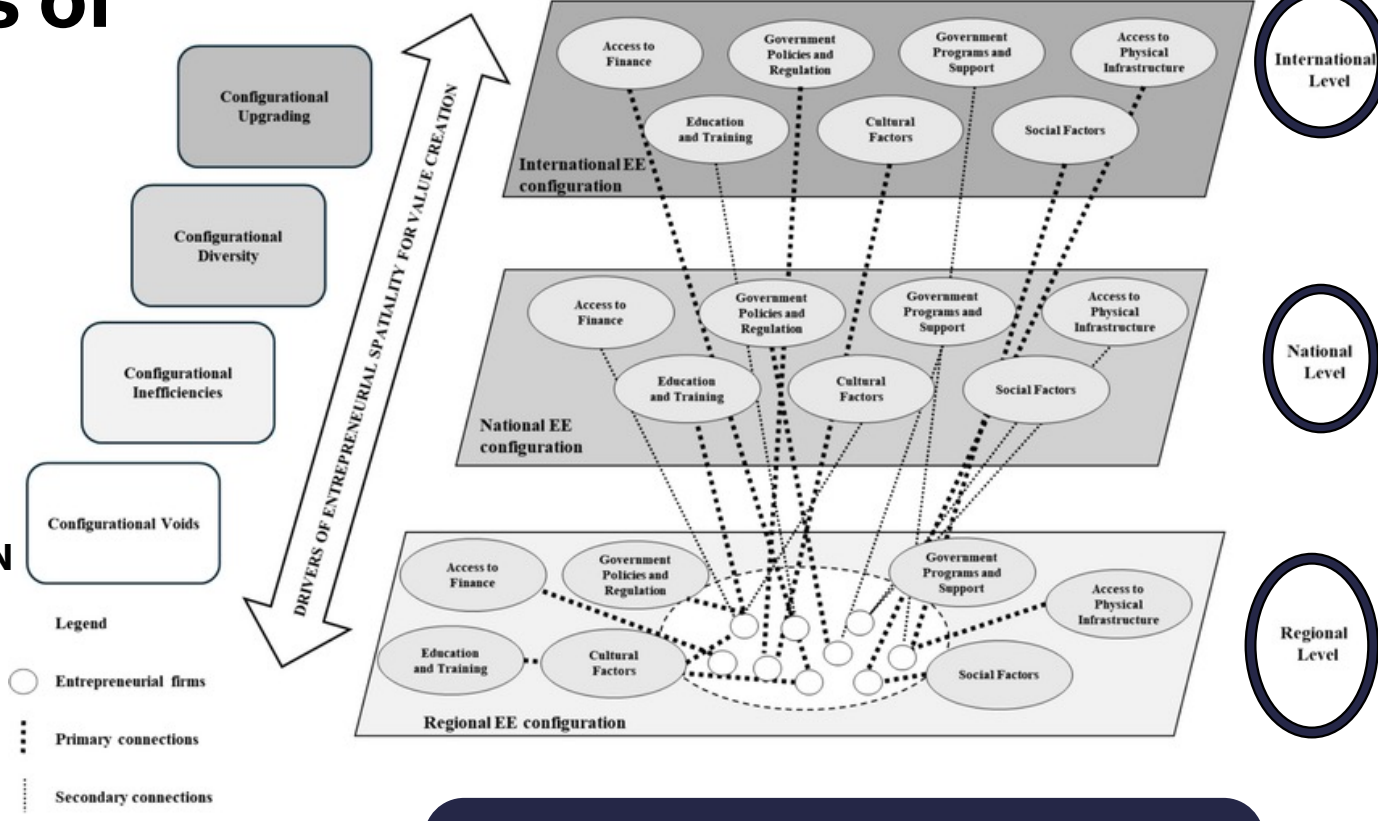
Spatial Features of EEs

MULTI-LEVEL CONNECTIVITY
Regional and global ties – EEs have different spatial configurations and "global pieplines" for resource access
(Bathelt et al., 2004; Bathelt & Li, 2020).

DIGITALIZATION & GLOBALIZATION
Reshaping EE dynamics and boundaries – more fluid and across scales
(Autio et al., 2018; Spigel & Harrison, 2018).

SPATIAL CLUSTERING IMPORTANCE
Geographic proximity influences collaboration and innovation
(Boschma, 2005; Martin & Sunley, 2007).

Pigola, A., Fischer, B., de Moraes, G.H.S.M. et al (2025)



EEs have **complex spatial topologies** - connections exist *within* but also ***between*** EEs across geographic levels

Complexity

"The relationships amongst the components of the system are usually more important than the components themselves"

Cilliers (2005, p 140)

DEFINITION AND SYSTEM-LOGIC
Micro-level interaction cause emergent macro-level behaviors – agents learn in a complex adaptive system (CAS) (Cadenasso et al., 2006; Holland, 2006)

KEY CAS PROPERTIES
Non-linearity, emergence, adaptation, self-organization, path-dependence (Thurner et al., 2018; Cilliers, 2001)

MANYFOLD AND MULTI-LEVEL INTERACTIONS
Across spatial, temporal, administrative levels- influence macro-patterns and system dynamics
(DeFries & Nagendra, 2017; Wurth et al., 2022)

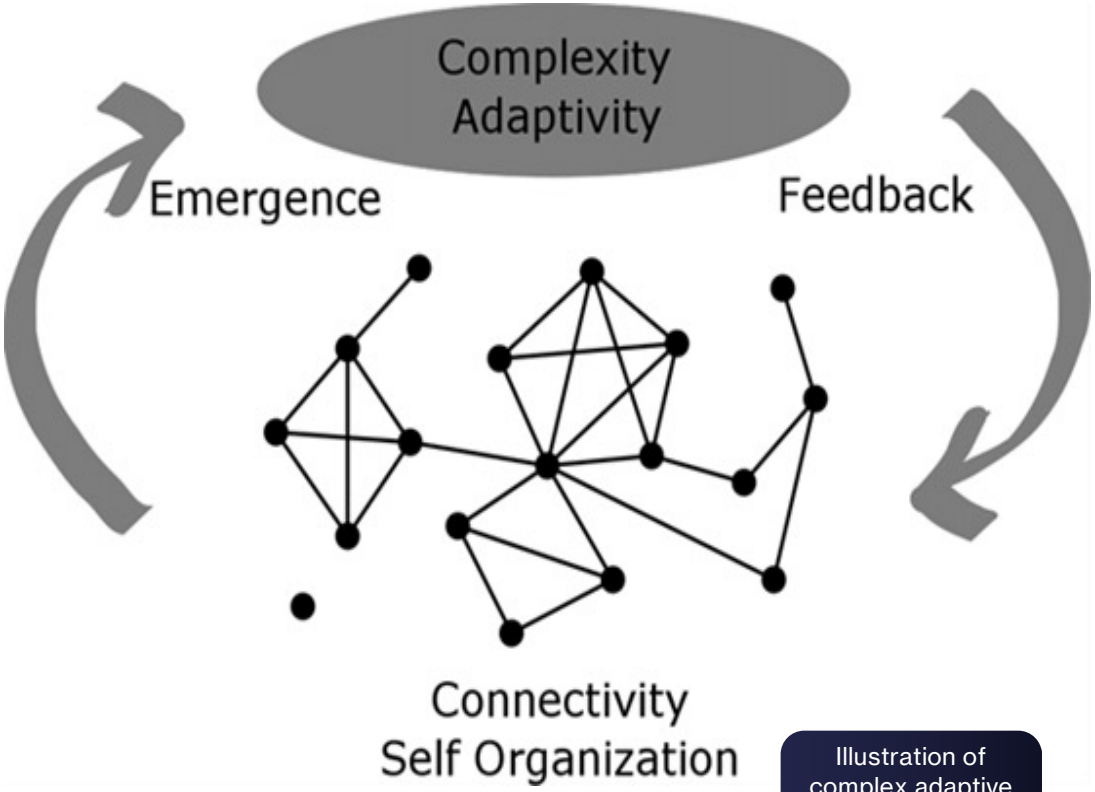
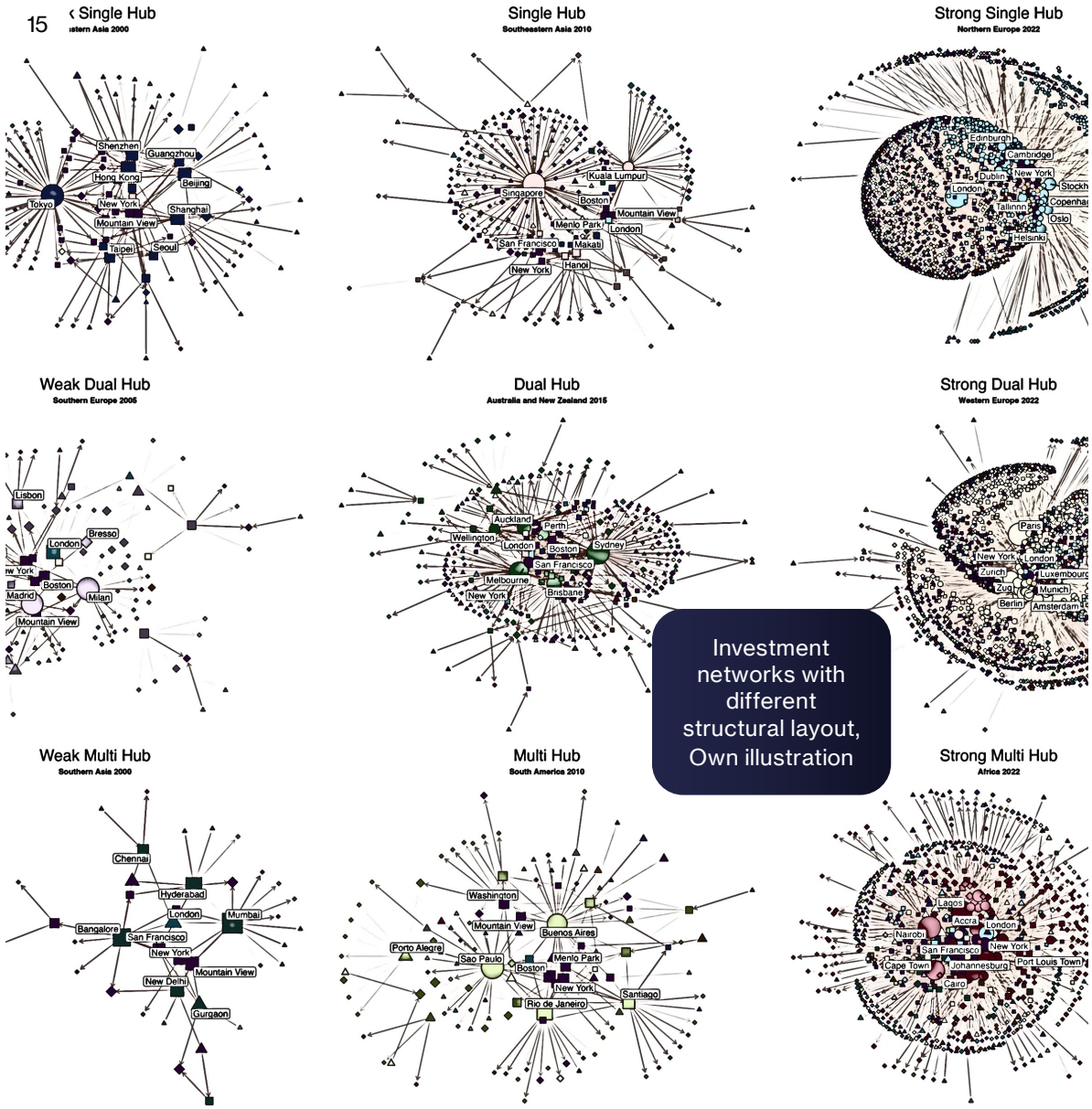


Illustration of complex adaptive system logic, Hilpert (2016)



Investment networks with different structural layout, Own illustration

Network Analysis

PRACTICAL INVESTIGATION OF NETWORKS
Tools and techniques for specific network properties like centrality, community structures (Borgatti et al., 2009)

SPECIFIC METRICS & ALGORITHMS
Identify influential players, detect patterns or barriers (Abraham et al., 2009; Camacho et al., 2020)

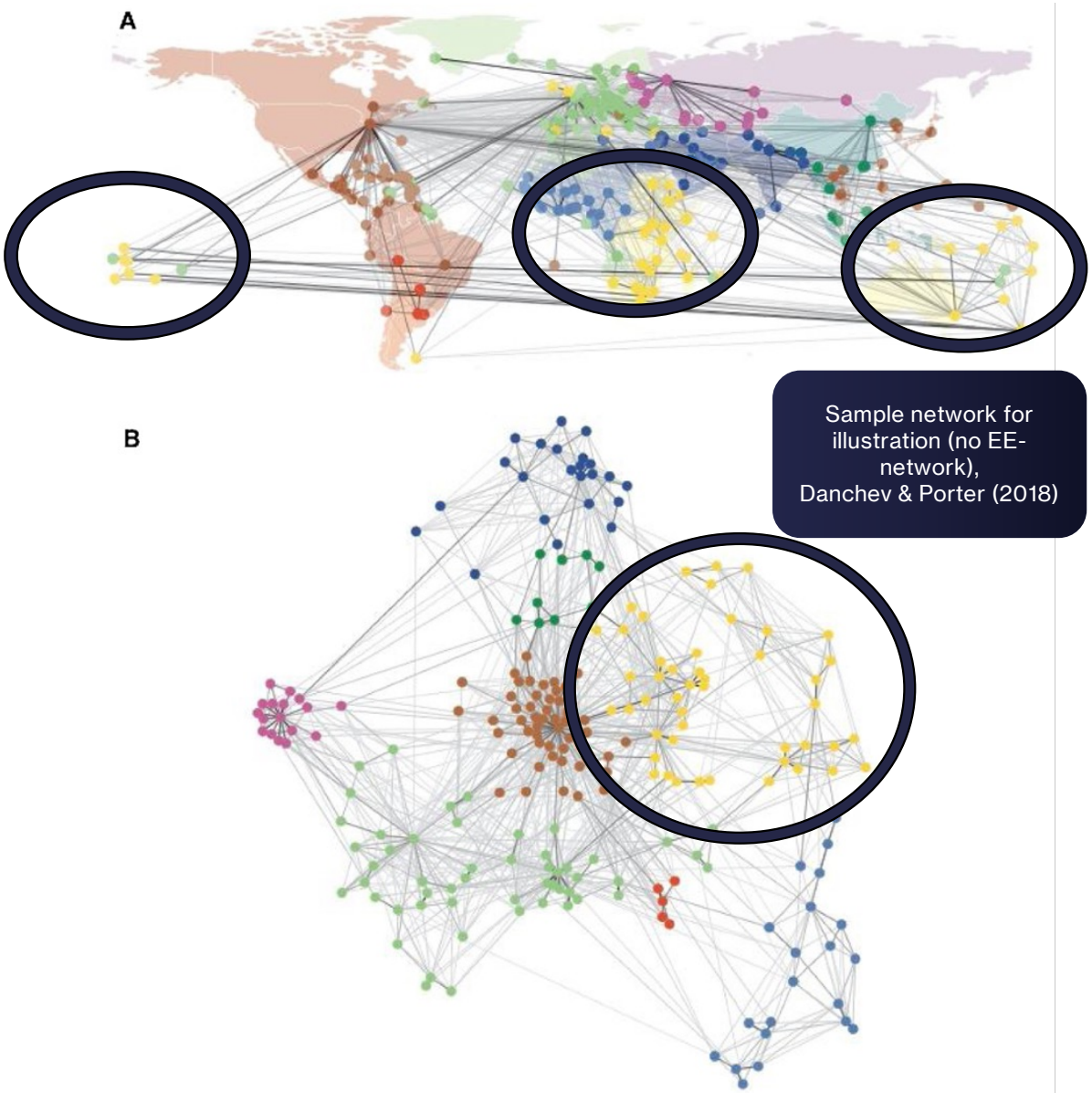
BROADER IMPLICATIONS
Provides specific insights; network science develops universal principles (Brandes et al., 2013)

Spatial Networks – Special Considerations

SPATIAL INFLUENCE
Geography may enable or constrain connectivity – node and edge characteristics matters *(Barthelemy, 2022; Anderson & Dragićević, 2020)*

PLANAR VS. NON-PLANAR NETWORKS
Physically embedded or abstract – implications are direct or indirect

GEOGRAPHIC IMPORTANCE
Spatial characteristics can be critical in transport, trade, innovation studies *(Ducruet & Beauguitte, 2014)*



Sample network for illustration (no EE-network), Danchev & Porter (2018)

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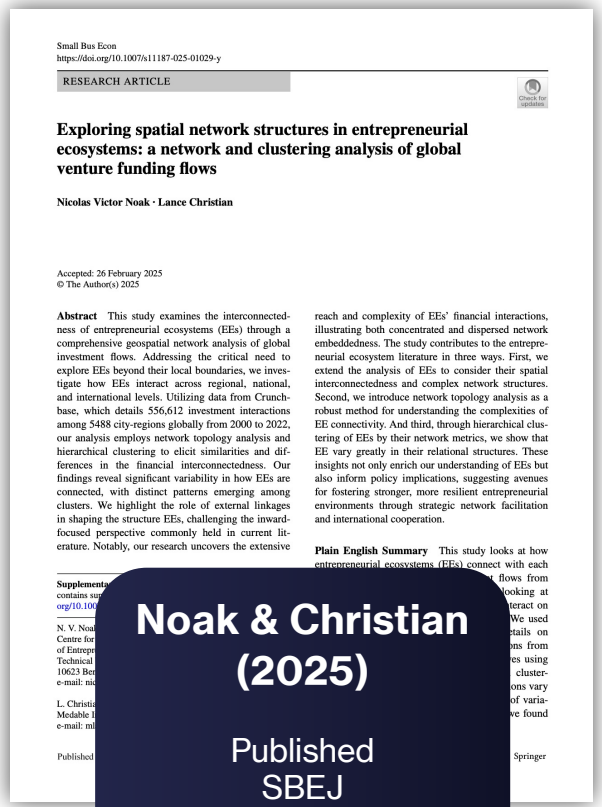
CHAPTER 3: PAPERS

Paper Overview



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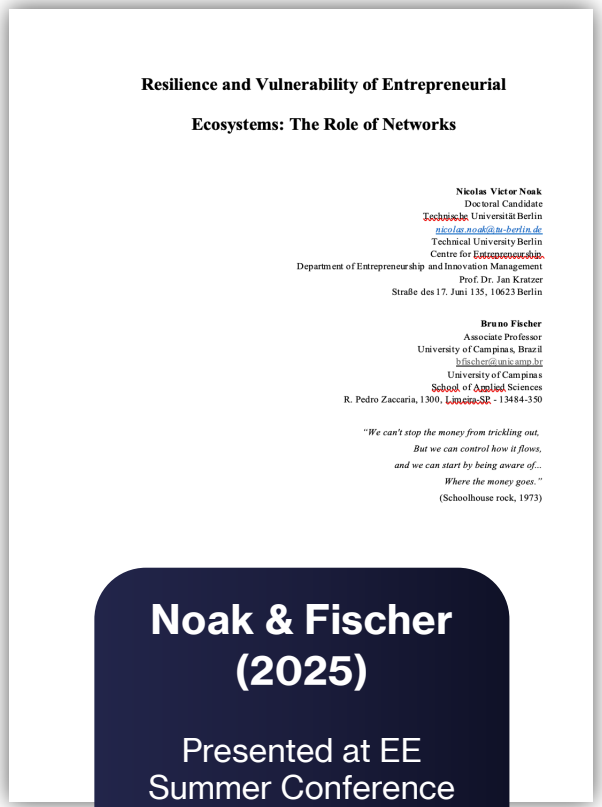
Noak & Christian (2025)

Published SBEJ (April 2025)



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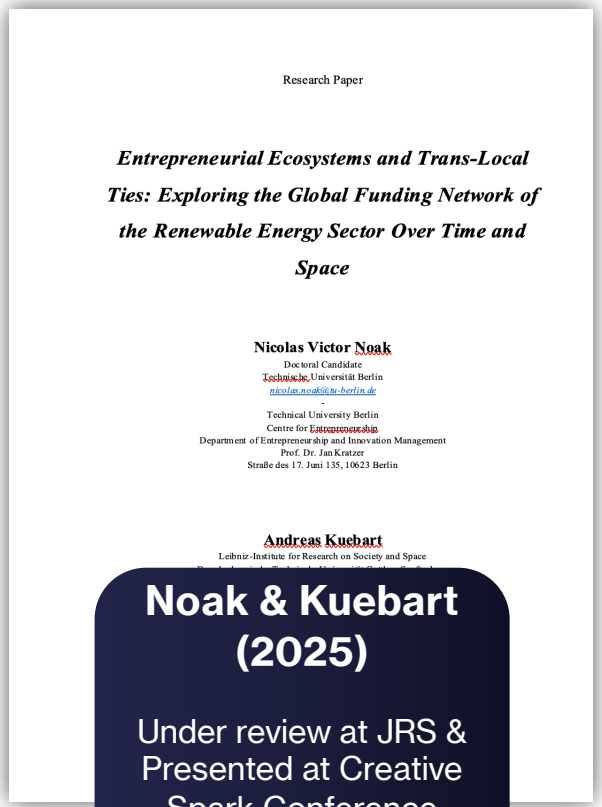
Noak & Fischer (2025)

Presented at EE Summer Conference (May 2024, Stuttgart)



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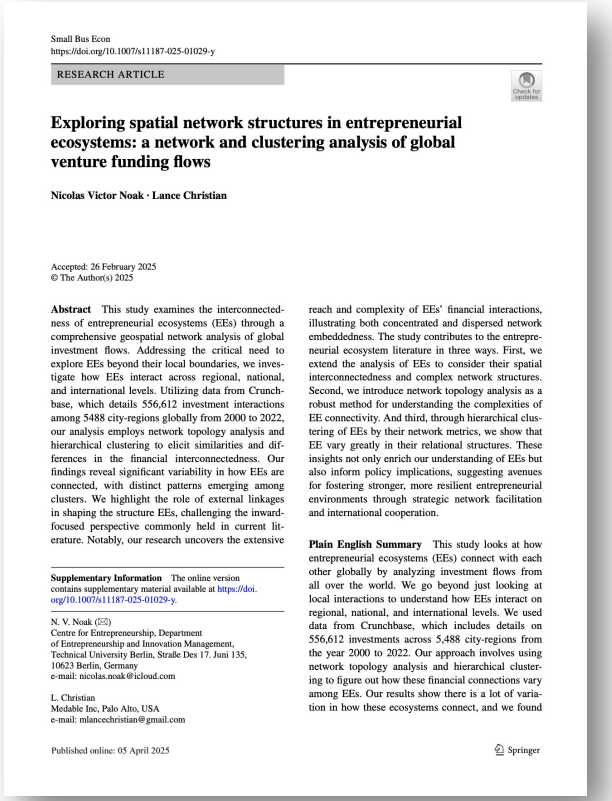
Noak & Kuebart (2025)

Under review at JRS & Presented at Creative Spark Conference (January 2024, Berlin)

1 Noak & Christian (2025): *Exploring spatial network structures in entrepreneurial ecosystems: A clustering and network analysis of global venture funding flows*

Summary	Maps how city-level EEs are embedded in global funding flows network
Method	Combines spatial network analysis and machine learning on geolocated investment data
Contribution	Introduces relational grouping of EEs and comparability based on network embeddedness



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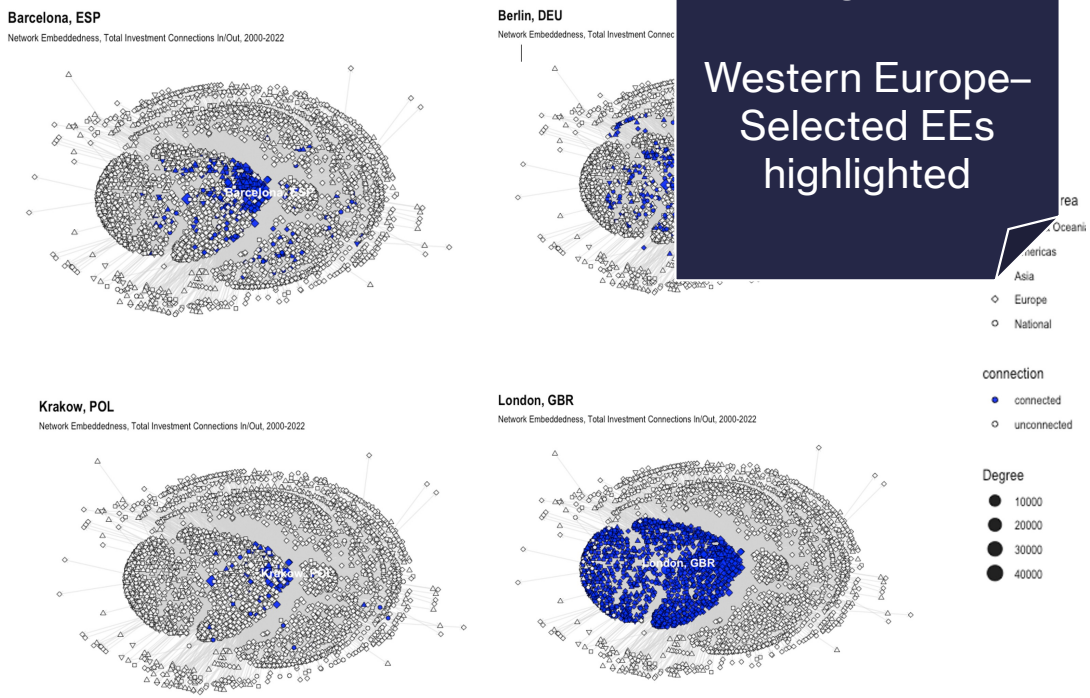
Springer

1 Methodological Highlights

Figure 1 – Network Embeddedness of selected EEs within Europe



Spatial network Integration

Western Europe–Selected EEs highlighted

Figure 2a – Two-Dimensional Cluster Visualizations

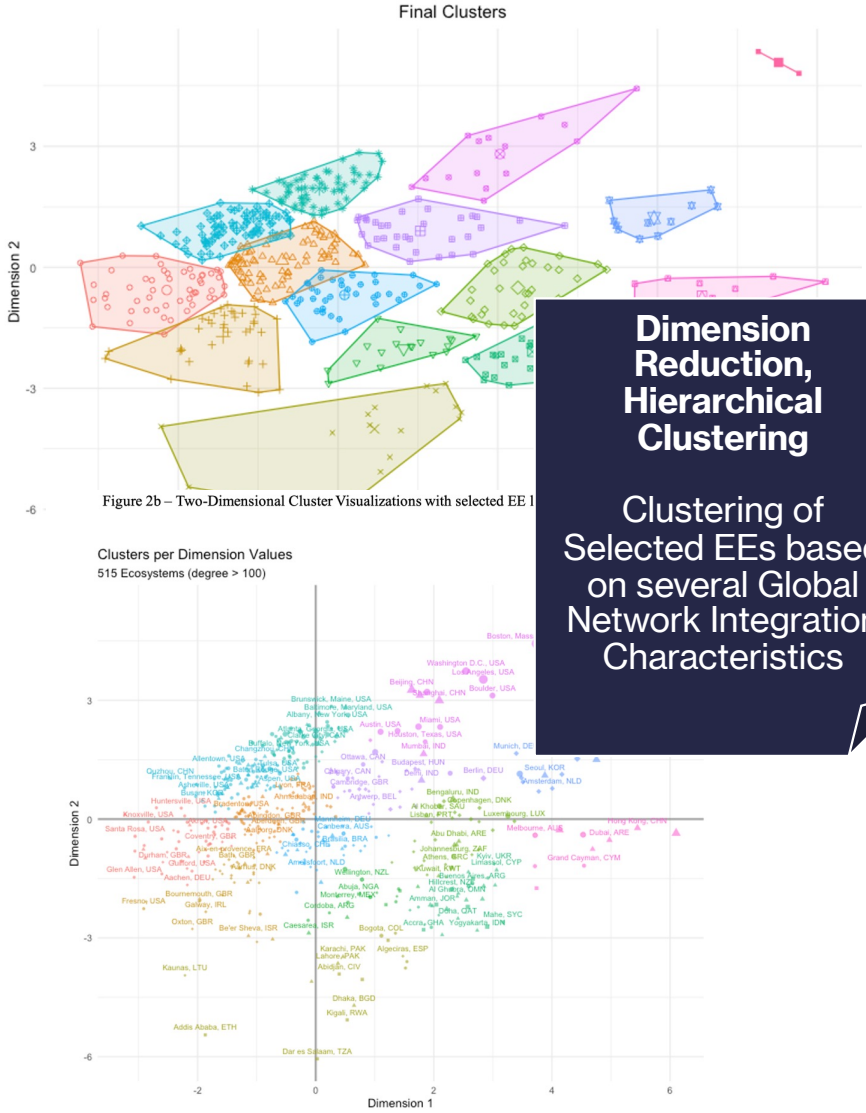


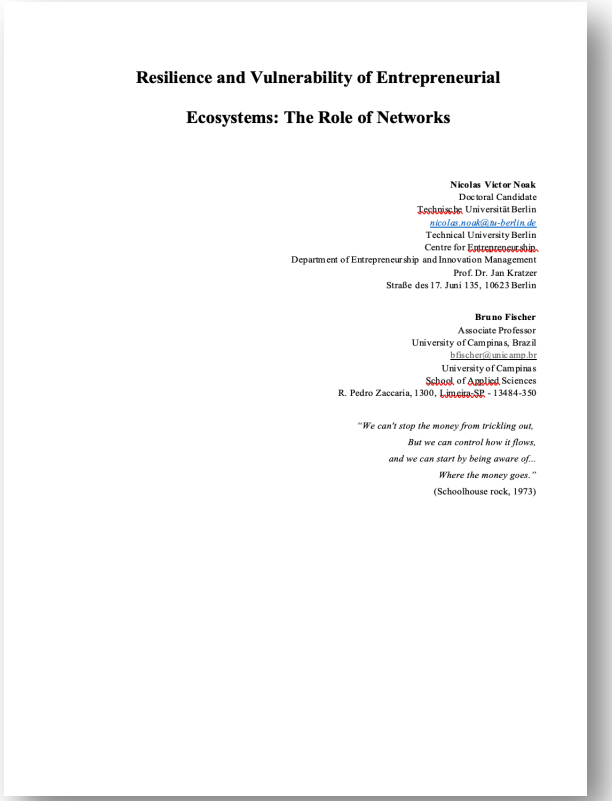
Figure 2b – Two-Dimensional Cluster Visualizations with selected EE l

Dimension Reduction, Hierarchical Clustering

Clustering of Selected EEs based on several Global Network Integration Characteristics

2 Noak & Fischer (2025): *Resilience and Vulnerability of Entrepreneurial Ecosystems: The Role of Networks*

Summary	Assesses how structurally vulnerable an EE is to external shocks
Method	Uses bipartite network projection and attack simulations to test network robustness
Contribution	Operationalization of EE vulnerability – policy-focused metrics and stress-test approach



Resilience and Vulnerability of Entrepreneurial

Ecosystems: The Role of Networks

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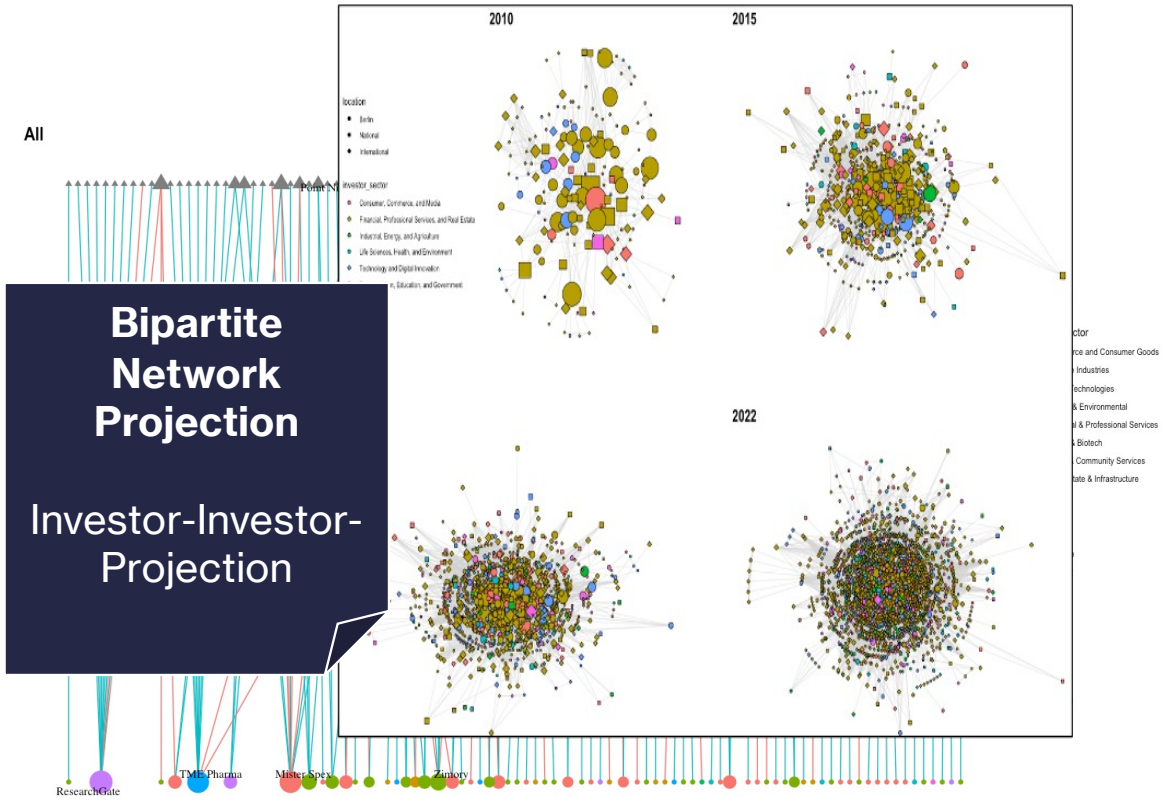
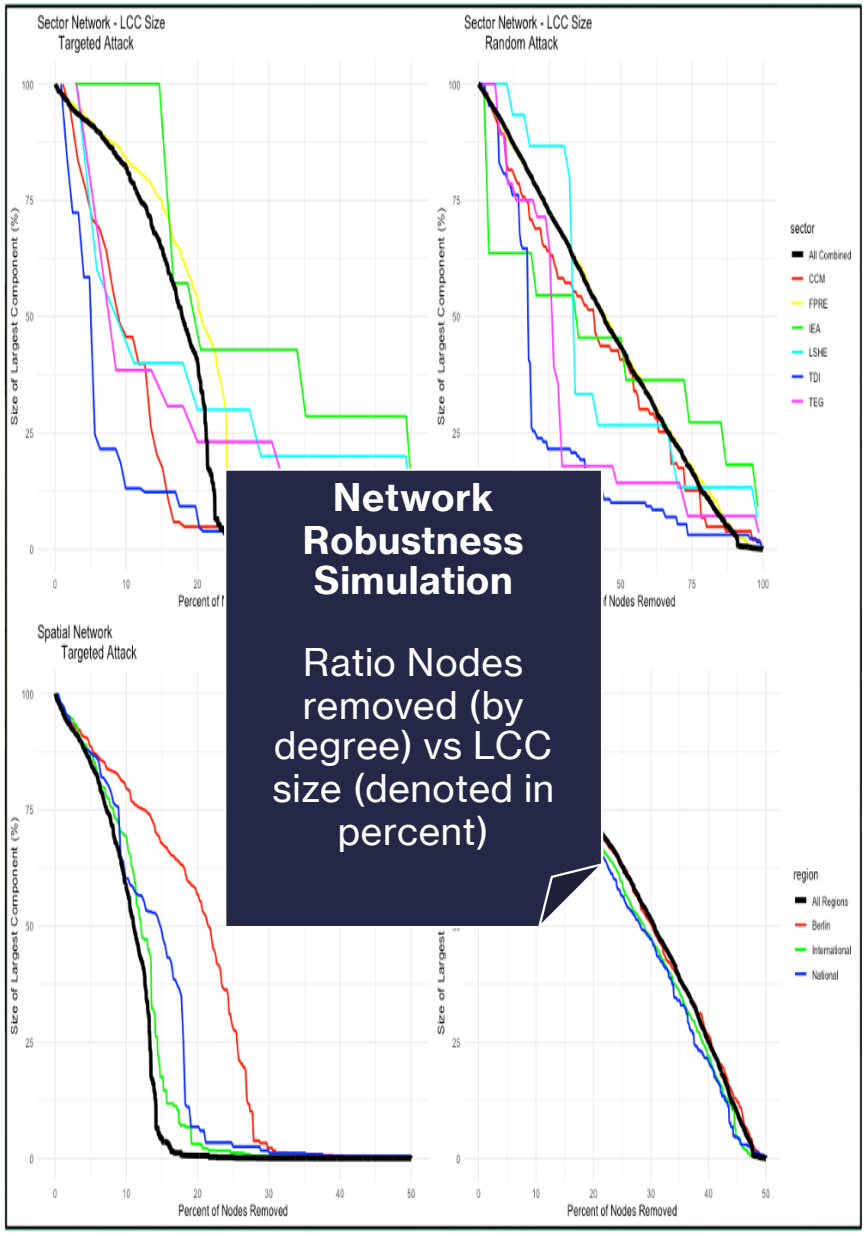
2 Methodological Highlights



Bipartite Network Projection

Investor-Investor-Projection

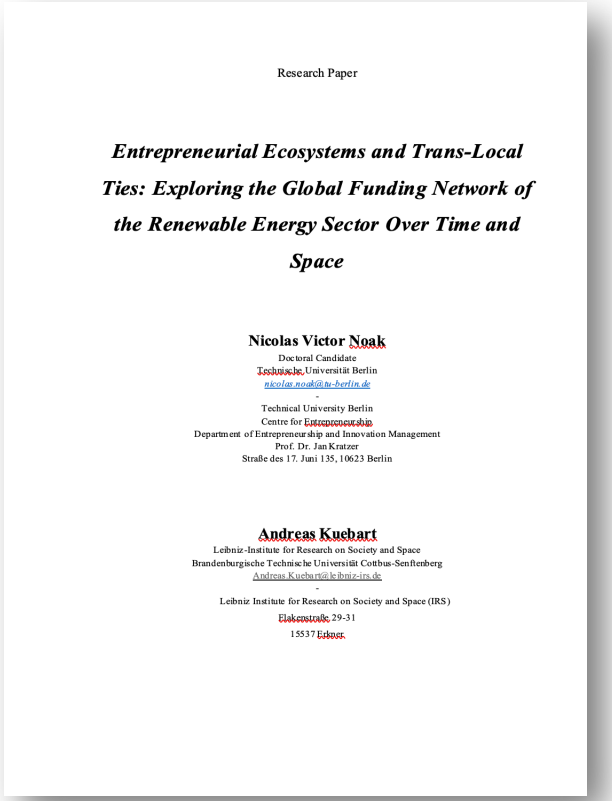


Network Robustness Simulation

Ratio Nodes removed (by degree) vs LCC size (denoted in percent)

3 Noak & Kuebart (2025): *Entrepreneurial Ecosystems and Trans-Local Ties: Exploring the Global Funding Network of the Renewable Energy Sector Over Time and Space*

Summary	Explores the evolution of global EE networks in the renewable energy sector
Method	Conducts detailed longitudinal network analysis with role-based node evolution
Contribution	Shows how functional network roles can be analyzed and observed over time



Research Paper

Entrepreneurial Ecosystems and Trans-Local Ties: Exploring the Global Funding Network of the Renewable Energy Sector Over Time and Space

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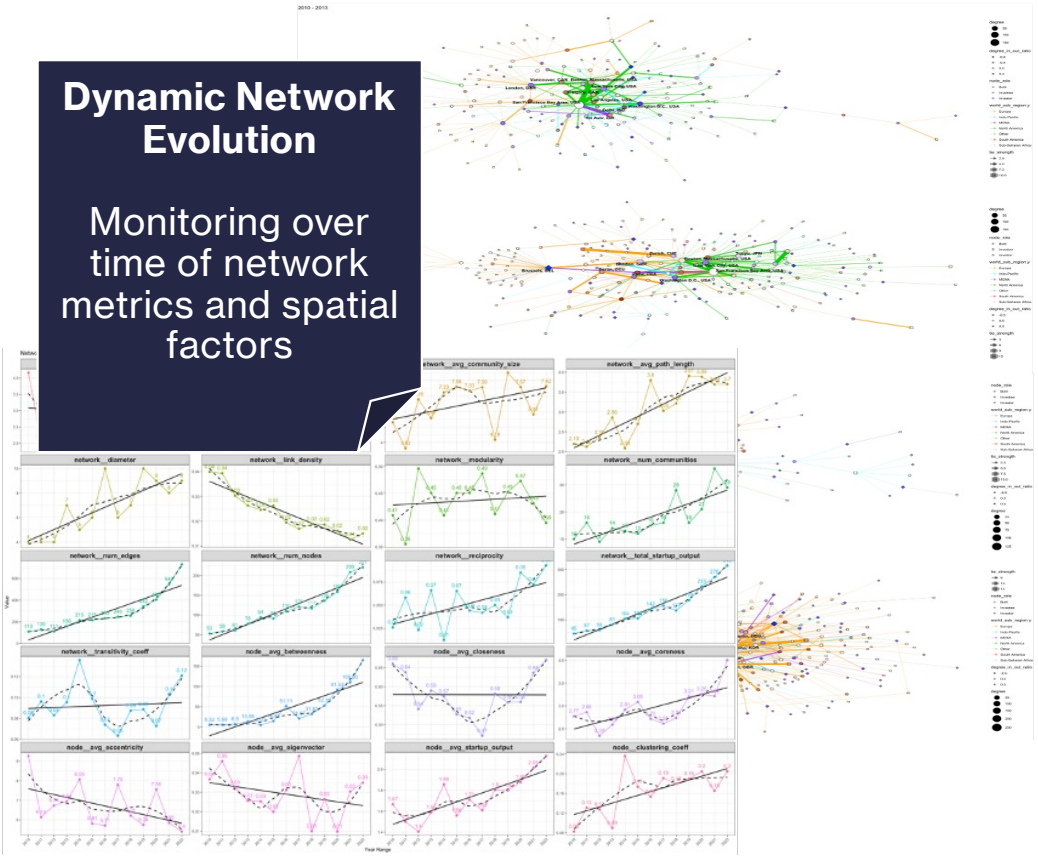
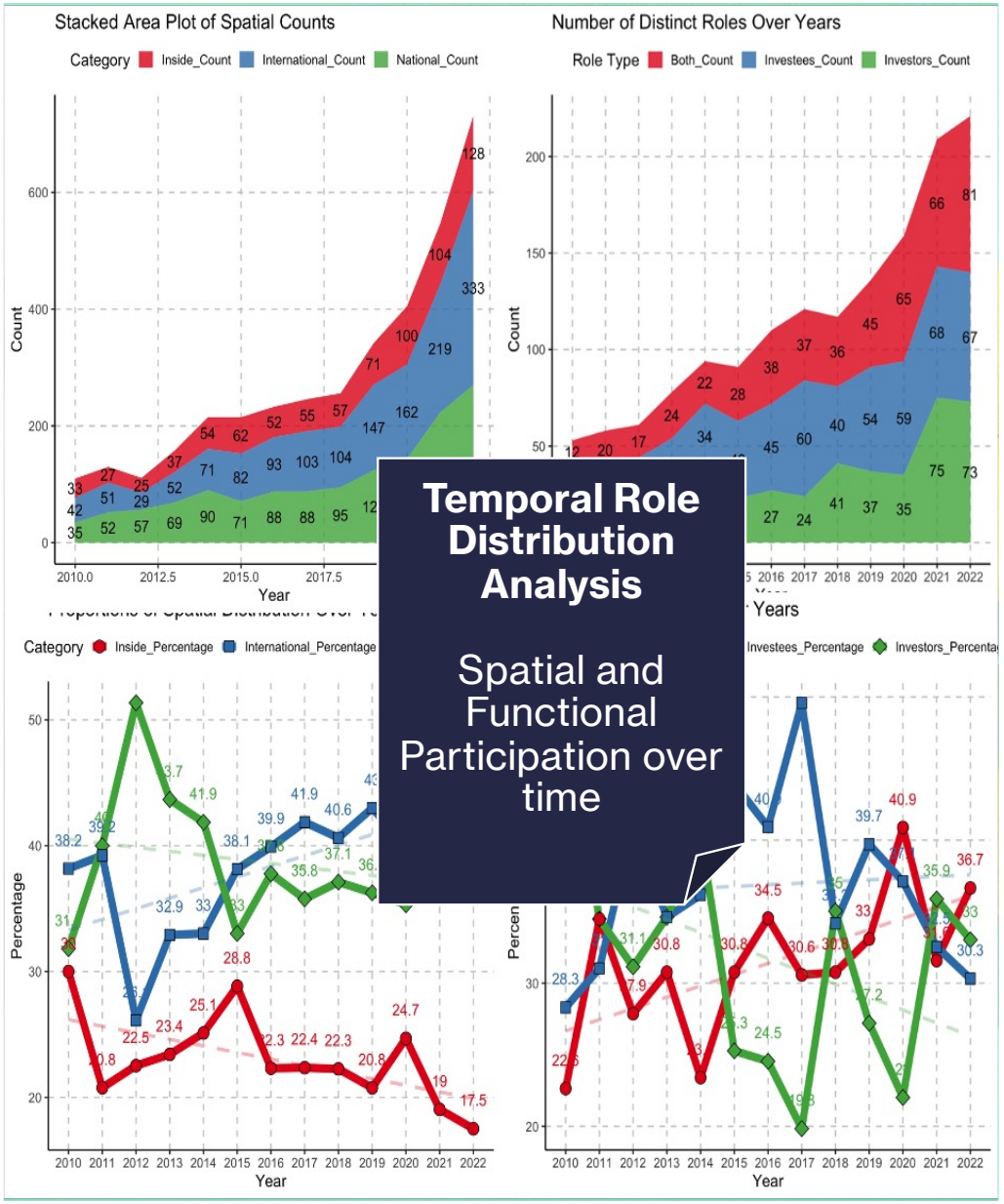
3 Methodological Highlights



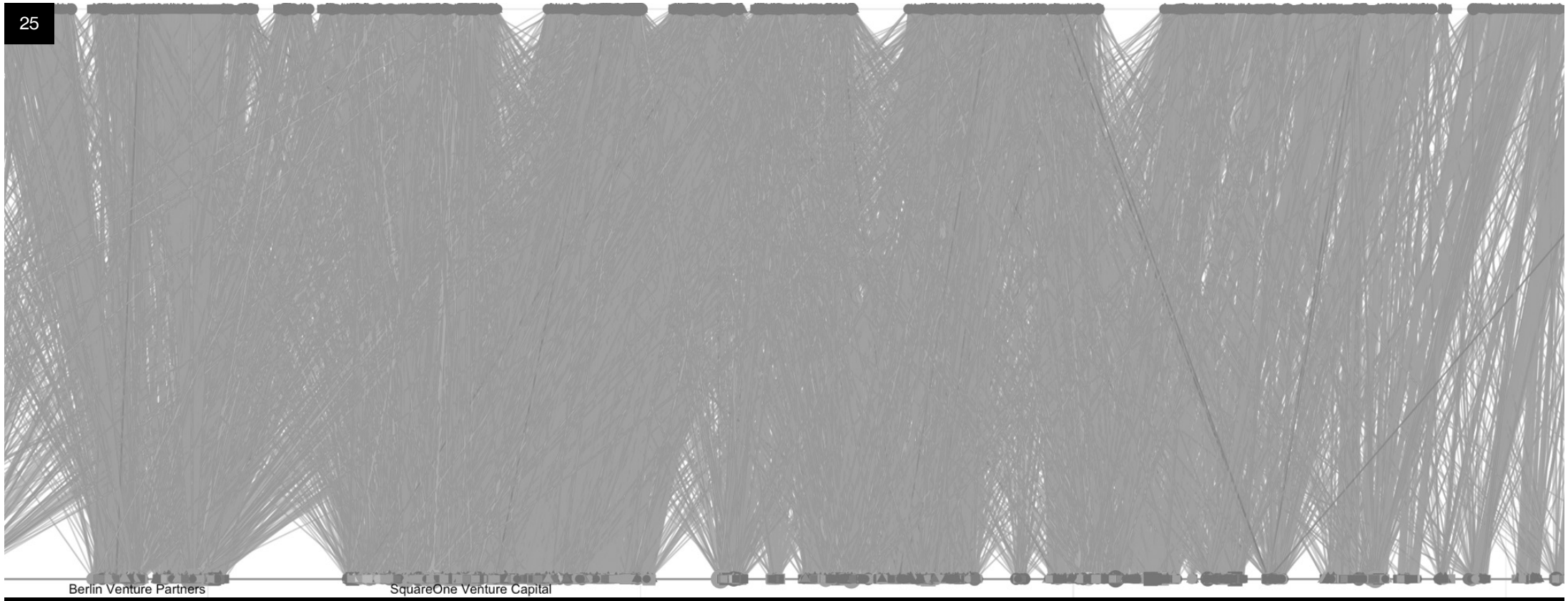
Dynamic Network Evolution

Monitoring over time of network metrics and spatial factors



Temporal Role Distribution Analysis

Spatial and Functional Participation over time



CHAPTER 4: INSIGHTS

Overall Insights

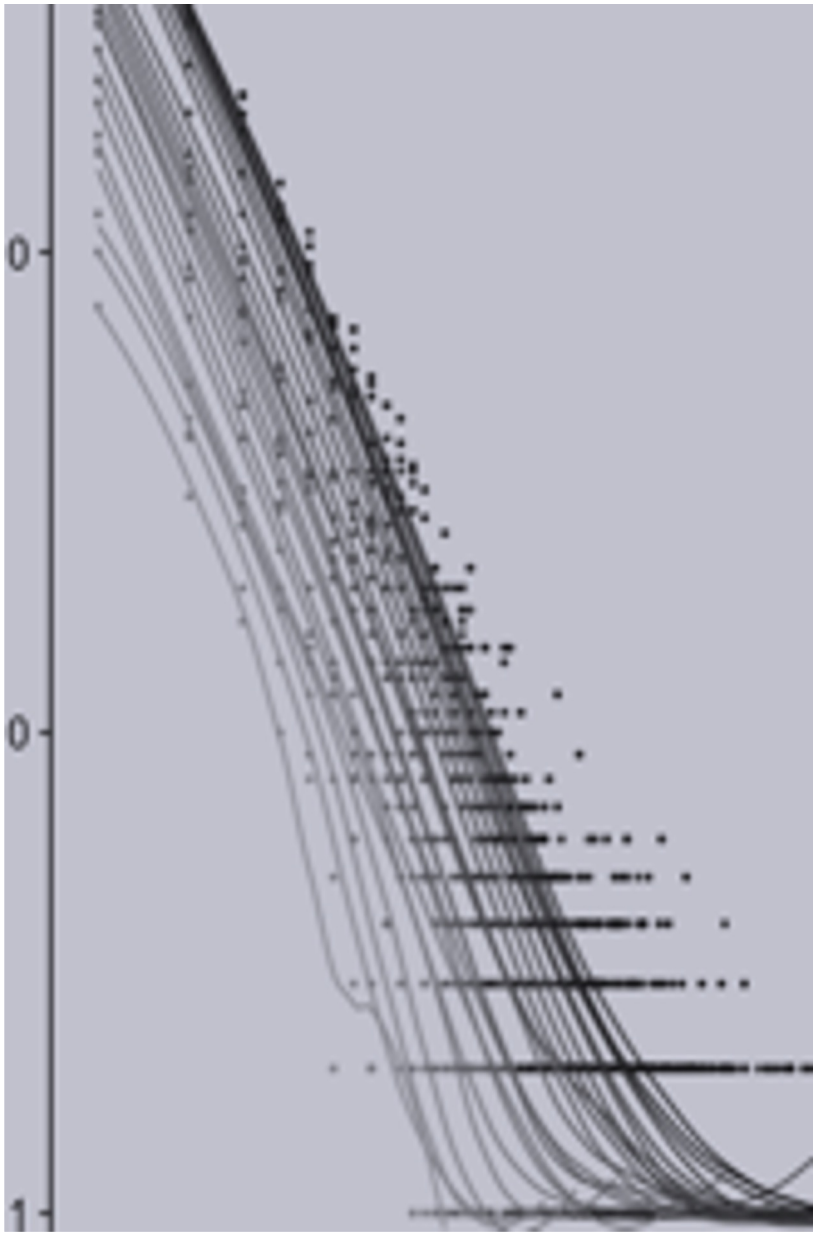
EES ARE RELATIONAL, DYNAMIC SYSTEMS
EEs cannot be understood through static indicators (e.g. funding volume, firm count), but must be assessed as evolving systems of actors and flows

SPATIAL AND TEMPORAL DIMENSIONS MATTER
EEs operate across scales, simultaneously embedded in local and global contexts (e.g. renewable sector)

RELATIONAL STRUCTURES SHAPE OUTCOMES
The way EEs are embedded (core/periphery, roles, vulnerability) affects their access to resources, exposure to shocks, and potential for resilience

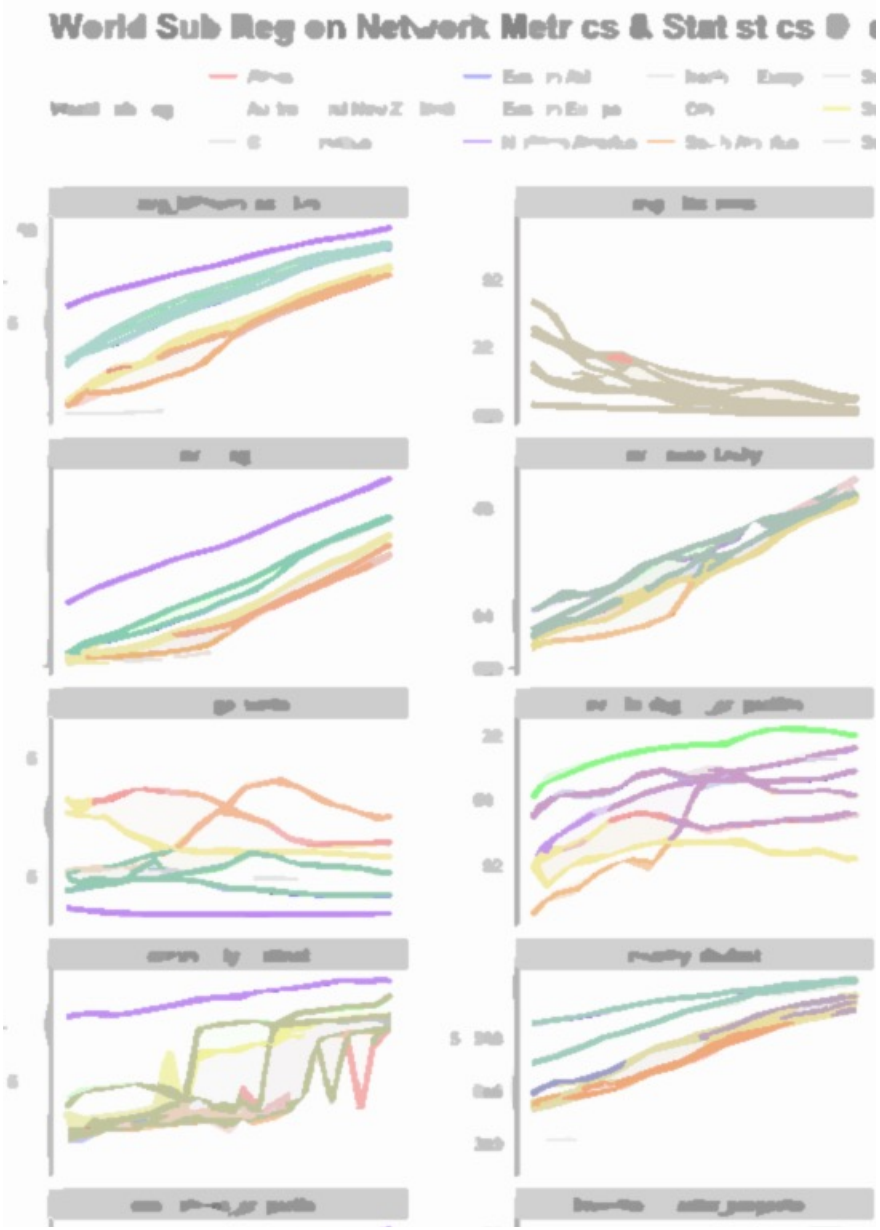
Advancements in Methodology

NEW EMPIRICAL APPROACHES	Novel concepts and perspectives grounded in network analysis (Spatial, longitudinal, simulations)
	Demonstration of power of advanced data analytics
FROM ENTITY COUNTS TO INTERACTION PATTERNS	Beyond classic static and linear measurements
	Showcasing the usability of relational data
TOOLS & APPROACHES	Operationalization and capturing EE complexity (e.g. clustering, node roles, percolation metrics)
	Expandable, and applicable to further contexts



Practical and Policy Relevance

Benchmarking	Monitoring	Designing	Informing
Compare EEs based on structural integration,	Track network evolution to assess ecosystem status	Interventions at weakly connected nodes or critical hubs	Guide funding decisions by revealing relational gaps
Move beyond traditional output-based rankings	Detect early-warning signs of stress or over-dependence	Strengthen bridging actors or cross-sector links	Support policy prioritization based on structural needs



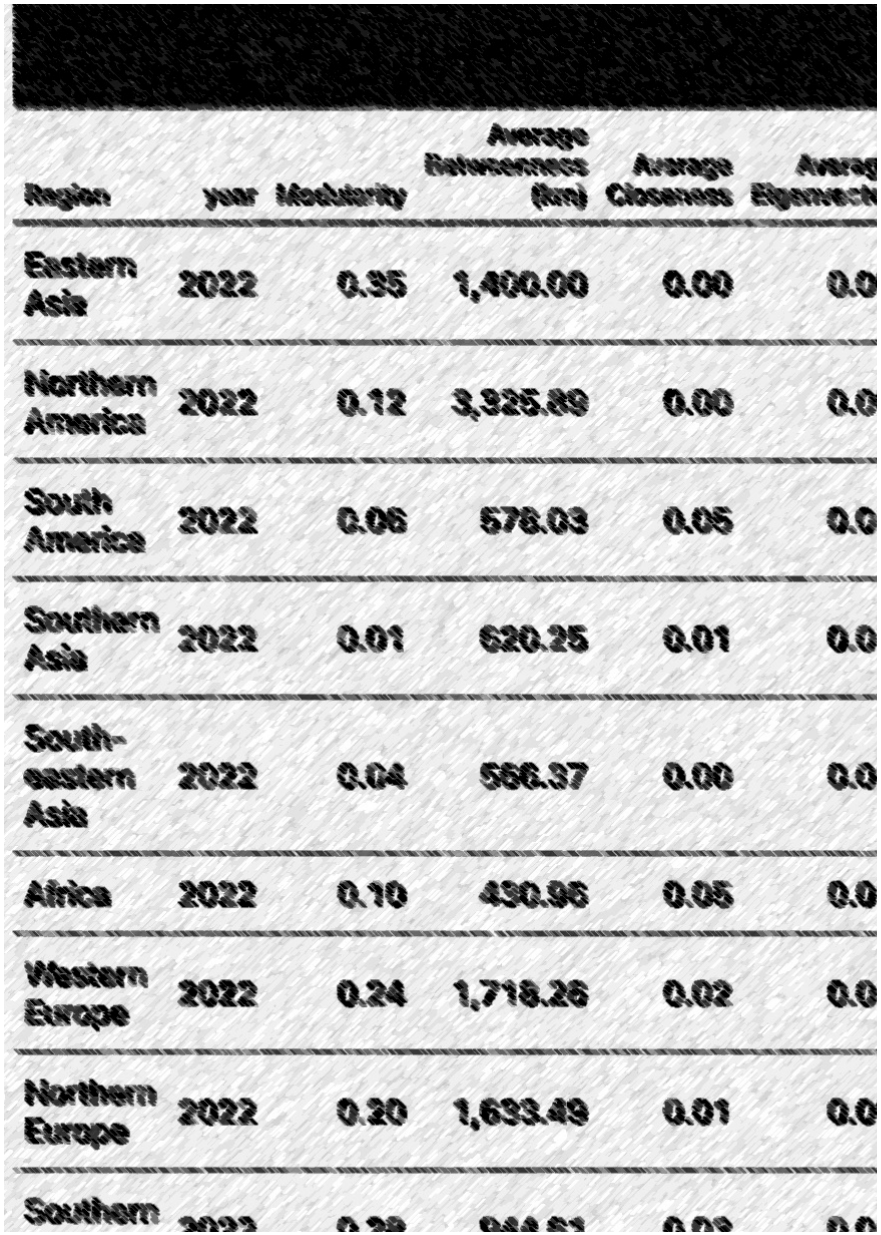
Future Potential

Integrating ***QUALITATIVE INSIGHTS*** (e.g. founder narratives) with network structure

Tracking the ***LIFE-CYCLE*** of EEs: formation, expansion, saturation, decline

Studying how ***GLOBAL SHOCKS*** (e.g. COVID, financial crises) ripple through EE networks

Identifying ***ANCHOR POINTS*** for policy: e.g. critical connectors, brokers, weak ties



Region	year	Modularity	Average Betweenness (km)	Average Closeness	Averag Eigenvect
Eastern Asia	2022	0.35	1,400.00	0.00	0.0
Northern America	2022	0.12	3,925.89	0.00	0.0
South America	2022	0.06	578.03	0.05	0.0
Southern Asia	2022	0.01	620.25	0.01	0.0
South-eastern Asia	2022	0.04	566.37	0.00	0.0
Africa	2022	0.10	430.96	0.05	0.0
Western Europe	2022	0.24	1,718.26	0.02	0.0
Northern Europe	2022	0.20	1,633.49	0.01	0.0
Southern					

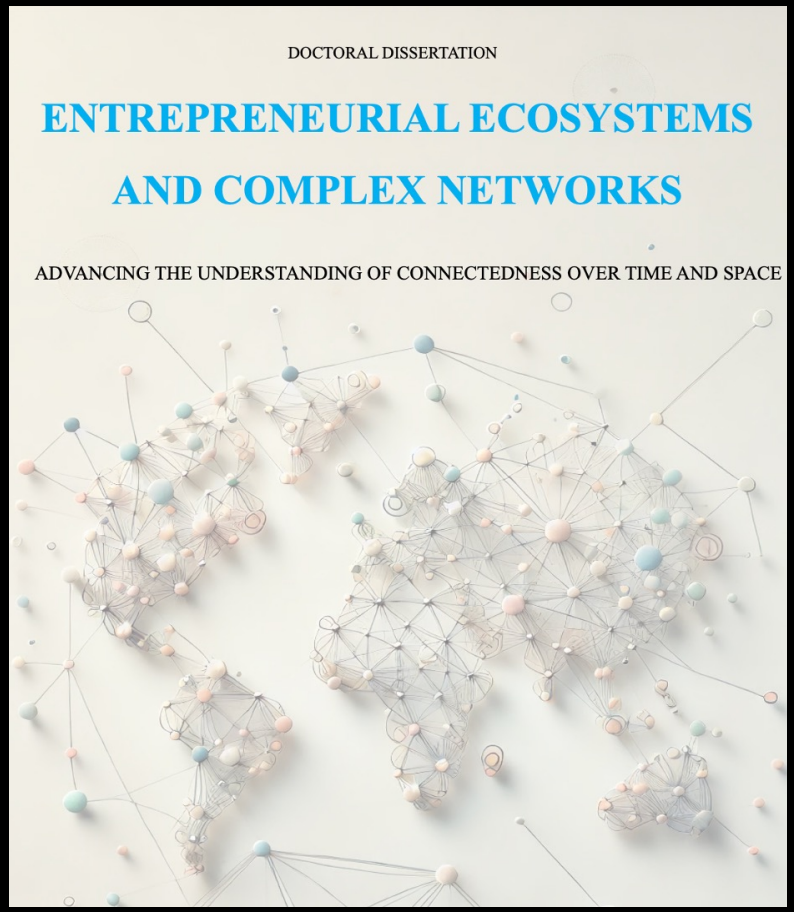
Challenges, Limitations and Outlook

DATA ACCESS & COMPLEXITY
Relational data is hard to obtain and may require advanced technical expertise to process

FOCUS ON FUNDING NETWORKS
Other aspects (e.g. mentorship, institutions) not yet modelled – more network analysis necessary

INTERPRETATION & GENERALIZATION
Method- and case-based insights need adaptation to other EEs

WHAT THIS DISSERTATION CONTRIBUTED



EXTENDED NETWORK-BASED FRAMEWORKS

- EEs as relational, dynamic, and evolving systems.

DEMONSTRATED METHODOLOGICAL NOVELTY

- clustering, simulation, and longitudinal analysis.

SHIFTED FOCUS FROM OUTPUT TO STRUCTURE

- new ways to compare and monitor EEs.

BRIDGED THEORY AND PRACTICE

- tools relevant to researchers and policymakers

OPENED A PATHWAY FOR SCHOLARS

- richer, more systemic EE research – spatial, sectoral, and structural.

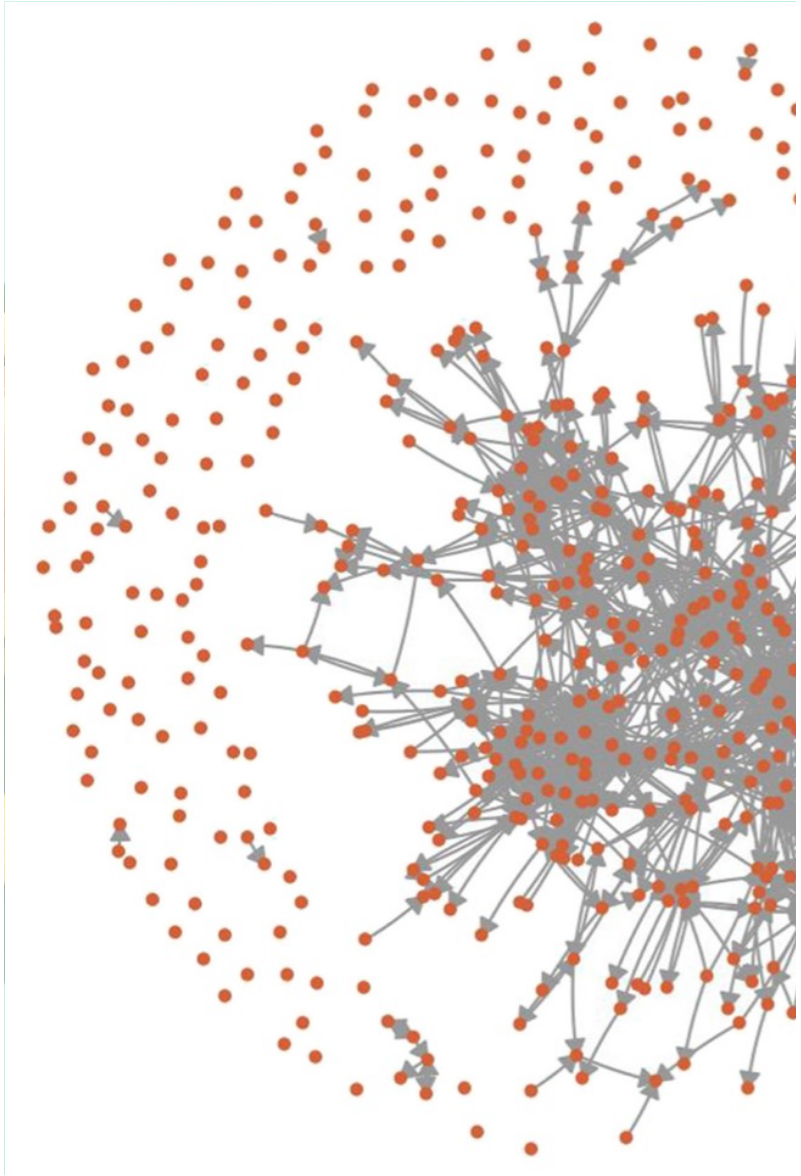
BACKUP

Cutting-Edge EE Network Studies

Social Media Networks: Twitter-based EE analyses introducing key network metrics (Ancona et al., 2023).

News-Based EE Typology: Longitudinal news network analysis establishing EE typologies (Guéneau et al., 2023).

Simulation Modeling: Agent-based models of EE dynamics (Fuentes et al., 2024).



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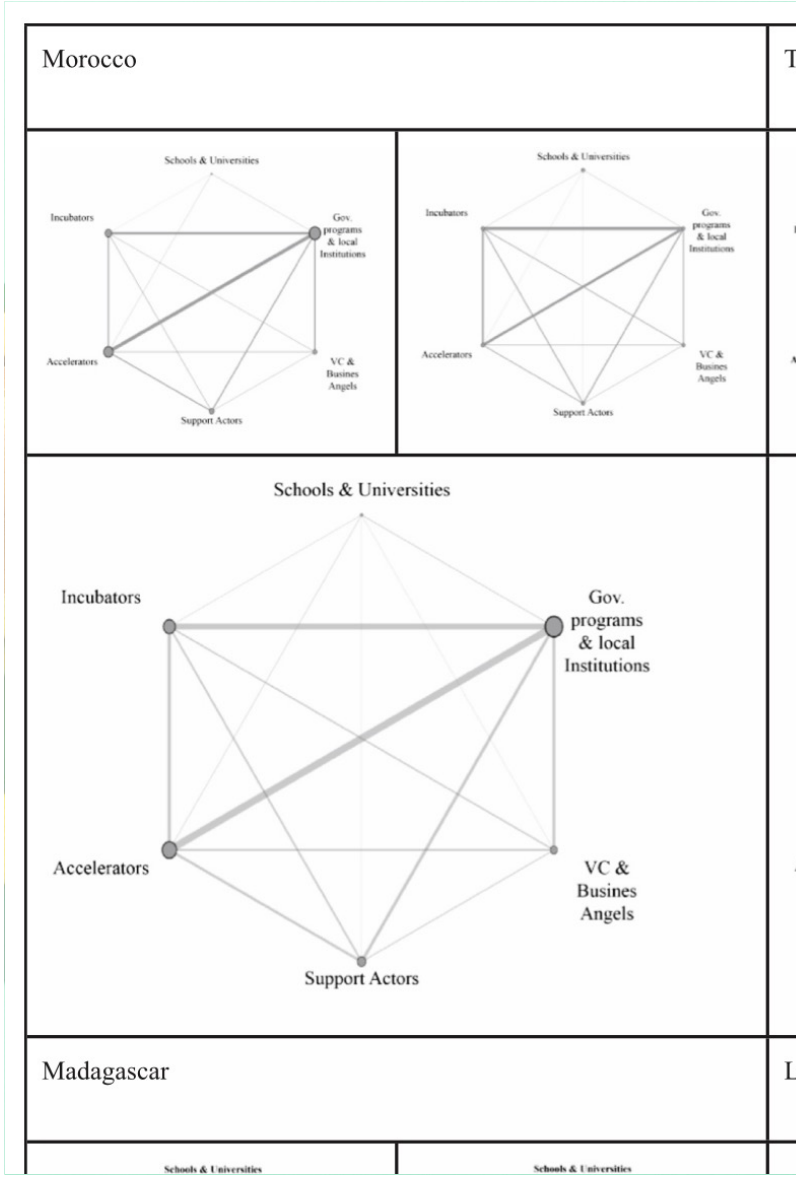

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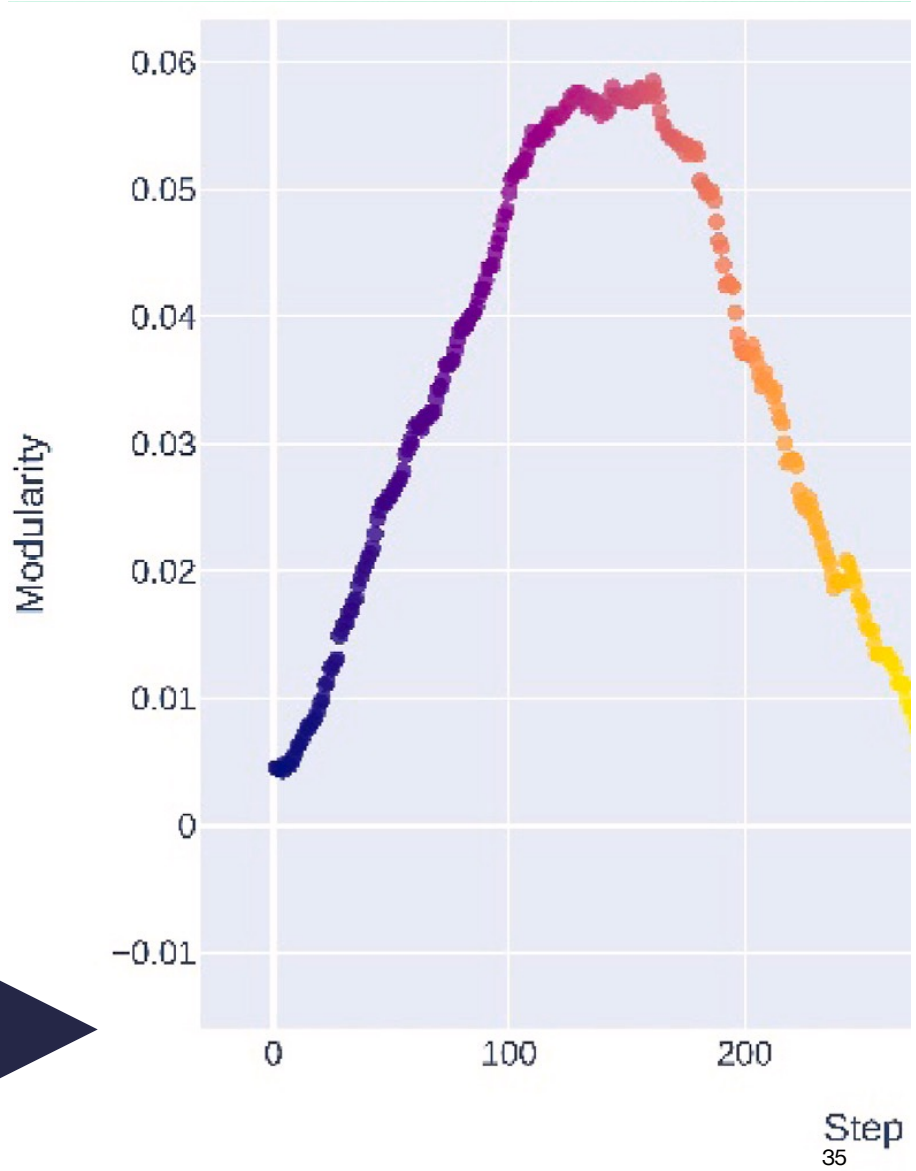
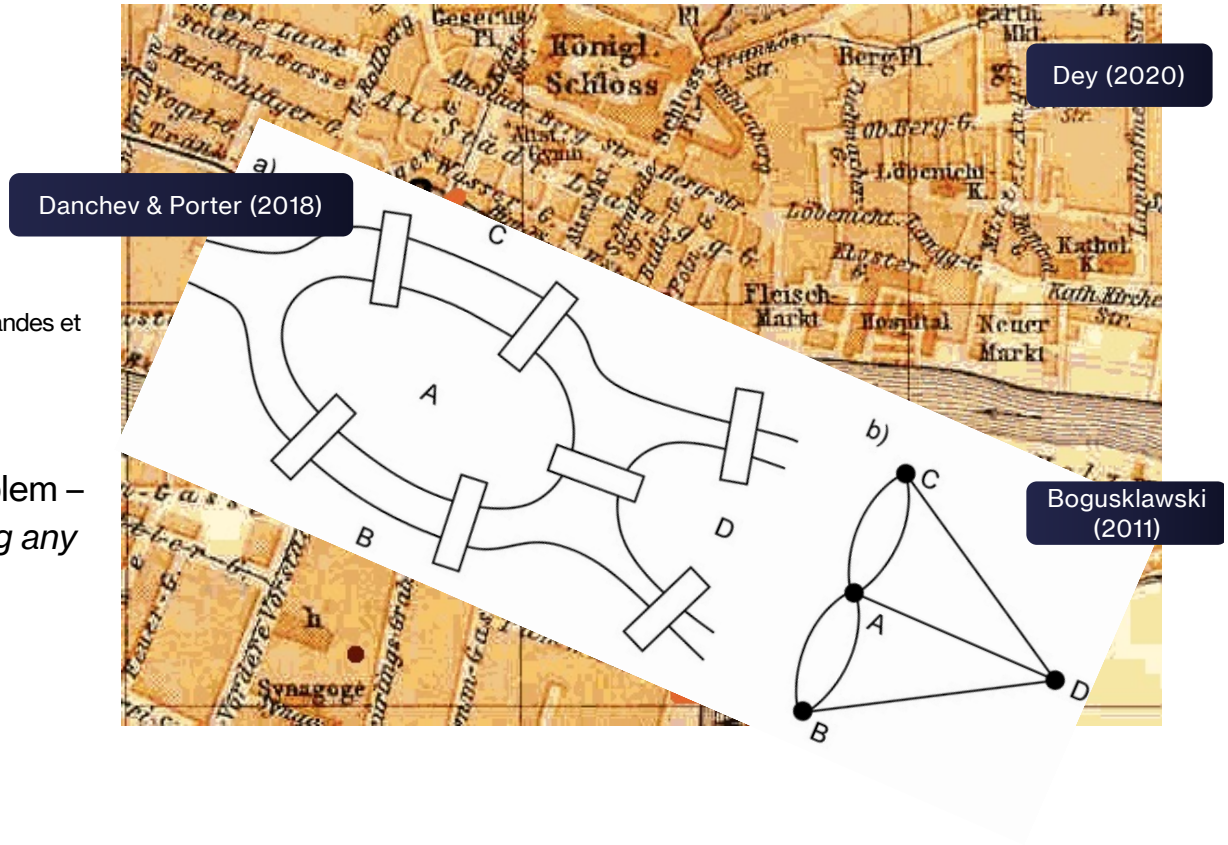


Network Science

Fundamental Concept
Studies networks across disciplines, analyzing interconnections causing global phenomena (Brandes et al., 2013)

Rooted in Graph Theory
Originated from Euler's Königsberg Bridge problem – "*crossing all 7 bridges in one go without crossing any twice*" (Barabási & Pósfai, 2016; Newman, 2018)

Modern Developments
Attributes like weights, direction, time analyzed (Boccaletti et al., 2006; Estrada, 2012)

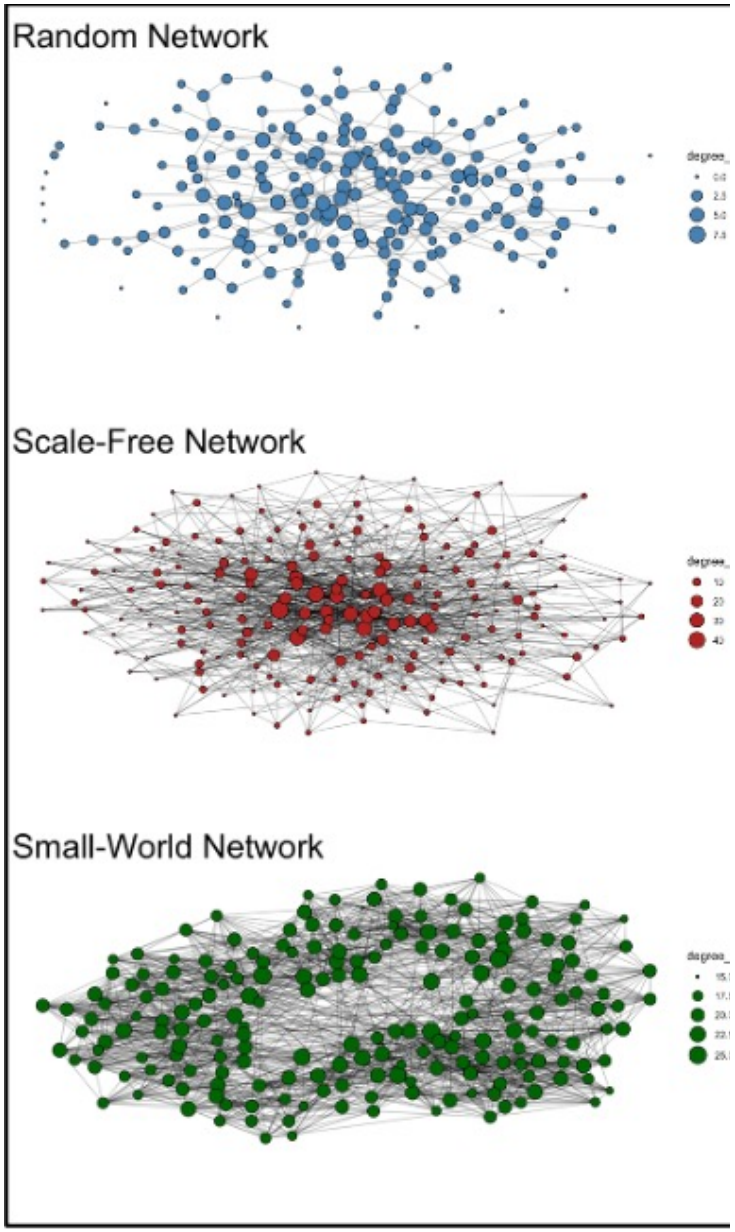


Prominent Network Structures

Random Networks: Random connections, Poisson degree distribution (Erdős & Rényi, 1959).

Scale-Free Networks: Few hubs, power-law distribution (Barabási & Albert, 1999; Broido & Clauset, 2019).

Small-World Networks: High clustering, short paths (Watts & Strogatz, 1998).



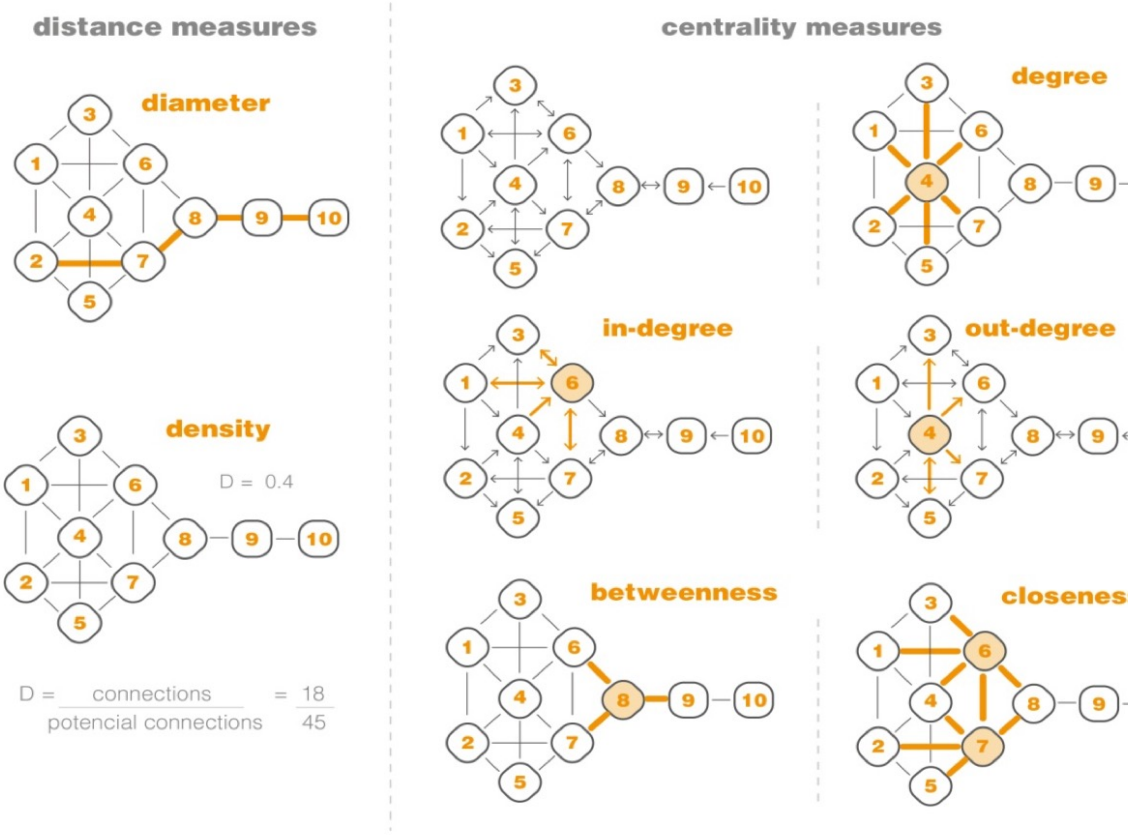
Common Concepts & Metrics in Networks

Nodes & Edges: Entities and relationships.

Centrality, Paths & Distance: Influence, connectivity, efficiency.

Community & Clustering: Internal structures, connectivity patterns.

Percolation & Dynamics: Robustness, changes over time.



Paper Overview

	Paper 1 **Noak & Christian (2025)** *Exploring spatial network structures in entrepreneurial ecosystems: A clustering and network analysis of global venture funding flows* Published in Small Business Economics	Paper 2 **Noak & Fischer (2025)** *Resilience and Vulnerability of Entrepreneurial Ecosystems: The Role of Networks* Not submitted yet	Paper 3 **Noak & Kuebart (2025)** *Entrepreneurial Ecosystems and Trans-Local Ties: Exploring the Global Funding Network of the Renewable Energy Sector Over Time and Space* Submitted and Under Review in European Planning Studies
Focus	Global spatial network structures and integration of EEs	Network resilience and vulnerability of EEs	Trans-local funding networks in renewable energy sector
Key Methodologies	Spatial network analysis, hierarchical clustering, topological metrics	Network percolation, bipartite projections, attack simulations	Longitudinal geospatial network analysis, custom metrics (node roles)
Theoretical Contribution	Highlights relational boundaries and network integration of EEs as crucial differentiators	Networks critically influence EE resilience and vulnerability; connectivity and structure crucial for EE health	Trans-local, born-global nature of renewable energy EEs; network roles evolve with EE maturity
Methodological Contribution	Introduces a novel combination of spatial network analysis and clustering to EE research	Introduces resilience analysis using percolation and network robustness simulations	Advanced sector-specific longitudinal network analysis and introduces custom metrics for node roles
Empirical Context	Global venture funding network, over 550,000 funding flows	Berlin EE, detailed longitudinal funding data	Renewable energy global EE funding network
Policy Implications	Shift from rankings to relational comparisons; improve global EE connectivity	Use network indicators to improve resilience; diversify, strengthen nodes, and prepare for shocks	Monitor EE roles in global networks; strategic international cooperation from early EE stages

Clustering Comparisons

Criterion	Definition	Relevance	Hierarchical Clustering	K-Means	DBSCAN	Spectral Clustering
Cluster Number	Whether the number of clusters must be defined prior	Important in exploratory analysis where cluster structure is unknown	dendrogram allows post hoc selection	k must be chosen before analysis	clusters emerge from data density	number of clusters must be specified in advance
Cluster Shape	Ability to detect clusters with non-convex or irregular geometries	Real-world often is not round or clear-cut	Flexible; not constrained by shape assumptions.	Assumes convex (spherical) clusters of similar size.	Accommodates non-convex clusters well.	Can identify complex, irregular structures via graph Laplacian.
Noise/Outlier Treatment	Capacity to handle or exclude data points that do not fit any cluster	Important for reducing misclassification	All observations are included in the hierarchy.	All data points are assigned to clusters; no outlier detection.	Explicitly identifies noise points as outliers based on density criteria.	Does not include an outlier-handling mechanism; all points are clustered.
Interpretability	Degree to which results can be understood, visualized, and communicated	Useful for presenting to mixed audiences	High; tree-based structure (dendrogram) aids visual analysis and interpretability.	Moderate; results are visualizable but depend on distance minimization assumptions.	Moderate to low; outcomes depend on parameter tuning, which can be difficult to explain.	Low; relies on eigenvector computations, which are less accessible to non-technical audiences.
Feature Vectors	Appropriateness of the method for reduced-dimensional data	Relevant for analyzing structural ecosystem indicators derived from network metrics	Well-suited; compatible with metric-based clustering of numeric features.	Limited; sensitive to scaling and variance unless preprocessed.	Poor fit in high-dimensional, abstract feature spaces; better for spatial or geometric data.	Limited; developed for graph partitioning, not feature-based clustering.

Bipartite Network Projection

Cells in the resulting matrix represent the number of shared neighbors (co-occurrence)

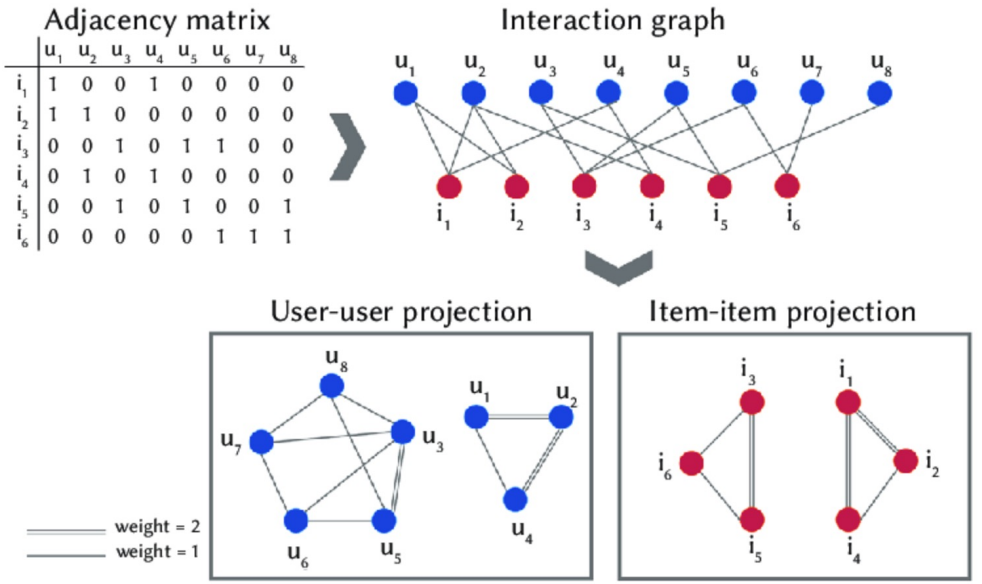
Edge weights in Projection:

- **Binary:** any shared neighbor - link (0/1)
- **Weighted:** number of shared neighbors
- **Normalized:** e.g., Jaccard similarity, cosine similarity

Projections introduce ***indirect links***

analytical abstractions, not observed relationships

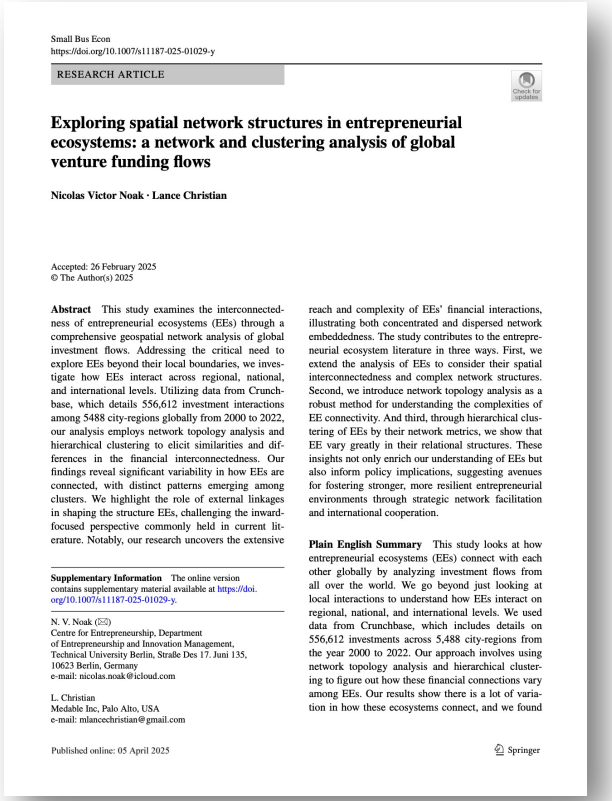
Valuable when modeling (***emergent) structural patterns***



Caro-Martinez, Marta & Jiménez-Díaz, Guillermo & Recio-García, Juan. (2021)

1 Noak & Christian (2025): *Exploring spatial network structures in entrepreneurial ecosystems: A clustering and network analysis of global venture funding flows*

Summary:
Examines global EE connectivity through funding flows.
Identifies structural patterns across regional networks.
Method:
Uses spatial network analysis of 550k+ funding flows.
Applies hierarchical clustering to determine and group EEs.
Calculates network metrics to assess integration
Novelty:
First to use spatial clustering in global EE research.
Clustering used both spatially and relationally.
Allows for comparing EEs based on relational characteristics



Small Bus Econ
https://doi.org/10.1007/s11187-025-01029-y

RESEARCH ARTICLE

Exploring spatial network structures in entrepreneurial ecosystems: a network and clustering analysis of global venture funding flows

Nicolas Victor Noak · Lance Christian

Accepted: 26 February 2025
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Abstract This study examines the interconnectedness of entrepreneurial ecosystems (EEs) through a comprehensive geospatial network analysis of global investment flows. Addressing the critical need to explore EEs beyond their local boundaries, we investigate how EEs interact across regional, national, and international levels. Utilizing data from Crunchbase, which details 556,612 investment interactions among 5488 city-regions globally from 2000 to 2022, our analysis employs network topology analysis and hierarchical clustering to elicit similarities and differences in the financial interconnectedness. Our findings reveal significant variability in how EEs are connected, with distinct patterns emerging among clusters. We highlight the role of external linkages in shaping the structure EEs, challenging the inward-focused perspective commonly held in current literature. Notably, our research uncovers the extensive reach and complexity of EEs' financial interactions, illustrating both concentrated and dispersed network embeddedness. The study contributes to the entrepreneurial ecosystem literature in three ways. First, we extend the analysis of EEs to consider their spatial interconnectedness and complex network structures. Second, we introduce network topology analysis as a robust method for understanding the complexities of EE connectivity. And third, through hierarchical clustering of EEs by their network metrics, we show that EE vary greatly in their relational structures. These insights not only enrich our understanding of EEs but also inform policy implications, suggesting avenues for fostering stronger, more resilient entrepreneurial environments through strategic network facilitation and international cooperation.

Plain English Summary This study looks at how entrepreneurial ecosystems (EEs) connect with each other globally by analyzing investment flows from all over the world. We go beyond just looking at local interactions to understand how EEs interact on regional, national, and international levels. We used data from Crunchbase, which includes details on 556,612 investments across 5,488 city-regions from the year 2000 to 2022. Our approach involves using network topology analysis and hierarchical clustering to figure out how these financial connections vary among EEs. Our results show there is a lot of variation in how these ecosystems connect, and we found

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11187-025-01029-y.

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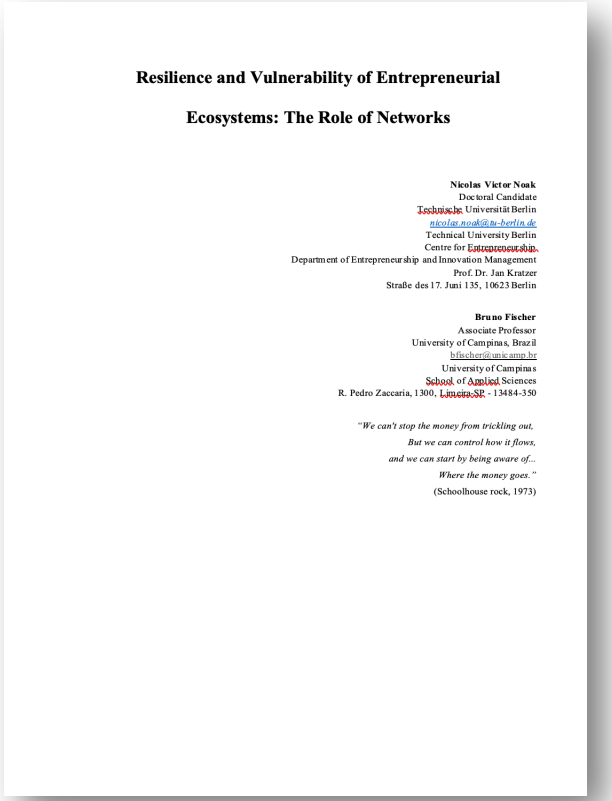
Springer

2 Noak & Fischer (2025): *Resilience and Vulnerability of Entrepreneurial Ecosystems: The Role of Networks*

Summary:
Assesses network resilience of Berlin EE over time.
Introduces structural vulnerability via shock simulations.
Method:
Creates bipartite network of investors and startups.
Projection into one-mode networks for indirect measurement
Attack simulations based on network percolation theory.
Novelty:
First to translate network to resilience metrics in EEs.
Highlights structural vulnerability as key concept.
Links resilience to network maturity



Resilience and Vulnerability of Entrepreneurial

Ecosystems: The Role of Networks

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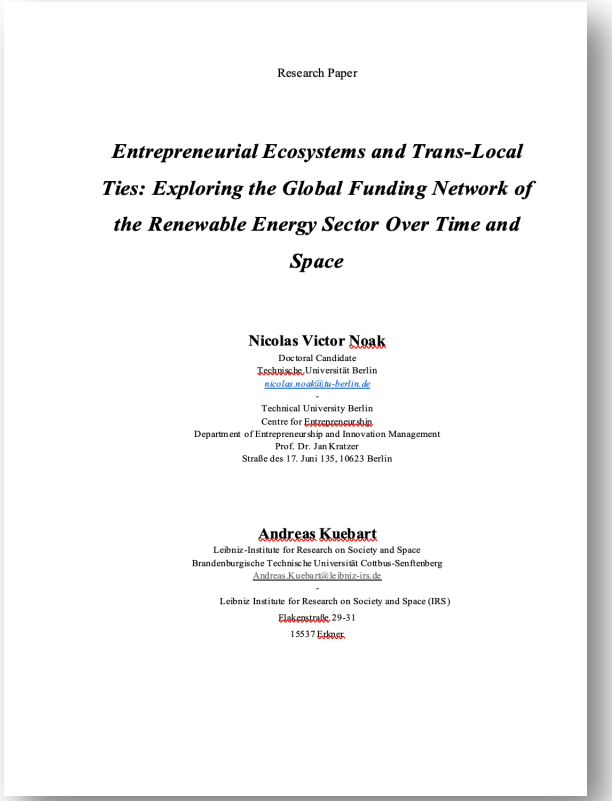
"We can't stop the money from trickling out,
But we can control how it flows,
and we can start by being aware of...
Where the money goes."
(Schoolhouse rock, 1973)

3 Noak & Kuebart (2025): *Entrepreneurial Ecosystems and Trans-Local Ties: Exploring the Global Funding Network of the Renewable Energy Sector Over Time and Space*

Summary:
Studies global funding in renewable energy startups
Analyzes EE evolution by roles and structure over time.
Method:
Uses longitudinal and geospatial network analysis.
Established custom metrics to classify EE inter-connectivity roles.
Maps and tracks core-periphery formation across periods.
Novelty:
model sector-specific EE networks as globally born and evolving
Introduces network role classification as a tool to assess functional dynamics
Captures dynamic growth transitions and “gold rush” patterns in EE integration



Research Paper

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Overall

Applied diverse network techniques

- to real-world EE data across spatial, temporal, and sectoral dimensions

Combined structural analysis

- with clustering and simulation

Introduced underused tools

- spatial embedding, role classification, and attack tolerance testing

Moved beyond descriptive analysis

- by modelling dynamic and systemic EE behaviors

Built a flexible framework

for analyzing EEs as relational, evolving, and embedded systems

Contributions to EE research

Filling the "network methods" gap:	Although EEs are often described as relational systems, few empirical studies actually use formal network science (Fernandes & Ferreira, 2022)
Supporting theory-building:	Operationalization of resilience, structure, and roles helps ground abstract EE theories in measurable constructs (especially around CAS, as called for by Phillips & Ritala, 2019)
Enabling better comparison between EEs:	Your relational grouping approach offers an alternative to ranking-focused comparisons – important in policy and regional strategy
Making EEs globally legible:	You show that EEs don't stop at city or country borders. This challenges earlier local-only perspectives and links to the **world city network** literature (Taylor & Derudder, 2015)