Guidelines for Blockmodeling International Trade: A case study of the first Trump administration

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Researching int'l trade today

New debates

Renegotiated Agreements
Revisit existing trade deals

Cancelled FTAs
Cancel new trade agreements

Trade Wars
Engage in trade conflicts

Geo-economic shifts

Trade Deficits
Focus on reducing trade imbalances

Re-shoring
Encouraging domestic production

A need for research methods apt to capture these changes

Why BM and Int'l Trade

Blockmodeling (BM) and Int'l Trade: A short history

The use of BM to analyse the int'l trade network (ITN) was the first instance of advanced network analysis in int'l economics (e.g., Steiber 1979; Snyder and Kick 1979; Nemeth and Smith 1985)

Its match with World-System Analysis (WSA) was labelled a 'natural wedding' (Breiger 1981, 356).

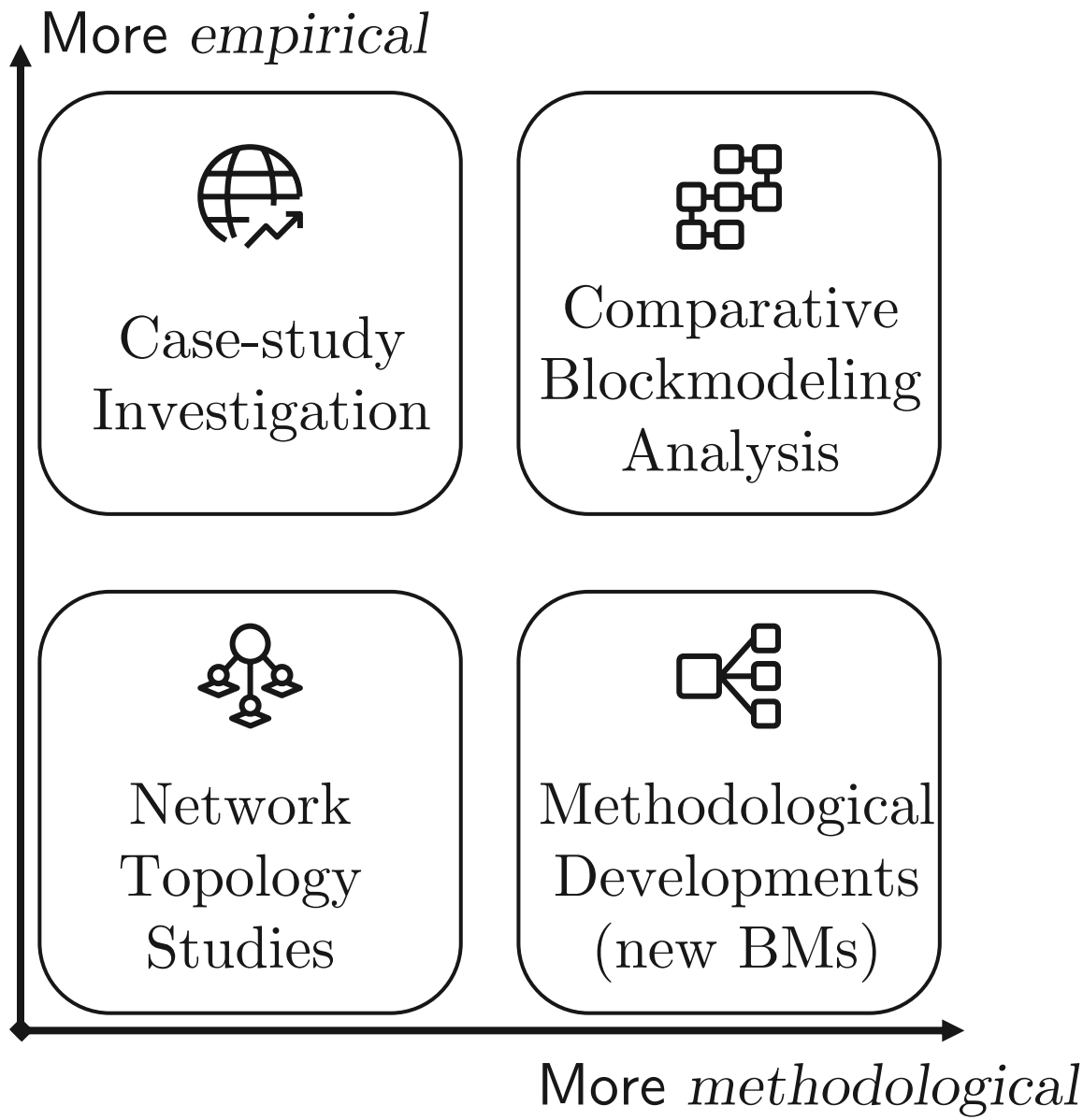
Nowadays, application is lagging behind

BM analyses of ITN are sporadic and do not use the latest methods (e.g., Smith and Sarabi 2022; Kostoska et al. 2020; Estevez and Nordlund 2025)

Rediscovering BM for Int'l Trade

The methodological literature at the intersection of int'l trade and network analysis mostly overlooked BM (e.g., Serrano 2003; Garlaschelli 2004; Garlaschelli 2005; Reyes and Fagiolo 2010; Fagiolo 2010; Squartini et al. 2011a; Squartini et al. 2011b ; DeBenedictis et al. 2011).

Reviews of existing BMs have generally overlooked the features that characterise the ITN (i.e.: asymmetry, values, unequal relational capacities)



Goals and RQs

GOAL

Providing *methodological guidelines* and *practical suggestions* on data gathering, tie-value normalisation, controls for relevant exogenous variables, and unit filtering.

Guidelines showcased on real-world data to answer two RQs.

1. Can existing BM approaches identify intelligible groups of countries that exhibit similar tendency in trade intensely and partner choice?
2. Does comparing the blockmodels of the ITN in 2015-2016 and 2019-2020 bear evidence of a *'Trump effect'* on trade?

Data Gathering: Available sources

The availability of multiple sources can be disorienting due to the technical nature of the differences between them.

UN Comtrade

(UNDESA 2024).

IMF's IMTS

(IMF 2024).

BACI database

(Gaulier 2010)

Data Gathering: Flow & Products

The choice of the query parameters for data-retrieval from a database significantly affects the final network and should depend on both the RQ and the chosen BM's features.

Imports or Exports → *CIF vs FOB valuation* 

'the trade flows reported by the importing country are more accurate than reports by the exporter' (Feenstra 2005, 1; see Shaar 2019)

Product disaggregation → *HS vs SITC schemes* 

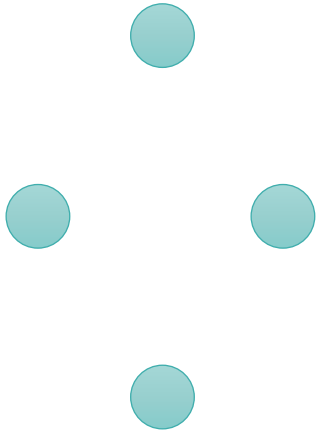
The aggregated ITN's connectivity features cannot be trivially deduced from the product-specific ITNs.(Cepeda-López et al., 2019, 452)

Data Gathering: Flow & Products

Aggregated Flows

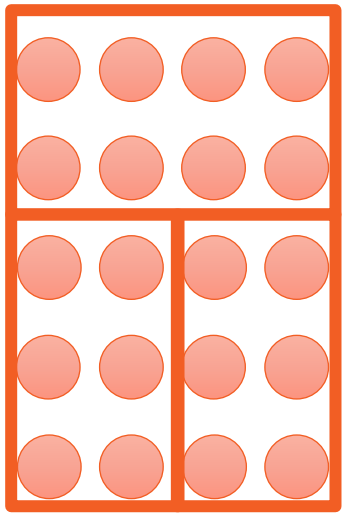
(Snyder and Kick 1979; Su 1995, Clark 2009; Telarico 2023)

Selected Goods



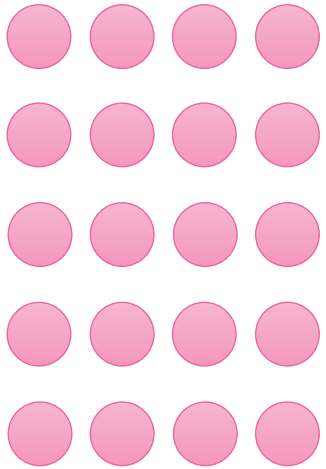
(Steiber 1979; Nordlund 2010; 2014a; 2014b)

Re-grouped Products



(Nemeth and Smith 1985; Smith and Sarabi 2022)

HS/SITC Schemes



(Mahutga 2006; Kostoska et al. 2020)

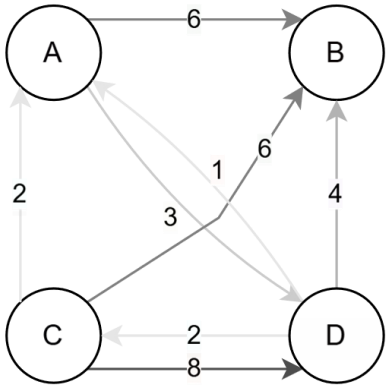
Data Preparation: Directionality

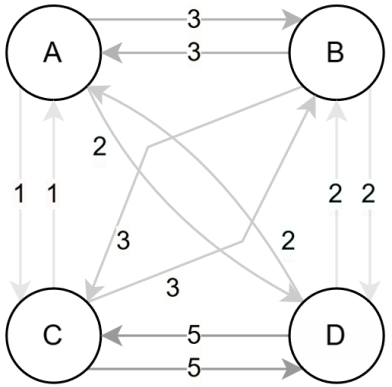
A country's exports to a partner rarely equal its imports from that partner (Guo et al 2018; Griswold 2023; and earlier Hilgerdt 1943, 395-403).

This makes the ITN's adjacency matrix inherently asymmetric. Yet, many symmetries the network (e.g., Steiber 1981; Su 1994) prioritising relations' strength over their directionality (Estrada 2011; Zhang 2016; Garlaschelli 2005; Squartini 2011) and masking the zero-inflation due to unequal relational capacities (cf. Duenas 2013, 175).

A		2	1
6	B	6	4
		C	2
3		8	D

A	3	1	2
3	B	3	2
1	3	C	5
2	2	5	D





Data Preparation: Tie values

Challenges stemming from the tie-value distribution

Node-level heterogeneity

- Domestic-policy effects
- Geographical factors
- Int'l Relations

Scale-Free Structure

- Few hubs
- Many smaller players
- Manifest inequality

Skewed Distributions

- Long-tailed GDP distribution reflects highly-skewed tie-value distributions
- GDP-Weighted Preferential Attachment

Data Preparation: Skew reduction

Several methods allow to filter-out countries with inconsistent or missing trade data to reduce the skew in the tie distribution.

(e.g. Snyder and Kick 1979; Mahutga 2006; Chung et al. 2020; Kostoska et al. 2020)

Missing-data correction

Remove countries based on missing data

Pruning Units

Removes (some) countries based on data or attributes

No Filtering

Risk : introduce biases due to missing data

Salient units

Based on narrow(er) RQs

Binarising ITN

Zeros ties below a threshold

Data Preparation: Exogenous factors

One may control for dyadic and node-level features to reduce the skew in the tie-value distribution due to unequal relational capacity

Geography			Relative competitiveness		Barriers to trade		Market size
Trade costs	Population distribution	Mere location	Exchange rates (Auboin 2013)		Tariffs	NTM	GDP, GNI
CIF-FOB margins (OECD-SDD 2024)	Population-weighted distances (Mayer 2011)	Geographic distance (Hummels 1999)	Bilateral	Relative to SDR	Integrated Data Base (WTO-ERSD 2024)	TRAINS (UNCTAD 2024)	WB World Development Indicators

Data Preparation: Periodisation

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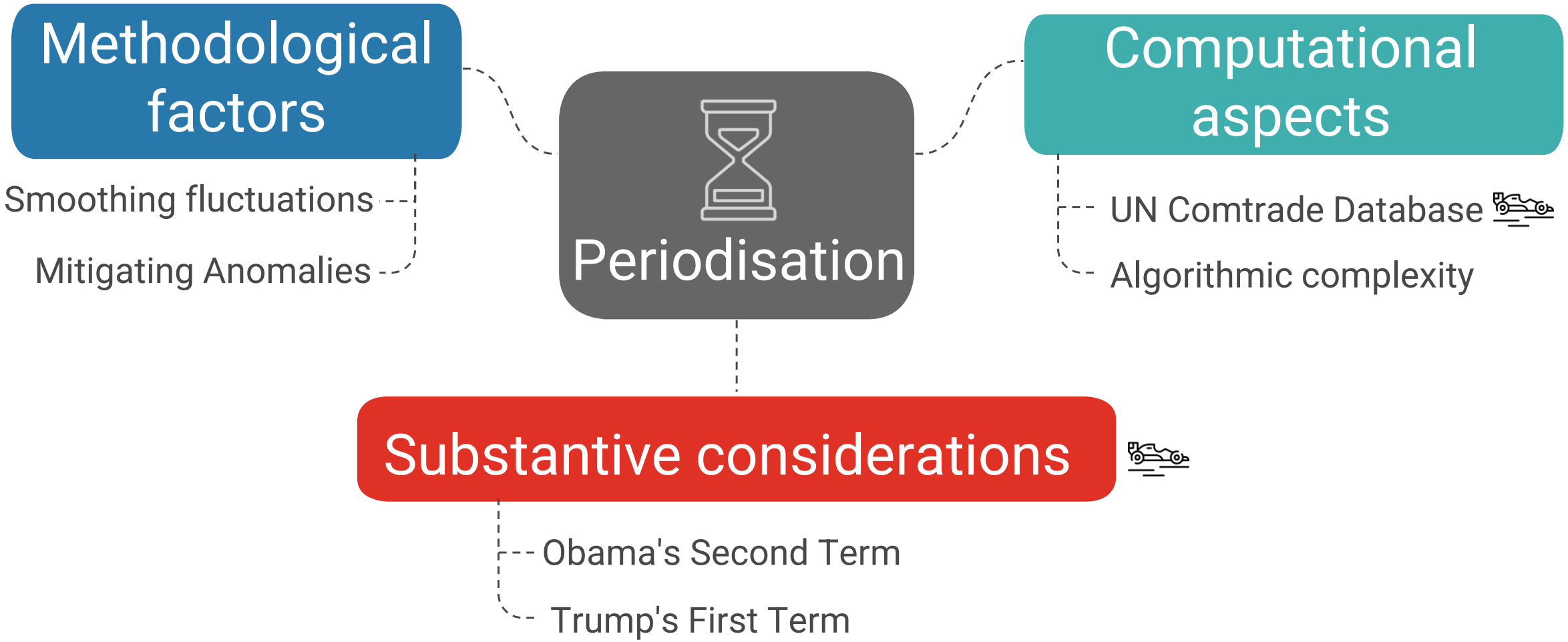


Data Preparation: Unit-filtering

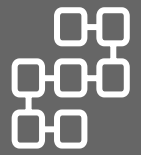
Given the global scope of the substantive RQ, the data was gathered for all countries and two filters are proposed: $(\mathfrak{F}_1)$ removing all LDCs and SIDSs with no reported imports, $(\mathfrak{F}_2)$ removing all countries with no reported imports.

Method selection: What is BM?

Origins

- Boorman & White (1976); White (1976)
- 1980s onwards, WSA

Blockmodeling



Functioning

- Profiling (Yousef 2020, 116–117)
- Simplifying complex networks to interpretable structures

Equivalences

- Deterministic (Doreian 2005; Žiberna 2007)
- Stochastic (Lambiotte et al 2021, 31–32)

Method selection: Chosen BMs

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	SBM (Leger et al. 2021)	DC SBM (cf. Peixoto 2014)	DSBM (Matias & Miele 2017)	HBSBM (Peixoto 2020)
Equivalence type	Stochastic			
Tie Values	Gaussian and Poisson			
Degree Correction	No	Yes	No	Yes
Zero-Tie Handling	As any tie	Through DC	Corrected	Through DC
Covariates	Too slow	No	No	No
Goodness-of-Fit measure	ICL	MDL	ICL	MDL
Estimation	VEM	Bayesian	VEM	Bayesian
Partition-Size Selection	Merge-split	Merge-split	Grid search	MCMC
Implementation	R	R	R	Python

Method selection: Normalisations

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Natural Logarithm

Makes the assumption of Gaussian tie values with constant variance more realistic (MacDonald et al. 2022)

$$w_{i,j} = \exp\left[\beta_0 + \beta_1 \ln(\text{GDP}_i) + \beta_2 \ln(\text{GDP}_j) + \beta_3 \ln(\text{Dist}_{i,j})\right] + \epsilon_{i,j}$$

Data Pre-processing and Normalisation

Balassa Normalisation

$$f(w_{i,j}) = \frac{w_{i,j} \cdot \overbrace{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,j}}^{\text{total value of global trade}}}{\underbrace{\sum_{i=1}^{n} w_{i,j}}_{i\text{'s out-flow}} \cdot \underbrace{\sum_{j=1}^{n} w_{i,j}}_{i\text{'s in-flow}}}$$

(trade flow: $w_{i,j}$)

- Deviation from expected
- Cancels absolute size

Gravity Model

- Residuals as Input
- Only size and distance

Results: Partition-size selection

ICL Maximisation yields larger partitions that capture more local heterogeneity (and noise), but are also less interpretable. The *kneedle method* yields smaller partitions that capture the general structure (hence, less detail), and are generally more interpretable.

Results: Effect of the filters

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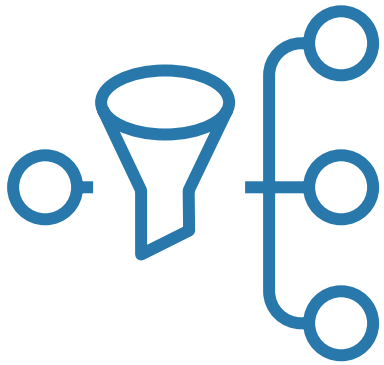
Measuring partition stability (adjusted Rand index, ARI) across the two periods, one finds systematically that:



Stronger **Filter $\mathfrak{F}_2$**

More consistent

Weaker **Filter $\mathfrak{F}_1$**

Affected by data quality

With the ARIs between partitions of the same size under $\mathfrak{F}_1$ being on average 20 times smaller

Results: HBSBM (Balassa)

Supplier Belts

Hub-and-Spoke structure visible across clusters.

Small Outliers

LDCs and SIDSs.

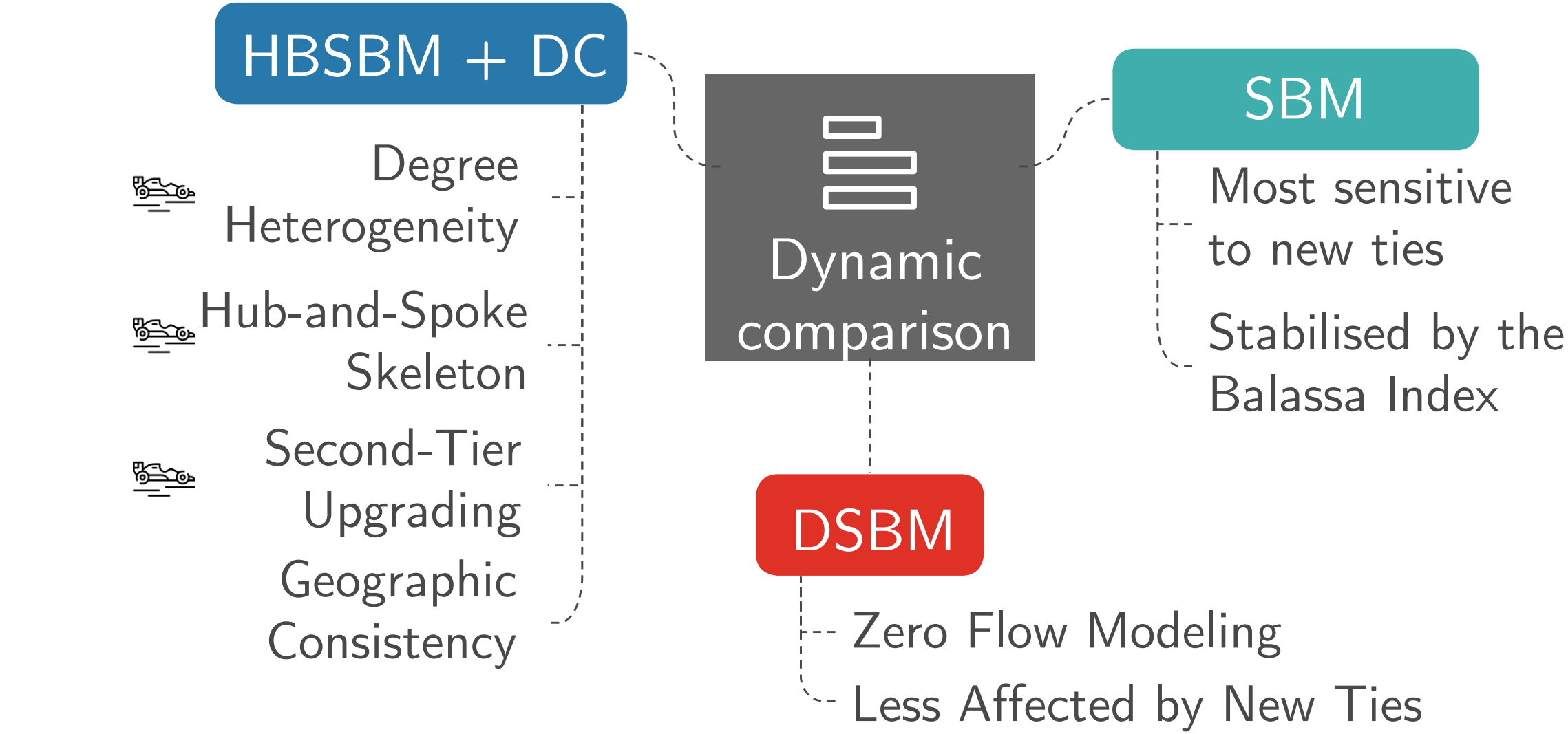
Decoupling cores

Between the two periods, a US-China split is consumed.

Second-Tier Upgrading

Especially Vietnam's and Thailand's cases.

Results: Comparison with 2019-2020



Findings & Next Steps

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Methodological Findings

BM can be effective, but attentive data-preparation is required.

Existing methods have limited ability to control for trivial drivers of trade, especially size

Substantive Findings

Slow US-China divergence

Multiplication of redundant routes and diversifying relations

Next Steps

Assess the use of gravity residuals

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Results: SBM (Balassa, 2015-2016)

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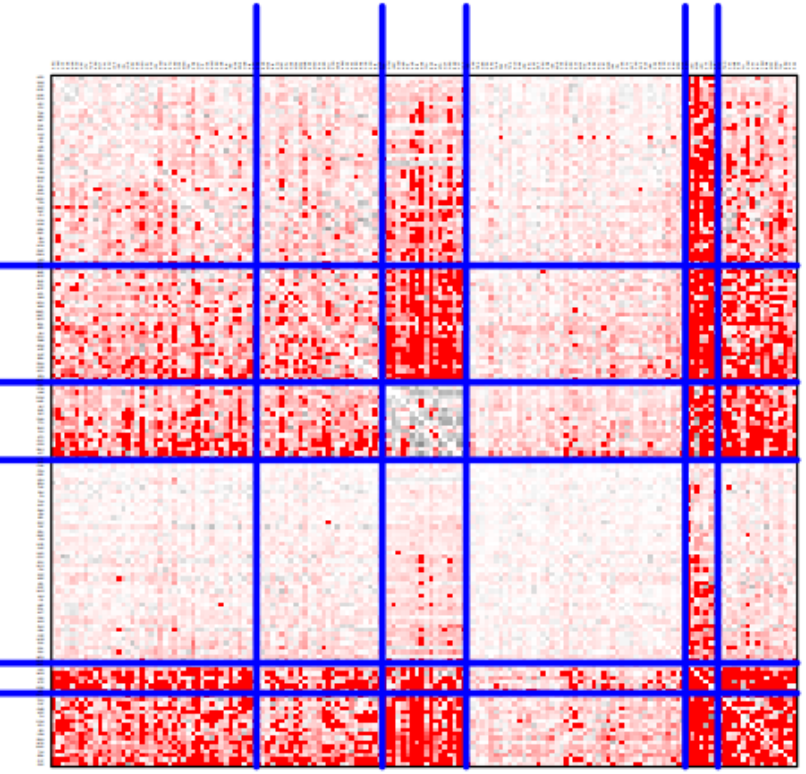
Matrix plot



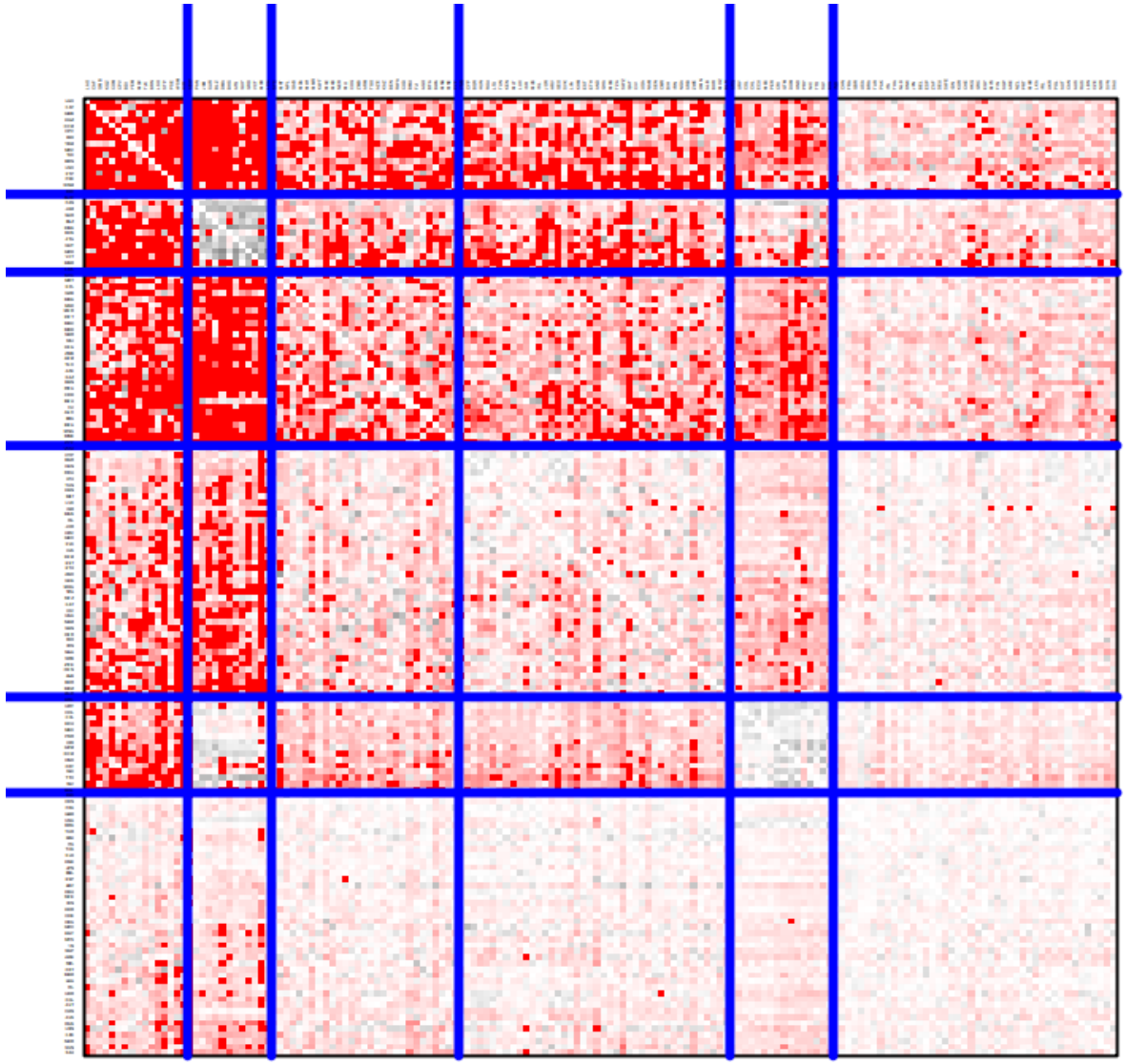
Mean

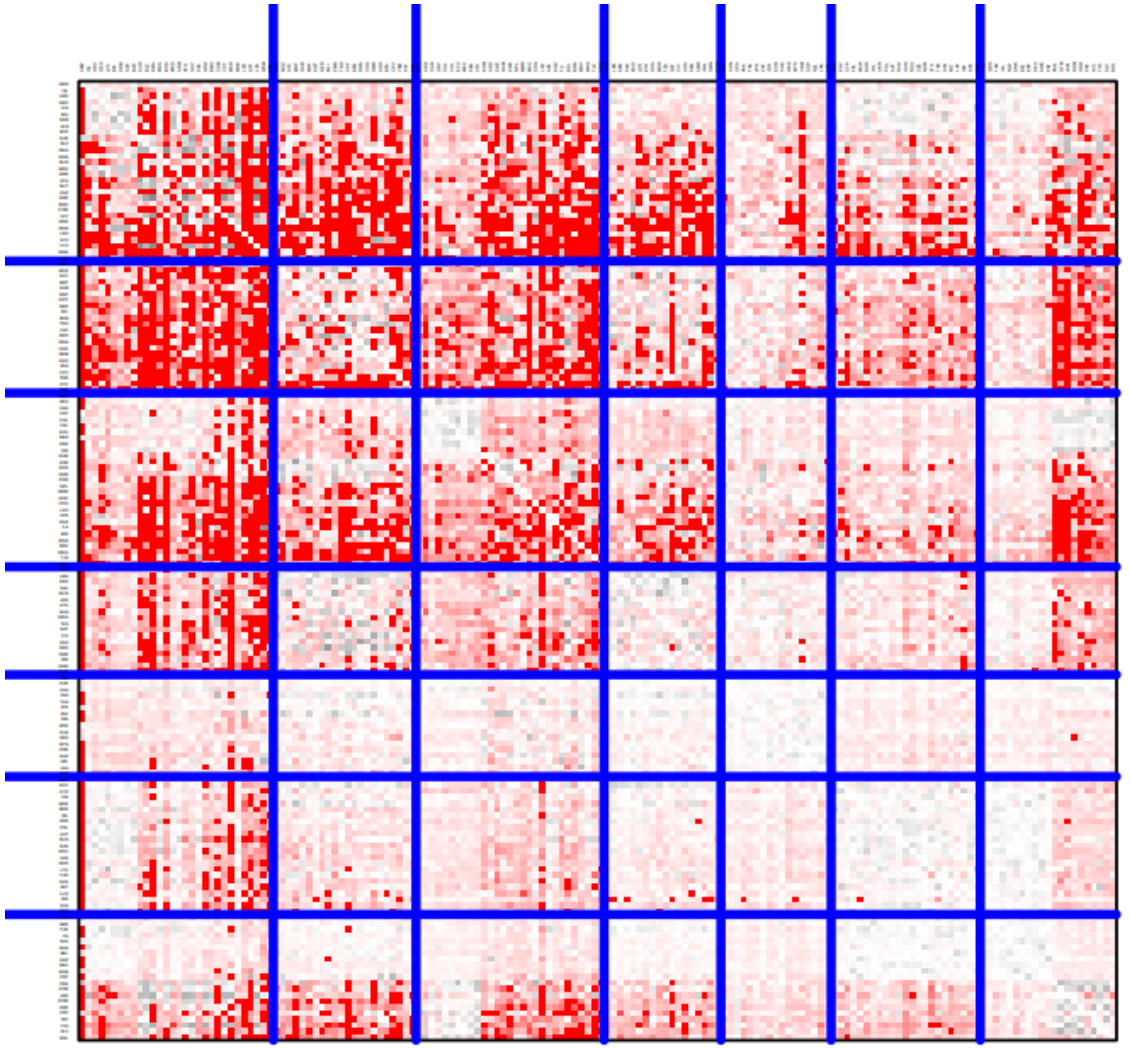
	1	2	3	4	5	6
1	−28	−22	−59	−11	−132	−51
2	−56	−56	−131	−23	−156	−104
3	−72	−67	−5	−30	−126	−118
4	−10	−10	−24	−8	−69	−18
5	−102	−82	−100	−45	−137	−130
6	−92	−78	−136	−34	−155	−128

Standard deviation

	1	2	3	4	5	6
1	42	34	64	19	71	61
2	61	63	64	30	58	78
3	68	64	68	34	84	72
4	19	18	32	24	72	29
5	78	76	85	58	77	76
6	71	72	64	40	63	76

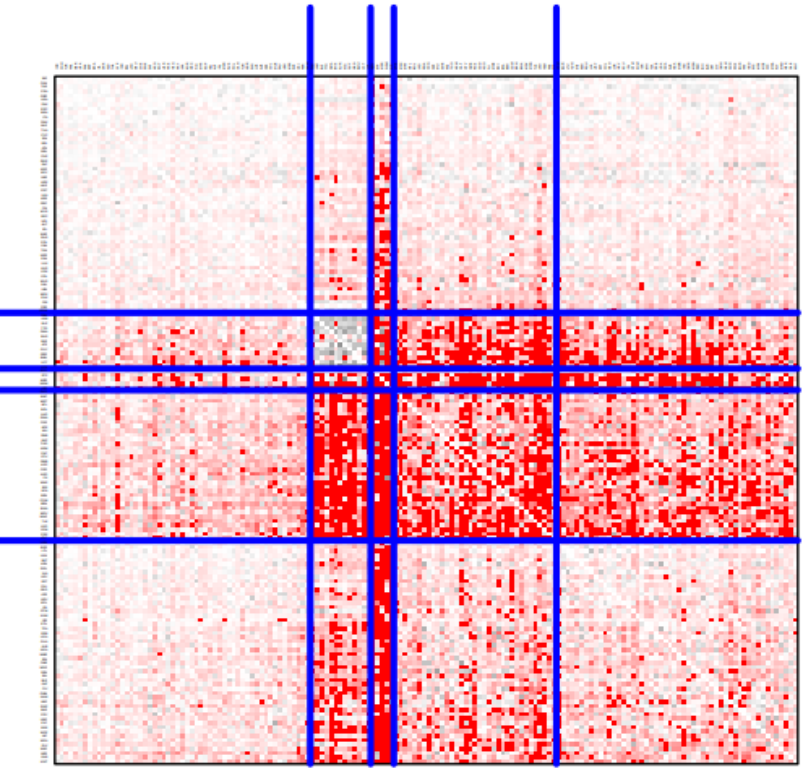
Results: DSBM & HSBM(2015-2016)





Results: SBM 2019-2020

Matrix plot



Mean

	1	2	3	4	5
1	−9	−21	−93	−18	−12
2	−36	5	−139	−110	−82
3	−50	−107	−152	−125	−103
4	−36	−147	−176	−103	−82
5	−16	−73	−165	−47	−34

Standard deviation

	1	2	3	4	5
1	24	31	85	31	20
2	46	72	96	78	75
3	66	95	77	85	87
4	40	69	54	81	72
5	23	71	61	60	49