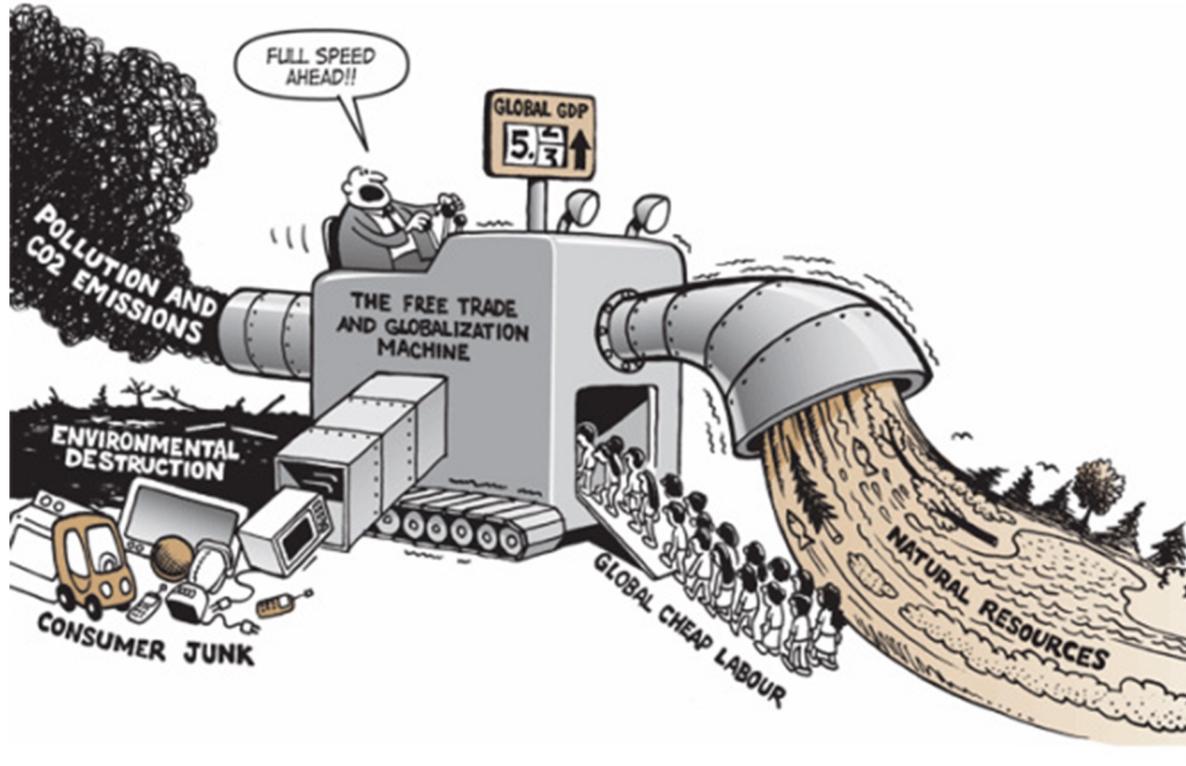
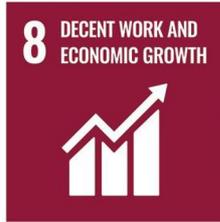


The world is increasingly interconnected socioeconomically & environmentally



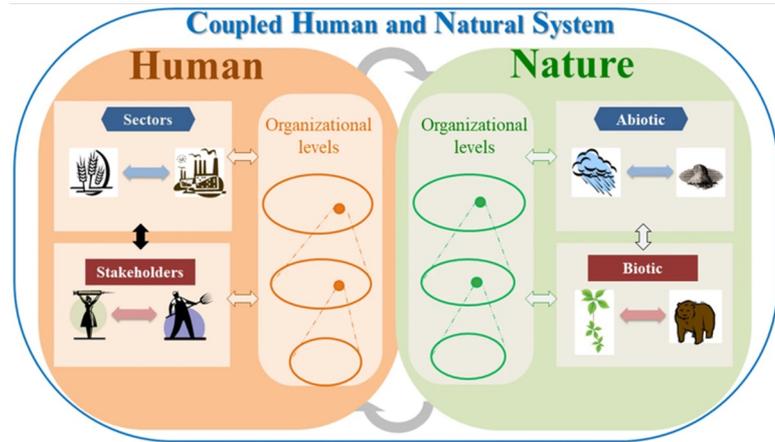
Credit: <https://troehlerenglish.weebly.com>

SUSTAINABLE DEVELOPMENT GOALS

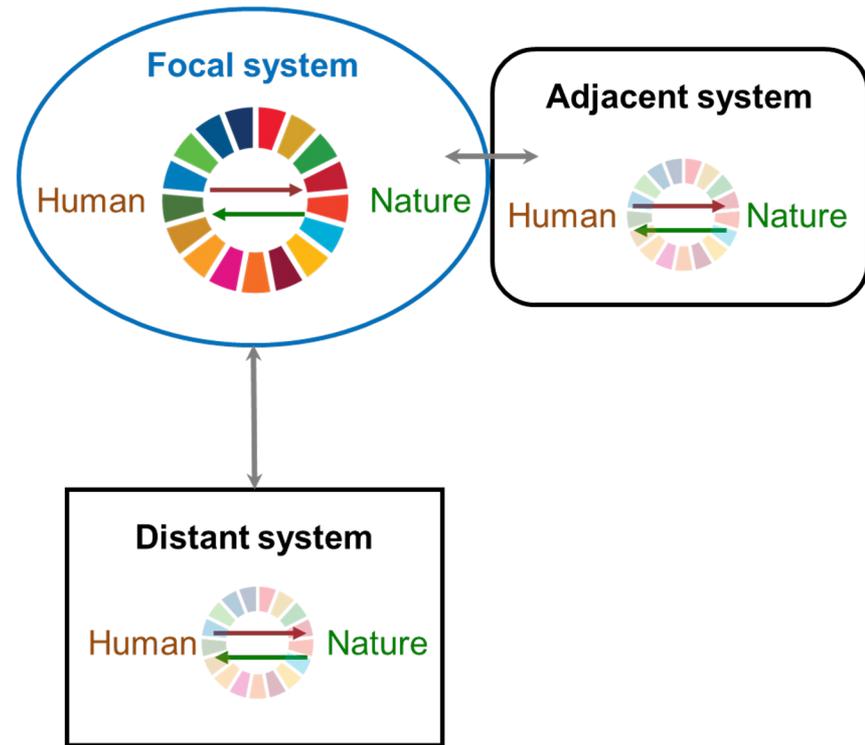


Metacoupling:

complex environmental-socioeconomic linkages across space

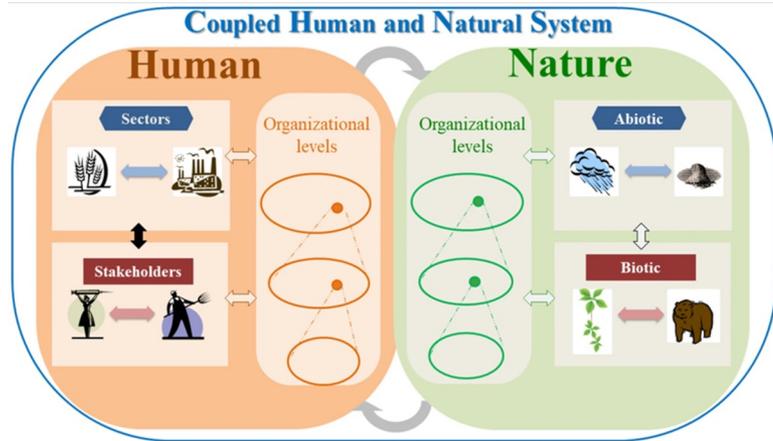


Source: Liu (2017) & Liu et al. (2021)

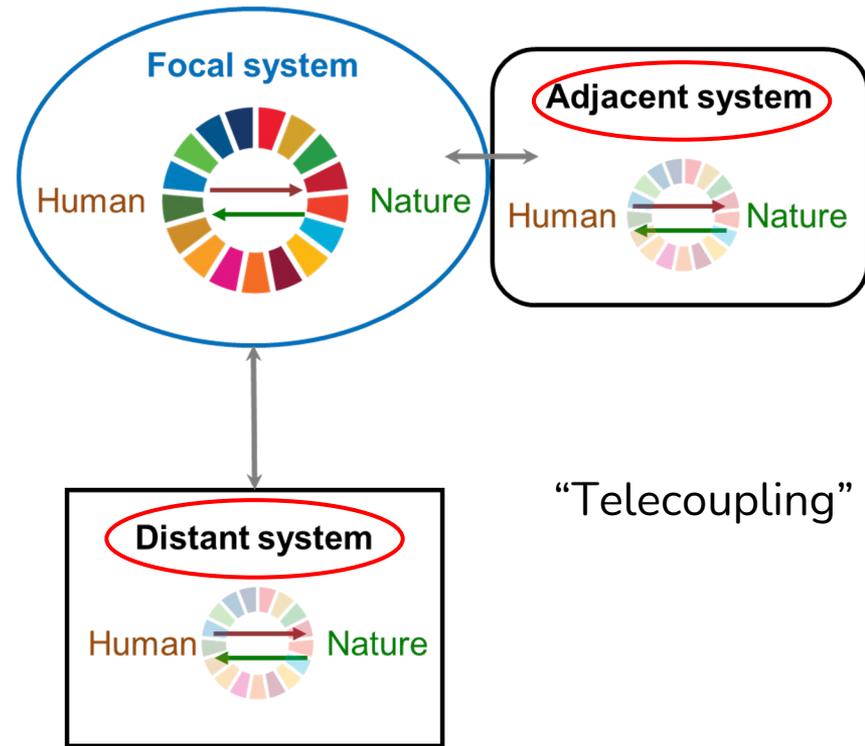


Metacoupling:

complex environmental-socioeconomic linkages across space



Source: Liu (2017) & Liu et al. (2021)



China's Covid wave threatens another snarl of U.S. medical supply chain

Features, Profiles

How COVID-19 has changed the coffee supply chain

JUNE 17, 2021

Why the Pandemic Has Disrupted Supply Chains



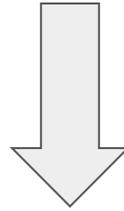
Risk Will Define Supply Chains for Years To Come

Driving research question

How did international trade patterns change during COVID-19?

Driving research question

How did international trade patterns change during COVID-19?



How did international flows of **crops** and **medical supplies** change between continents, within continents, and between countries from 2019 to 2021?



Driving research question

Specifically, how did international flows of **crops** and **medical supplies** change between continents, within continents, and between countries from 2019 to 2021?

Hypothesis:

Due to the high interconnectedness of global supply chains, COVID was highly disruptive, at all scales, for these commodity flows

Analytical Approach

Multiple techniques to analyze trade flows across different scales

1. Data cleaning & pre-processing

2. Trade flow visualization: circos maps

- Overview linkage patterns

3. Trade network analysis: community detection & visualization

- Optimized communities algorithm
- Key countries: importers and exporters, by region

Data: UNComtrade

Annual international trade volumes by country, 2019-21

1. Medical supplies
2. Crops (grains, vegetables)

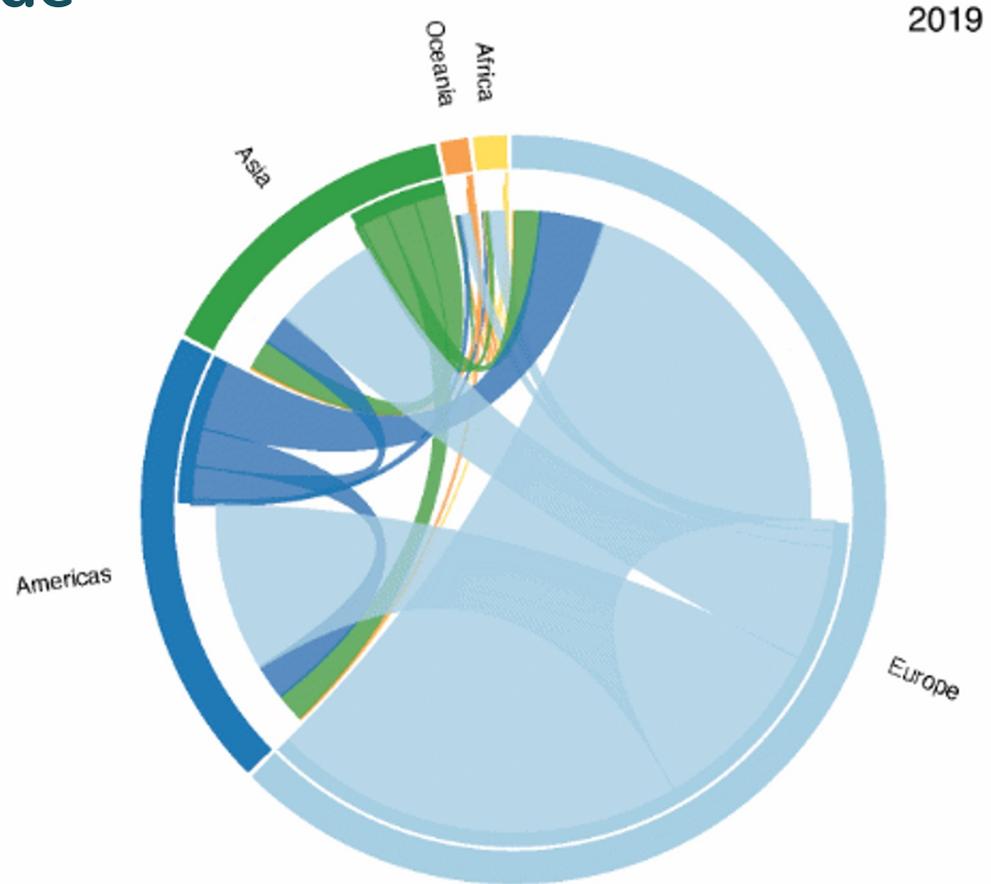
Software:

R, ArcGIS, QGIS

*Additional regional sub-analyses not shown

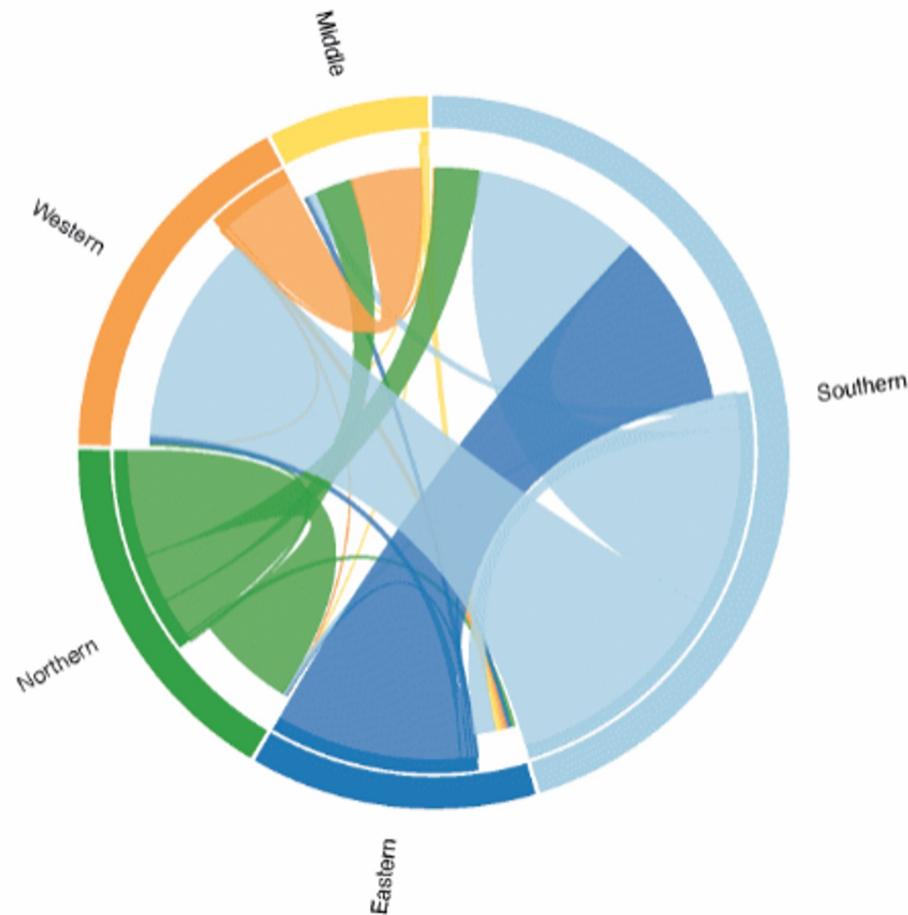
Global medical supply trade by regions/continents

- Europe dominates **inter-continental** medical supply trade
- Asia increases exports 2020-21



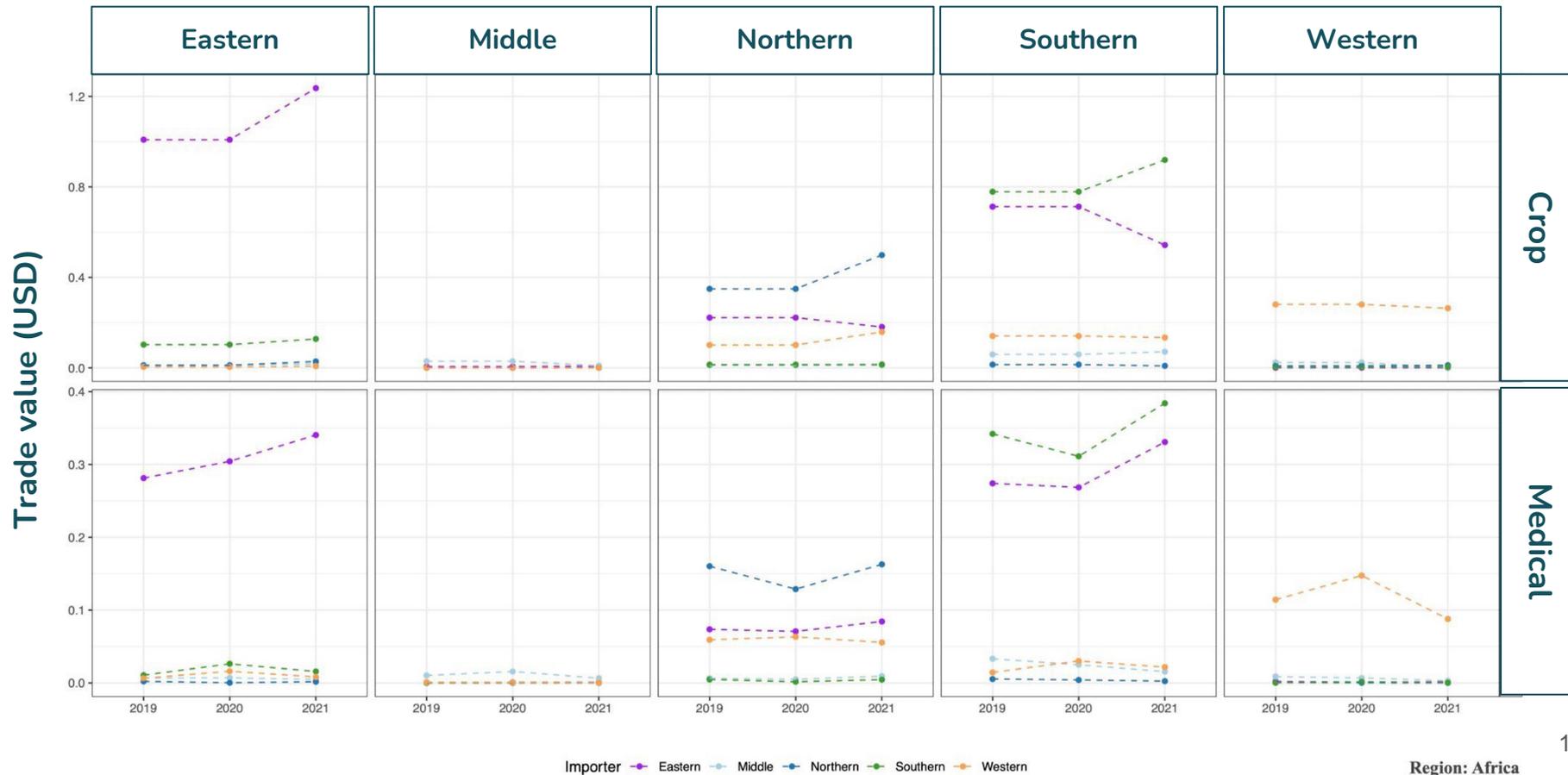
Case study: Africa intra-regional medical supply trade

2019

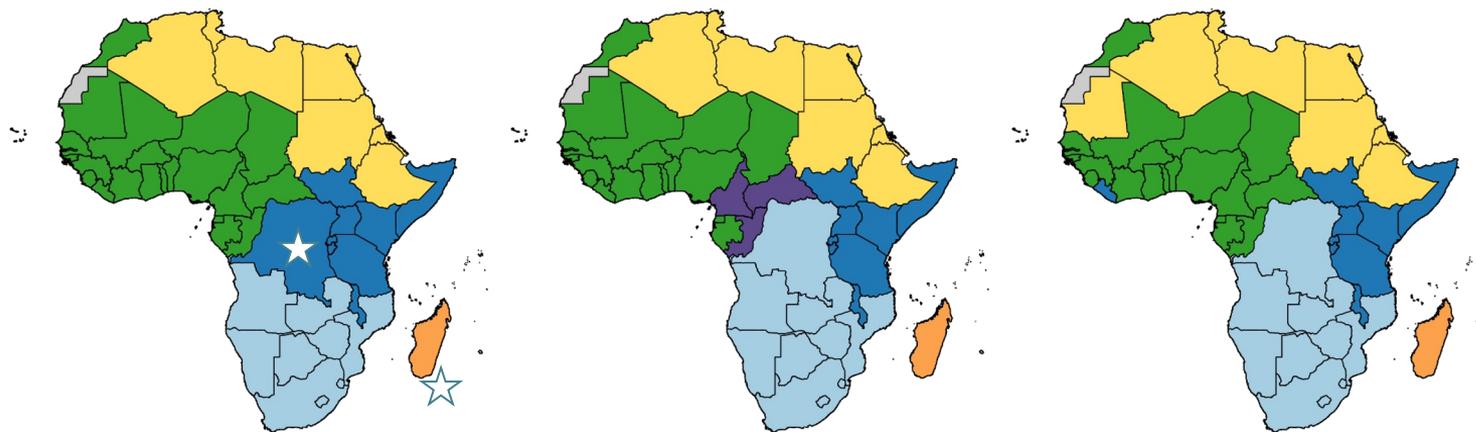


Case study: Africa

Change in commodity trade, by region over time



Africa trade communities: Medical supplies, 2019-2021

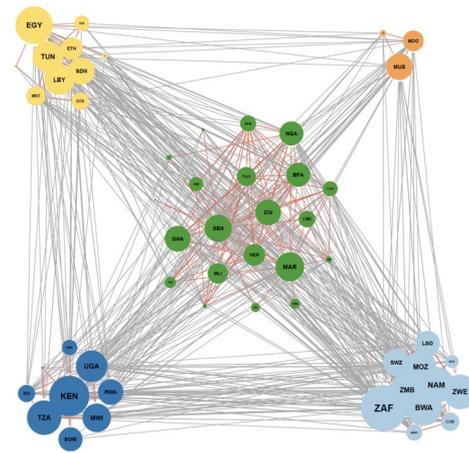
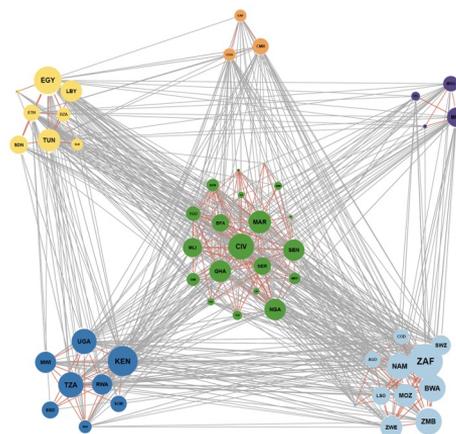
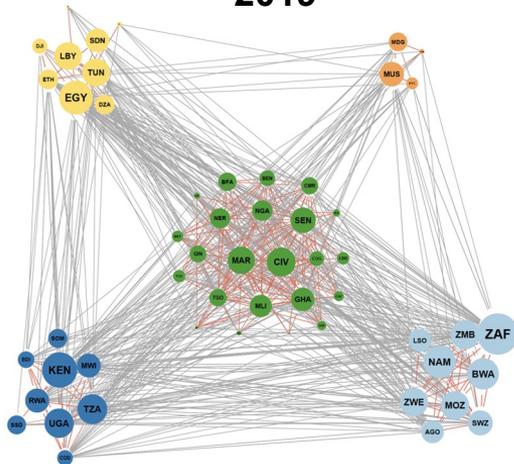


2019

2020

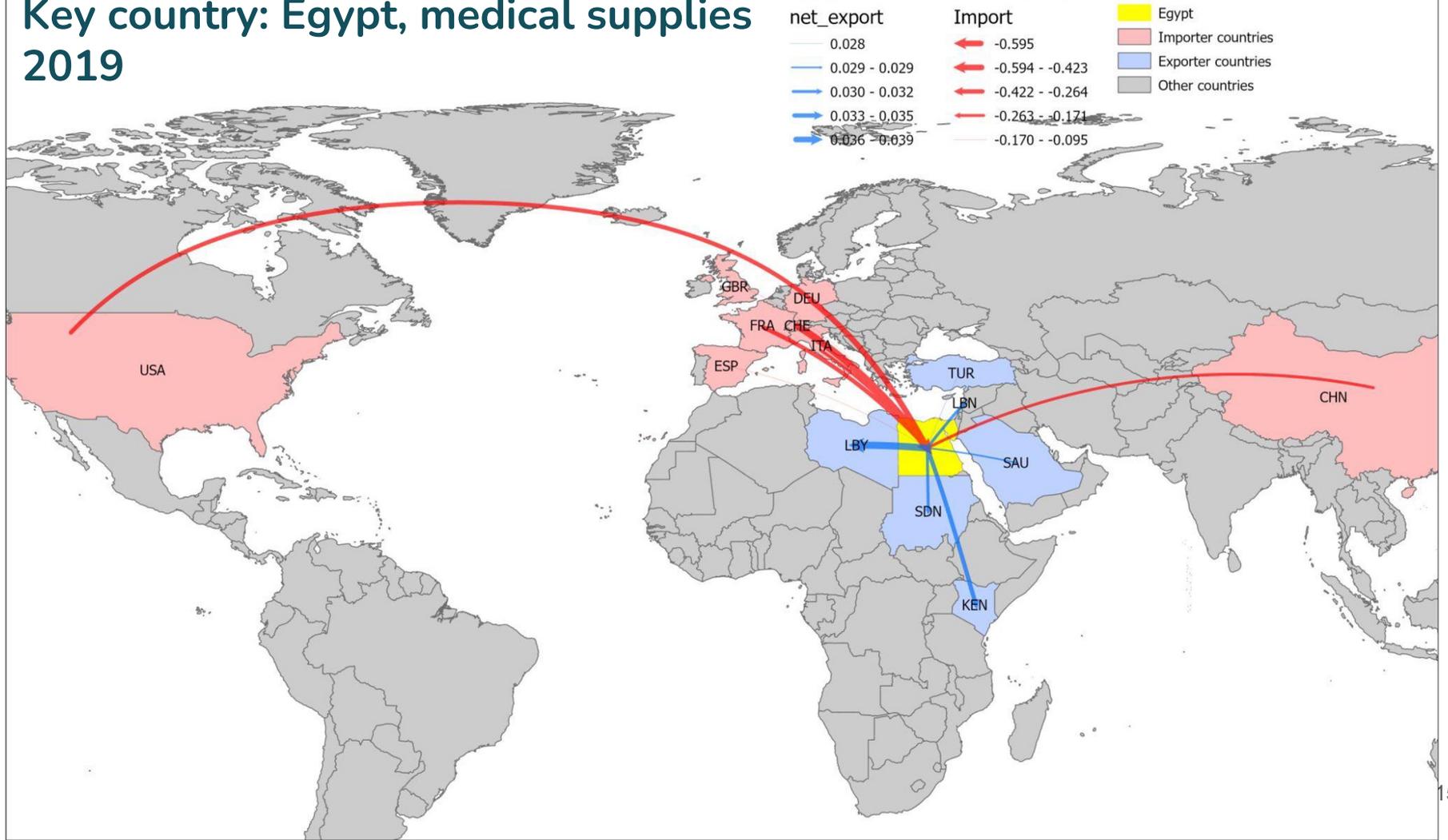
2021

Cluster



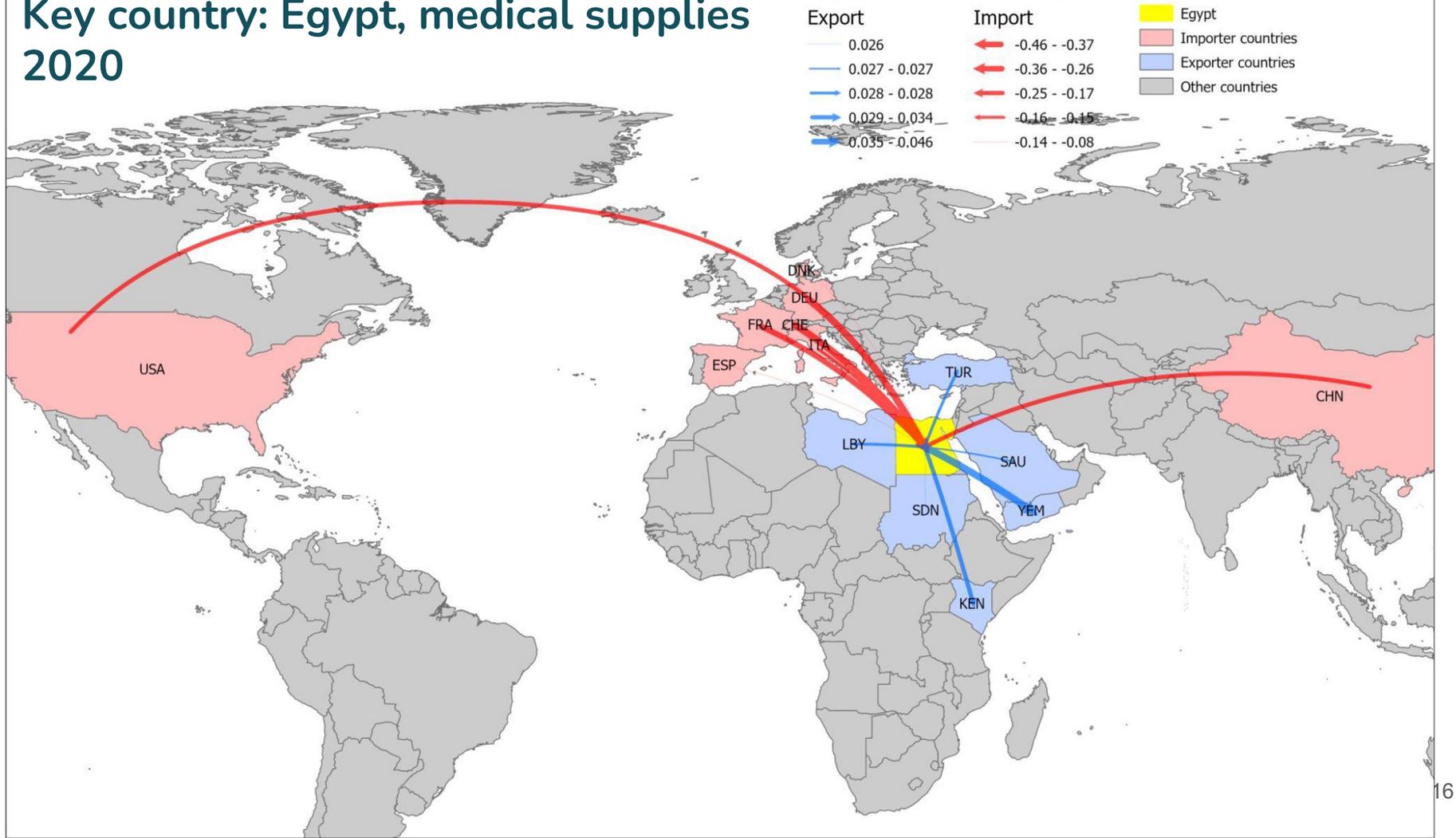
Key country: Egypt, medical supplies 2019

Egypt Net Medical Supply Trading 2019



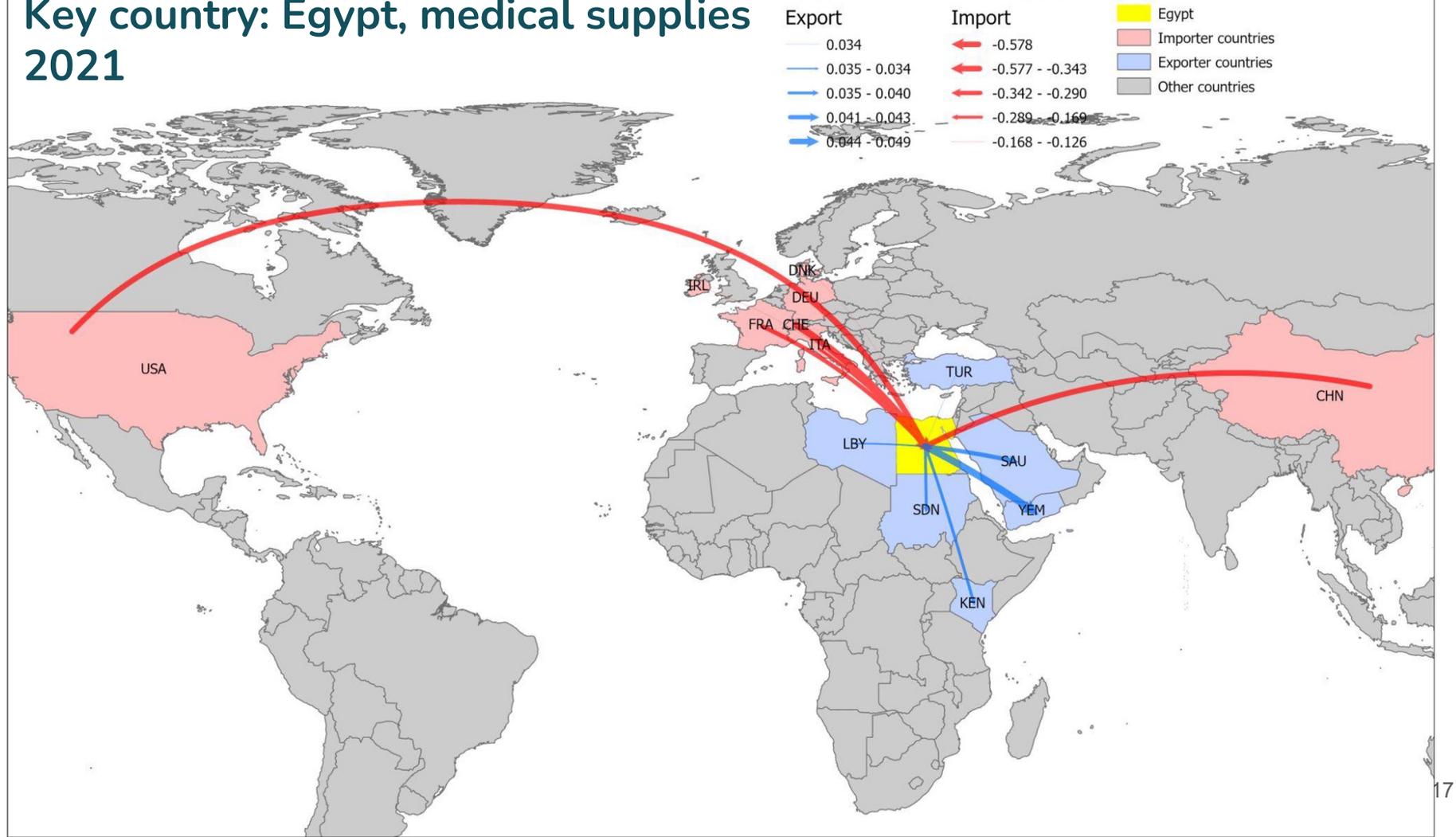
Key country: Egypt, medical supplies 2020

Egypt Net Medical Supply Trading 2020



Key country: Egypt, medical supplies 2021

Egypt Net Medical Supply Trading 2021



Takeaways

Medical supplies trade, 2019-2021

- Trade flows **across scales** (intercontinental, intra-continental, international) changed
- Trade communities became **more integrated**, contrary to initial hypotheses
 - More integrated = trade volume (number, monetary value) increased between members of trade communities
- **Key trade countries** experienced changes in trade flows, not communities

Ethical considerations

Dataset biases and limitations

- Avoid many privacy risks
- But completion an issue
 - Re-import / re-export (e.g., Netherlands, Singapore)
 - Some countries/commodities missing entirely (e.g., India)

Data transferability

- Usage is appropriate for our study
- Smaller-scale or nuanced processes may not apply to other

A. Data Collection

- ✓ **A.2 Collection bias:** Have we considered sources of bias that could be introduced during data collection and survey design and taken steps to mitigate those?
 - In data cleaning process, we took great care of these biases and used multiple dataset to avoid biased dataset (WTO/Comtrade).

B. Data Storage

- ✓ **B.1 Data security:** Do we have a plan to protect and secure data (e.g., encryption at rest and in transit, access controls on internal users and third parties, access logs, and up-to-date software)?
 - We used open-source data.
- ✓ **B.3 Data retention plan:** Is there a schedule or plan to delete the data after it is no longer needed?
 - Yes, the open-source datasets are updated after this project by United Nation.

C. Analysis

- ✓ **C.2 Dataset bias:** Have we examined the data for possible sources of bias and taken steps to mitigate or address these biases (e.g., stereotype perpetuation, confirmation bias, imbalanced classes, or omitted confounding variables)?
 - We found issues from reimport/reexport, e.g., Netherland. There are codes designed by data scientists to mitigate this issue and will be applied in future research.
- ✓ **C.3 Honest representation:** Are our visualizations, summary statistics, and reports designed to honestly represent the underlying data?

D. Modeling

- ✓ **C.5 Audit and reproducibility:** Have we audited our code and reproduced our results?
 - The workflow is documented in a Jupyter notebook.
- ✓ **D.3 Metric selection:** Have we considered the effects of optimizing for our defined metrics and considered additional metrics?
 - Yes, here are some steps we planned to optimize the metrics:
 - 1) Monetary values can be replaced by other physical measurements
 - 2) Due to time constraints, we used optimal community algorithm for subregions and walktrap for global level, but can apply other network clustering algorithms in the future.
- ✓ **D.4 Explainability:** Can we explain in understandable terms a decision the model made in cases where a justification is needed?
 - We have avoid using jargons as much as we could.
- ✓ **D.5 Communicate bias:** Have we communicated the shortcomings, limitations, and biases of the model to relevant stakeholders in ways that can be generally understood?
 - We plan to communicate in the future potential academic/industrial communications.

E. Deployment

- ✓ **E.1 Redress:** Have we discussed with our organization a plan for response if users are harmed by the results (e.g., how does the data science team evaluate these cases and update analysis and models to prevent future harm)?
 - Our outcomes are descriptive, and are not harmful.
- ✓ **E.3 Concept drift:** Do we test and monitor for concept drift to ensure the model remains fair over time?
 - Yes, we have tested and ensure a fair model under different concepts.

Future Directions

- Examine variables related to COVID outcomes or environmental/social drivers
 - COVID deaths, vaccinations
- Replicate analyses with additional *services*
 - Tourism (World Trade Organization), Official Development Assistance (Organisation for Economic Co-operation and Development)
- Contextualize results within Sustainable Development Goals

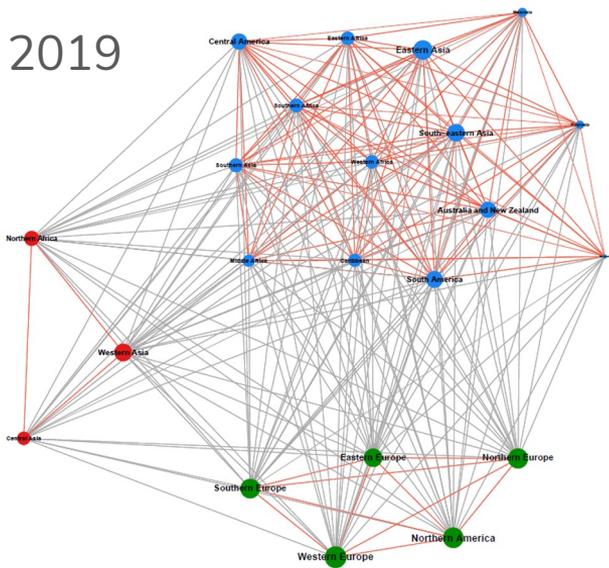


Metacoupling:

complex environmental-socioeconomic linkages across space

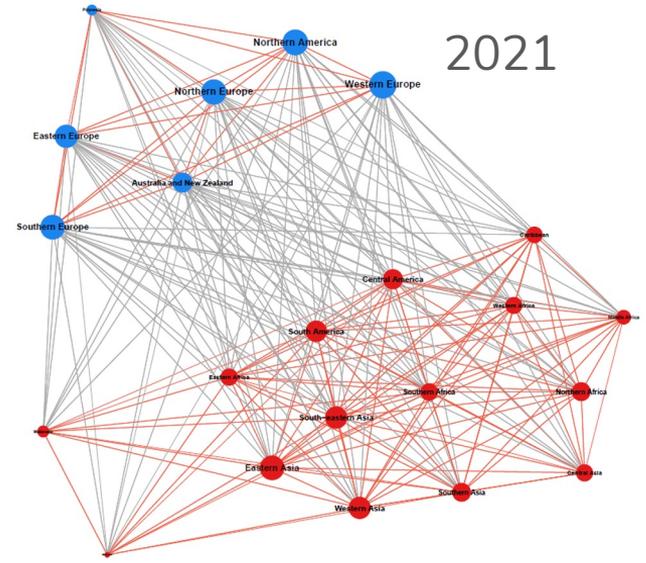


2019



Medical trade communities by subregion

2021



THANK YOU!