

TRB 2015

Presentation Number: 15-4328

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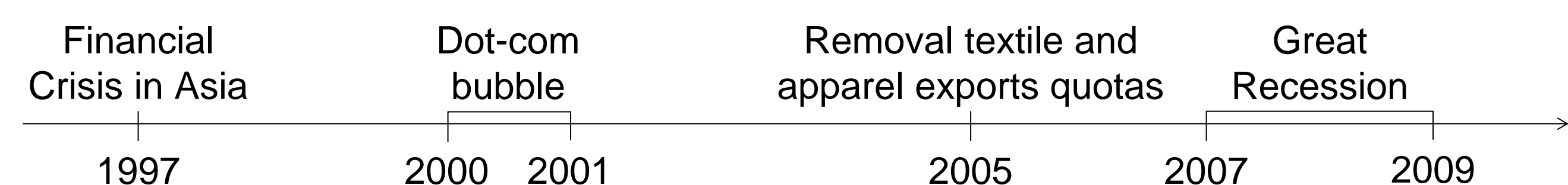
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## INTRODUCTION

- Maritime transportation is very important for international trade
- The International trade network has evolved into complex global value chains (GVCs)



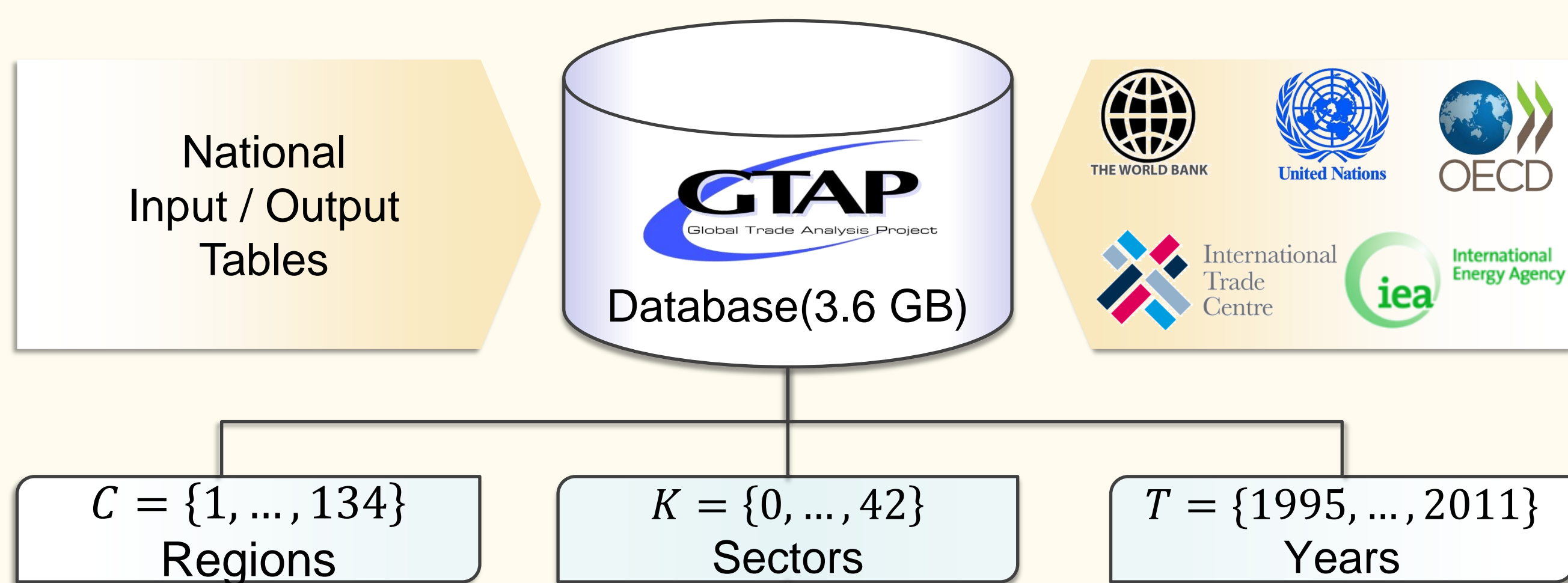
- Global crises reduce trade and generate restrictive trade policies



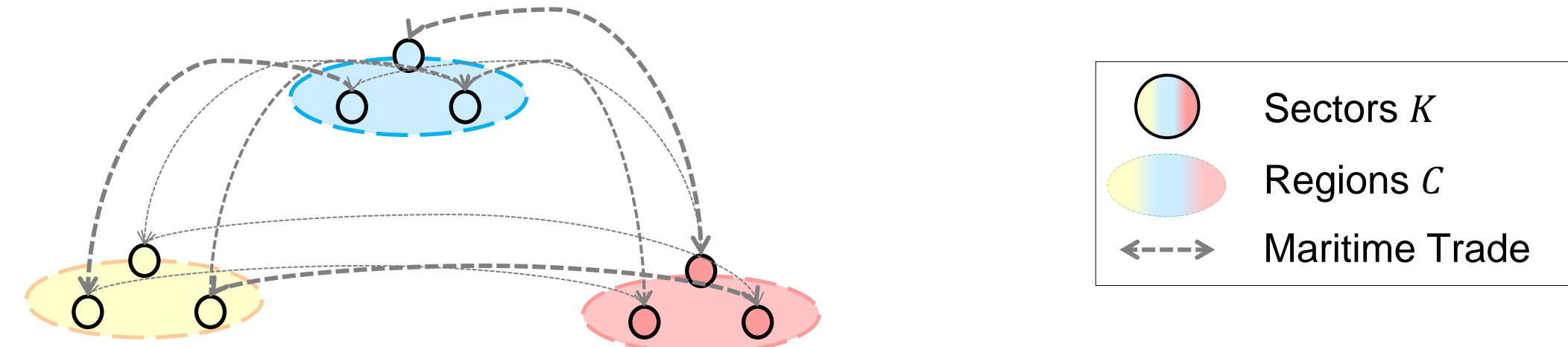
- Different to the common bilateral analysis, Statistical Network Analysis captures trade network effects
- Previous analyses do not consider: GVCs, global crises, transportation linkage
- This work:

- Rich Data from the Global Trade Analysis Project (GTAP)
- Novel representation of the Maritime Multi-commodity International Trade Network (MM-ITN) replicates GVCs
- Suite of Statistical Network Analysis tools
- Evolution of the MM-ITN clearly illustrated
- Impact of global crises described from a network perspective
- Economic policy provided

## DATA AND NETWORK REPRESENTATION

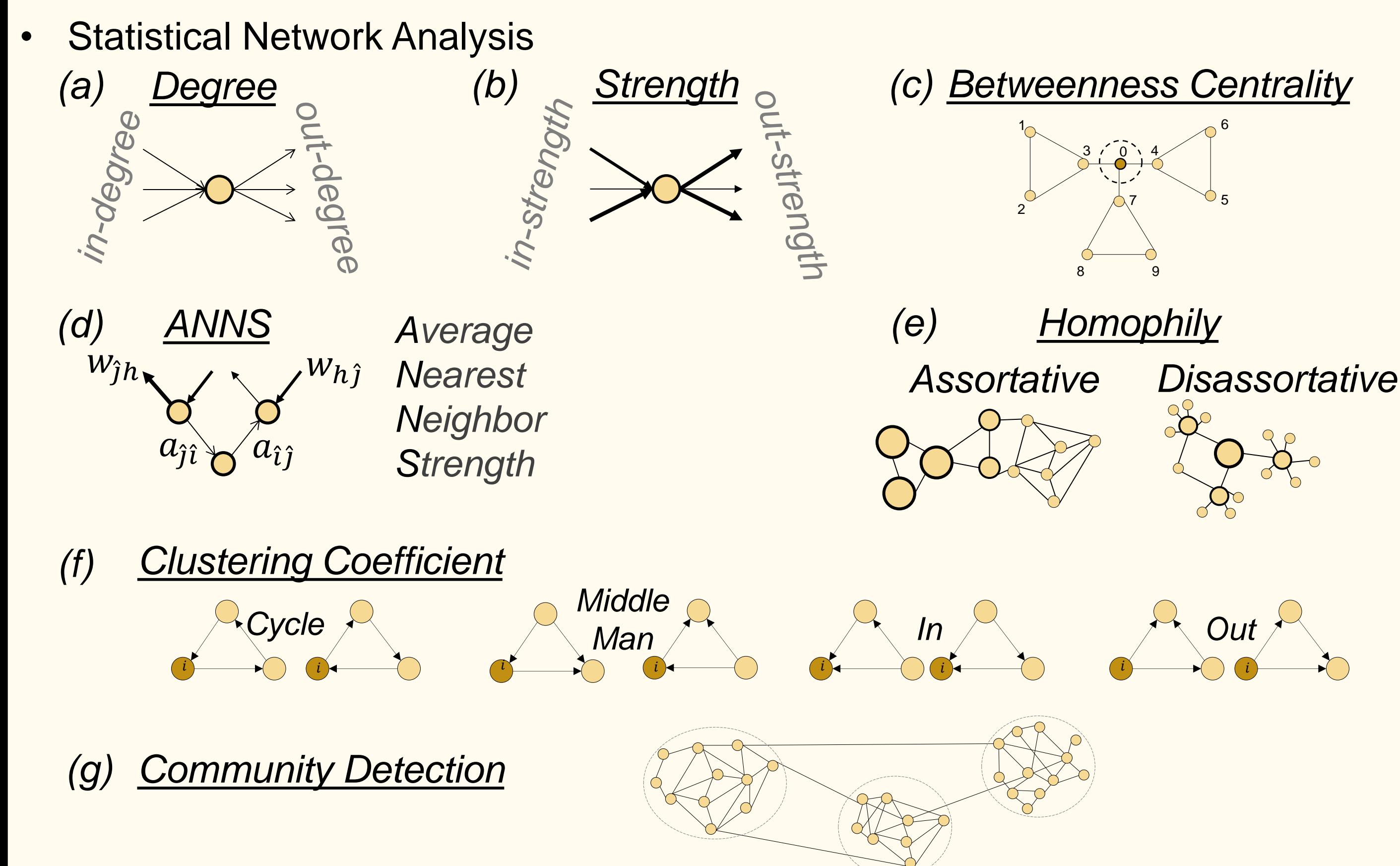


### Maritime Multi-commodity International Trade Network: MM-ITN



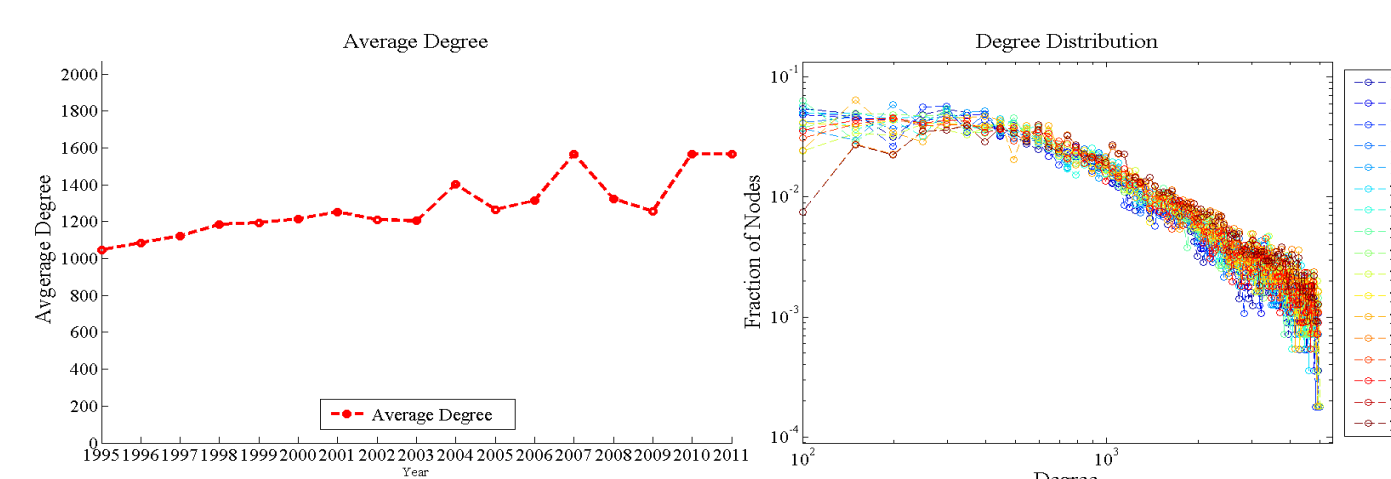
$G(N, A^t)$  MM-ITN in year  $t \in T$   
 $N$  Set of nodes,  $N = \{i = k_c : k \in K, c \in C\}$   
 $A^t$  Set of arcs in year  $t \in T$ ,  $A^t = \{(i, j) : i, j \in N, w_{ij}^t > 0\}$   
 $w_{ij}^t$  Total value exports sector  $k$  from region  $o$  ( $i = r_o \in N$ ) to region  $d$  used by sector  $s$  ( $j = s_d \in N$ ) in year  $t \in T$

## STATISTICAL NETWORK ANALYSIS

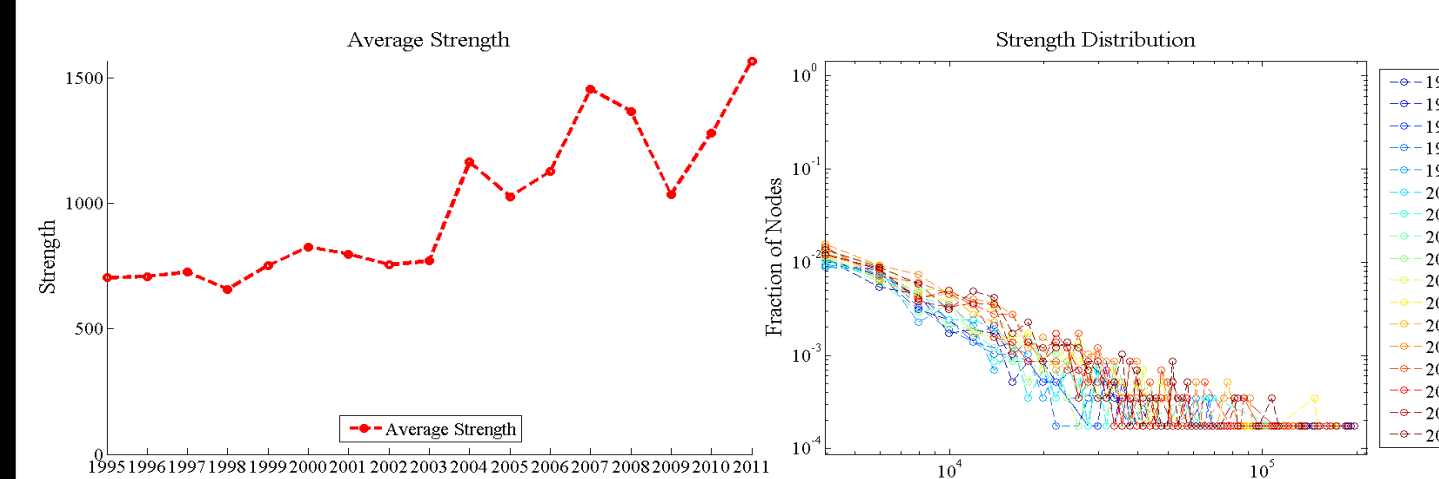


## RESULTS AND DISCUSSION

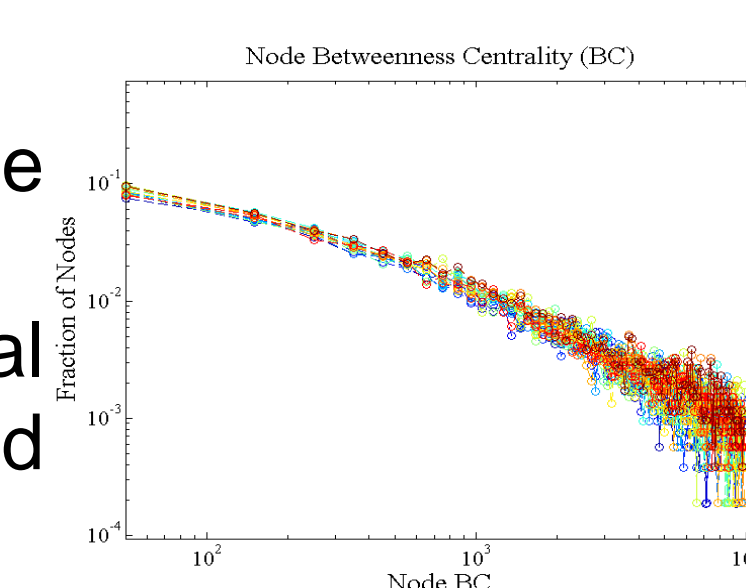
- Degree**  
Sustained expansion (1995-2007) consistent with broadly liberal trade policies leading to global integration. 1997 Asian crisis did not have major global trade repercussions. 2001 crisis has had a small negative effect until 2003 (crisis related to the services side). Minor fall from 2004 to 2005: In 2005, MFA (Multi-Fiber Arrangement) quotas that restricted imports from developing to developed countries were removed. Just before their removal (2000-2005), the developed countries had restrictions in these sectors fearing negative effects on their domestic industry. 2007 degree peak declines until 2009: recession in this period. Two factors summarize the implications of this global crisis: (1) overall reduction in demand, and (2) trade restrictions spread to protect domestic production.



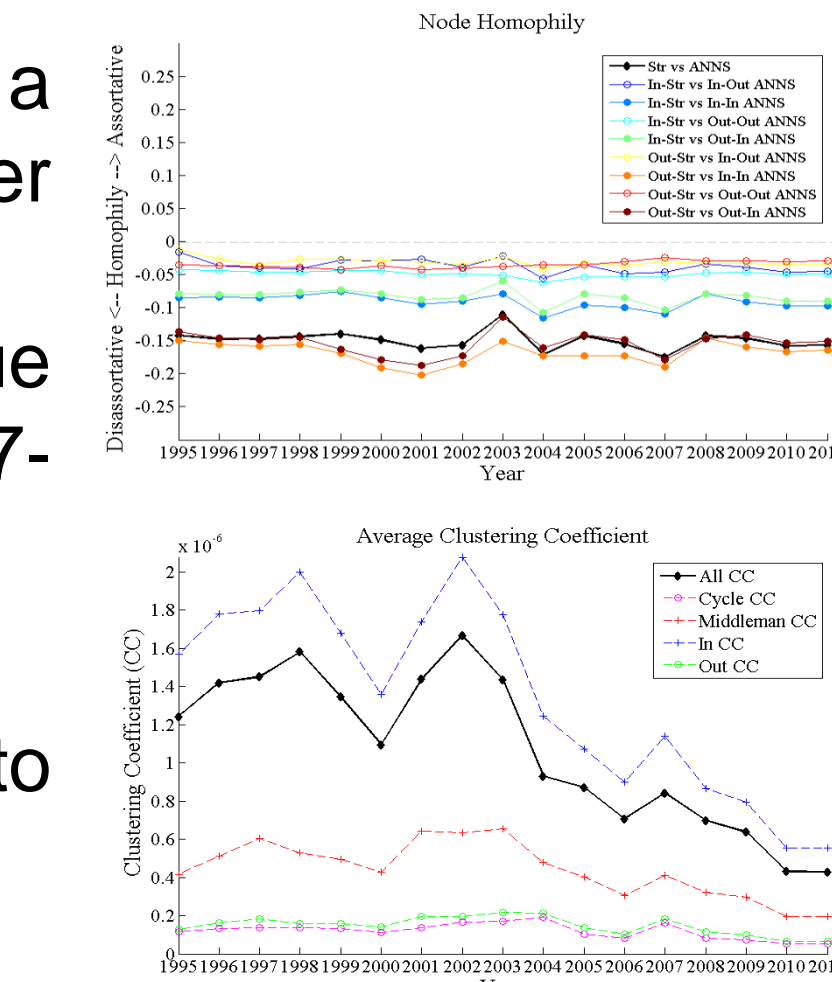
- Strength**  
Clear expansion of maritime global trade that is not masked by inflation (constant prices). The 1997 crisis had a small negative effect on strength. Reductions on average strength continue in 2004-2005 and 2007-2009 as consequence of the crises in these periods (explained before). The increment in the fraction of nodes with low strength in recent years is a sign of maritime-trade diversification.



- Betweenness Centrality**  
GVCs are vulnerable to strategic attacks/disruptions due to the low number of central economic geographies. Recent years show an increase in the fraction of central nodes indicating that the MM-ITN is more decentralized and resilient as compared to earlier years. However, the small fraction of central nodes still makes it susceptible to disruptions. The U.S. and other developed countries lost some centrality during 2007-2009



- ANNS and Homophily**  
Sectors in maritime GVCs tend to connect randomly with a small tendency for high-trade nodes to connect with many other lower-trade nodes (disassortative behavior). There is a prominent decrease of this trend in recent years due to trade restrictions from developed to developing countries (2007-2009 crisis).  
Clustering and Community Detection  
Clustering indicates that close trade blocks have opened to maritime GVCs that are more interrelated and complex.
- Specific Analysis of the MM-ITN**  
USA and Germany (sectors: machinery/equipment, chemicals/rubber/plastics, and motor vehicle parts) have the higher number of import/export partners. Food products are also important for USA. Machinery/equipment and chemicals/rubber/plastics in UK, France, and Italy have high degree. Partnerships increased after the 1997 Asian crisis but the beginning of the dot-com bubble crisis (2000) slows down this behavior. A small recovery is dramatically reduced after 2001. 2005 quotas removal and the big 2007-09 recession significantly impacted their partnerships. These common sectors with high degree have large scope in maritime GVCs.



- Strength unmasks other important sectors. Final demand is the most important, specially in USA, Japan, UK, China, Italy and France. It is also important for Germany although political issues in the 90s give priority to machinery/equipment. USA's final demand dominates trade since mid 90s. Chemicals/rubber/plastics and machinery/equipment are also important for USA and other countries. Electronic equipment is significantly relevant for Japan and China. The enormous increase of China's trade is extraordinary after joining the WTO in 2003. The 1997 Asian crisis have high impacts over these sectors in Asia, especially in Japan. The impact in China is almost unperceivable. 2000 crisis has a significant impact. The recovery starts about 2002 and the entry of China to the WTO does not have negative impacts over the most important countries-sectors. 2007 have significant impacts in trade. The strength of China in recent years is almost equal to the jointed strength of traditional large traders like Japan, UK, and Germany.
- USA is the most central country for GVCs (9 sectors). Manufactures, transport equipment, metal products, and paper products/publishing complement the sectors shown before. However, USA is losing centrality. The same happens with countries like Germany, UK, Italy, France, Russia, and Netherlands. The dot-com bubble crisis has small impacts in 2000. 2003 is more critical, perhaps because China enters the WTO. UK's loss is significant as GVCs move to other geographies with better economic conditions. 2005 quotas removal and 2007-09 recession represented generalized losses of centrality. However this means gains in resilience for GVCs.

- Final demand is the most clustered sector. Specially in Japan, USA, and China. However, such redundant trade reduces over years as maritime GVCs evolve towards an open economy.

## CONCLUSIONS

- Crisis have larger effects in trade value (strength) than connectivity (degree). Centrality is reducing at different economic geographies enhancing global resilience. Maritime GVCs conform a disassortative (hub-spoke) structure, where weaker traders tend to connect to stronger ones. Small clusters opened over time promoting global integration into fewer complex GVCs. Final demand in USA dominates over years with the highest strength. However, final demand in China approaches USA and have replaced Japan, UK, and Germany. USA and other important countries are slowly losing centrality in GVCs.
- Implications:**
  - Policy efforts are needed to strengthen trade from a network perspective.
  - Maritime infrastructures need to evolve accounting for global trade networks
  - Global trade facilitation should be promoted minimizing trade barriers.
  - Final demand from emerging countries gains importance for trade policy and infrastructure improvements (China's example)