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GLOBAL TRADE DYNAMICS AND THEIR EFFECTS ON NATIONAL ECONOMIES

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ABSTRACT

This article aims to analyze the evolution of trading networks, emphasizing aspects of centrality and reciprocity among the major exporting nations, specifically, the U.S., China, India, Japan, and South Korea, from 1992 to 2020. The study problem we address is how these network structures have shifted over time, and what the implications of these changes are for international economic relations and policy. We further consider the impact of major global events on these trade networks and how they have shaped the evolution of these networks. We utilized three distinct methods. First, we examined time-series trade data during the study period and quantified network reciprocity through the sum of squared trade imbalances across different product categories. Second, we visualized these trade networks using arrows, with their sizes being proportional to the trade value between each pair of countries; significant trade relationships were indicated by arrows with a standard deviation value of 55 or above. Finally, we introduced a new cluster analysis methodology for studying the evolution of network structures over time. This method utilized an 80-dimensional vector representation of the annual networks, divided into four categories, and the resulting structures were visualized as dendrograms using R software. The network structure has become more reciprocal for most product categories, and the center of the network has shifted from the U.S. to China for all product categories, except for consumer goods and raw materials. The study also highlights the significant impact of global events and crises such as 9/11 attacks on the international trade network structure. Our findings inform several policy recommendations. These include encouraging balanced trade for economic stability and improved international relations, realigning trade focus in response to the shift in trade network center, and developing resilience policies that account for the substantial impact of global events on trade networks.

Keywords: *Global, National Economies, Dynamics*

INTRODUCTION

The US announced the imposition or increase of import tariffs in a series of statements, both on steel and aluminium against all trading partners (invoked under Section 232 of the Trade Expansion Act), on other products against imports from China (invoked under Section 301 of the Trade Act of 1974), and recently also on motor vehicles. In response, various trading partners have announced tariffs measures against products from the United States. These events could be the start of a series of retaliatory tariff increases between different countries with one possible outcome being a global trade conflict.

In this paper we determine the potential effects of global trade conflict on trade, real income and GDP employing the WTO Global Trade Model, a recursive-dynamic CGE model. The trade conflict scenario is based on estimates of the difference between cooperative and non-cooperative tariffs. Trade conflict refers to the "worst case" scenario where international trade cooperation breaks down and countries set tariffs non-cooperatively. For WTO members, this would mean not honouring their tariff commitments and setting tariffs that will exceed WTO bindings. With our recursivedynamic model we can focus on the projected medium-run effects, taking a reallocation of investment across countries into account. discusses the literature on trade conflicts in a succinct way. briefly describes the employed CGE-model and the construction of the baseline of the global economy. introduces and motivates the trade conflict scenario employed. presents the economic effects of a potential trade conflict.

Globalization and Trade

A radical transformation of economic life is presented with the process of globalization which resulted in the generalization of market economy, increase in production, circulation of information, products, people and capital, implementation of technical systems becomes more efficient. Nations are no longer self-sufficient in the global economy and they are included in trade at different levels to sell what they produce to obtain what they are in need. The countries usually produce more efficiently in some economic sectors than its trade partners.

As supported by conventional economic theory, eventually trade promotes economic efficiency and it can be concluded that the globalization of production is contributing to the globalization of trade. The increase and expansion of the globalisation process were the result of a number of factors. These include the advances in the liberalisation of world trade and capital movements, technological progress that implied a significant decrease in transport and communication and co-ordination costs. The growing openness of developing and emerging market economies with special emphasis on large economies such as China and India and countries of Central and Eastern Europe is also reflected by the acceleration in globalisation process. The strong increases in both activity and international trade flows practiced the developing and emerging economies reflected this phenomenon to global level.

National Economy

A national economy is the production, distribution and trade, consumption of goods and services by different agents of a nation. The national economy in a global context is primarily about macroeconomics. But microeconomic principles do influence the behaviour of the macroeconomy.

The main functions of a national economy are related to the production and consumption of goods and services. A national economy has goals and characteristics that allow it to function properly. However, these may be different from nation to nation. Let’s look at some of these goals and the general characteristics of a national economy.

Goals and Characteristics of a National Economy

Every country wants its economy to be successful. Thus, each nation has different goals that will ensure the success and stability of its national economy. Some goals an economy might have are:

- Efficiency.
- Equity.
- Economic freedom.
- Economic growth.
- Full employment.
- Price stability

OBJECTIVE

1. to study on Global Trade Dynamics
2. to study on Three types of mutuality between two actors

MATERIALS AND METHODS

Suppose there are n actors A1, A2, …, An. When a link from A1 to A2 and a link from A2 to A1 exist, and both links have the same flow quantity, we say the relation between A1 and A2 is perfectly mutual (Fig 1(A)). On the other hand, when the link from A1 to A2 has a large flow quantity and the link from A2 to A1 has a little flow quantity, we say the relation between A1 and A2 has little mutuality (Fig 1(B)).

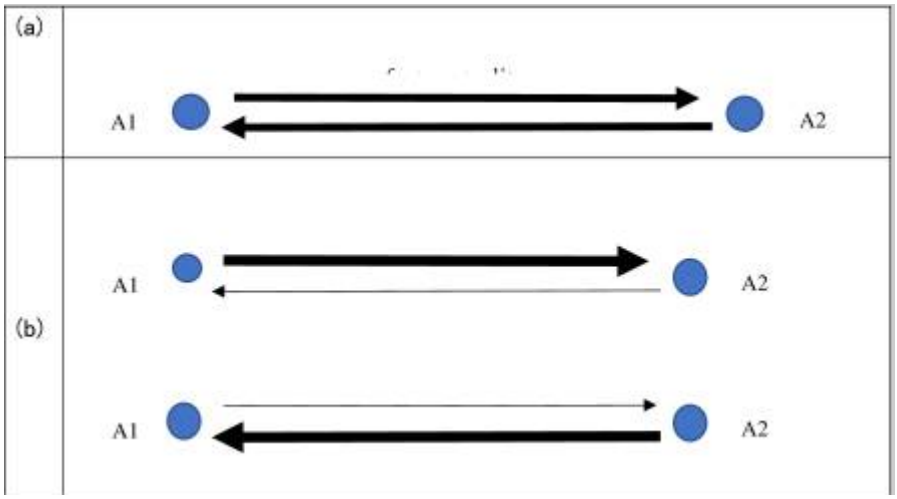

Fig 1 Three types of mutuality between two actors.

We will quantify the strength of the link and let it have positive real number a. Let the flow quantity of the link from A1 to A2 be F(1,2), and from A2 to A1 be F(2,1). Then we quantify the proportion of the flow from Ai to Aj in the total flow of the network as X(i, j, tl) in the following way.

In this subsection, we regard directed links as output flows from actors. We define X(1,2, tl) representing the proportion of output flow from A1 to A2 in the total flow in the network at the time tl in Eq (1).

$$X\left(1,2,t_l\right) = \frac{F(1,2,t_l)}{\mathrm{T}(t_l)} \tag{1}$$

T(tl) is defined in Eq (2)

$$T\left(t_l\right) \equiv \sum_{i=1}^{n} \sum_{k \neq i} F(i,k,t_l) \tag{2}$$

In general, X(i,j,tl) is formulated as below (Eq (3)).

$$X\left(i,j,t_l\right) \equiv \frac{F(i,j,t_l)}{\mathrm{T}(t_l)} \tag{3}$$

In Eq (3), X(i, j, tl) represents the proportion of the flow from Ai to Aj in the total flow of the network at the time t = tl.

$$\sum_{i=1}^{n} \sum_{j \neq i} X(i,j,t_l) = 1 \tag{4}$$

Methods

As previously outlined in Chapter 1: Introduction, the fundamental theory guiding our analysis is as follows:

International Trade Theory: This theory undergirds our analysis of trade dynamics among the U.S. (U), China (C), India (I), Japan (J), and South Korea (K). It aids us in interpreting trade imbalances, shifts in trade dominance, and the impact of political and economic crises on these aspects. The principles of this theory guide our examination of these trade relationships over a 29-year period.

Network Analysis: This methodological approach is integral to our study as it helps us to unravel the complex structure of international trade relationships. Network Analysis, in our context, enables us to visualize and comprehend the complexities of trade networks, shedding light on their centrality and reciprocity. It allows us to identify dominant players and the characteristics of their trade relationships. Furthermore, we use hierarchical clustering as a method of network theory for community detection.

Time-Series Analysis: We employ this analytical method to examine trade data collected at regular intervals. The principles of Time-Series Analysis assist us in identifying underlying trends, cycles, and patterns in the data. This approach is crucial in our investigation of the evolution of the structure of trade networks over time and in assessing the impact of significant events such as political and economic crises.

Crisis Theory: This theory guides our analysis of how political and economic crises disrupt trade flows and reshape the structure of trade networks. It facilitates our understanding of shifts in the centrality and reciprocity of trading partners in response to crises.

In our study, we employed the following three methods:

Analysis of the time series variation in trade balance between partners

The degree of reciprocity within a trade network can be quantified by calculating the sum of squared trade imbalances between each pair of actors. Thus, from Eq (3), for each item, the following value

$$\sum_{i,j} |X(i,j,t_l) - X(j,i,t_l)|^2 \quad \left(i = 1,2,3,4,5; j = 1,2,3,4,5; i \neq j\right) \tag{5}$$

was computed from 1992 to 2020. As this value decreases, the reciprocity within the network increases. We examined the time-series changes in the values of all products, capital goods, consumer goods, intermediate goods, and raw materials, and examined whether the bidirectional relationship has deepened.

Visualization of the time series progression of network structure

Using trade data (X(i, j, tl)) from 1992 to 2020 between five countries, we constructed a network of major directed arrows between the five nodes on a PowerPoint slide. The width of the arrows is proportional to X(i, j, tl). Consequently, 29 networks were created in a time series for the items (all products, capital goods, consumer goods, intermediate goods, and raw materials). Major directed arrows refer to those arrows with a value of 55 or higher in terms of standard deviation value within the set of all directed arrows for each item for each year. Thus, links with a standard deviation of 55 or greater were depicted out of a total of 20 links on the slides.

Hierarchical clustering

Previous studies on cluster analysis have focused on countries in trade networks, whereas the present study innovatively approaches the subject by targeting 29 years, ranging from 1992 to 2020, and grouping years with similar characteristics through cluster analysis. Annually, there are networks for four categories (capital goods, consumer goods, intermediate goods, and raw materials) of items, each containing 20 arrows. Therefore, the initial step involves calculating twenty nine 80-dimensional vectors (4×20 = 80) representing the network structure. A total of 29 vectors, covering the period from 1992 to 2020, were obtained. These vectors were then subjected to hierarchical clustering using the following steps.

Step 1: Distance Matrix Creation: The distance matrix was created by calculating the Euclidean distance between the vectors of each year.

Step 2: Hierarchical Clustering: The hierarchical clustering was performed using the average linkage

method, where each vector starts as a separate cluster, and the closest pairs (years) are merged iteratively, until all vectors are in one cluster.

Step 3: Visualization: The dendrogram, a tree-like diagram, was used to visualize the clusters of

29 vector (years), allowing us to identify the sets of years each set, as a cluster, composed of neighboring years whose distance is measured by the Euclidean distance in step1.

Note that the study employed R software (version 4.0.3) for hierarchical clustering. The results of the study provide insights into the changing dynamics of international trade networks.

ANALYSIS AND RESULTS

Analysis of the time series variation in trade balance between partners

From Fig 2 , the squared sum of trade imbalances for all products shows an overall increase from 0.036 in 1992 to 0.041 in 2020, despite some fluctuations in between. the highest value was recorded in 2015 and 2020 at 0.041. The capital goods category experienced a decrease in the squared sum of trade imbalances from 0.129 in 1992 to 0.060 in 2020. The highest value for this category was 0.143 in 1993, and the lowest value was 0.033 in 2008. Consumer goods saw a decrease in the squared sum of trade imbalances from 0.128 in 1992 to 0.131 in 2020. The highest value was 0.142 in 2007, and the lowest value was 0.072 in 1996. The intermediate goods category experienced a decrease in the squared sum of trade imbalances from 0.008 in 1992 to 0.007 in 2020. The highest value for this category was 0.020 in 2009. Raw materials show an overall decrease in the squared sum of trade imbalances from 0.274 in 1992 to 0.154 in 2020. The highest value for this category was 0.287 in 1993, and the lowest value was 0.080 in 2005.

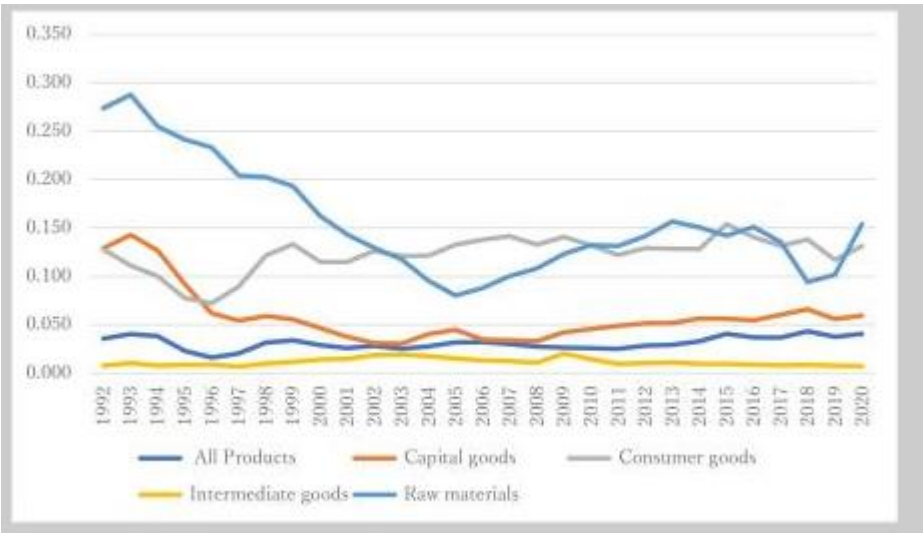

Fig 2 Time series variation in trade between partners.

Regarding the annual rate of change, the all products category experienced the highest positive rate of change in 2015 at 23.3%, while the highest negative rate of change occurred in 1995 at -39.8% (Table 2). The capital goods category saw the highest positive rate of change in 2004 at 32.6%, while the highest negative rate of change occurred in 1996 at -32.9%. The consumer goods category experienced the highest positive rate of change in 2015 at 20.1%, while the highest negative rate of change occurred in 1995 at -22.6%. The intermediate goods category saw the highest positive rate of change in 2009 at 87.9%, while the highest negative rate of change occurred in 1994 at -25.8%. The raw materials category experienced the highest positive rate of change in 2020 at 51.3%, while the highest negative rate of change occurred in 2004 at -18.8%.

In summary, the time-trend analysis indicates that all products have experienced an increase in squared trade imbalances, while capital goods, intermediate consumer goods, and raw materials exhibit a decreasing trend over the period from 1992 to 2020. Consumer goods, however, show a more stable trend throughout the same period. This implies that excluding all products and consumer goods, it can be said that there has been a shift towards a more reciprocal network structure in each product category. Furthermore, while reciprocity is initially high at the all-products level, it does not increase further; instead, it exhibits a slight decreasing trend.

From Table 3, the analysis of trade imbalances between 1992 and 2020 shows varying trends across different categories of products. For all products, there was an overall increase of 14.3% in squared trade imbalances, indicating a growth in trade imbalances during this period. In contrast, the capital goods category experienced a significant decrease in squared trade imbalances, with a rate of change of -53.8%, suggesting a reduction in trade imbalances for capital goods over the period. Intermediate goods also saw a decrease in squared trade imbalances, albeit at a smaller rate of -6.6%. This demonstrates a reduction in trade imbalances in the intermediate goods category during the studied period. However, the consumer goods category displayed a positive rate of change, with an 2.8% increase in squared trade imbalances, indicating a slight growth in trade imbalances for consumer goods over the period. Lastly, the raw materials category followed a trend similar to capital goods, with a significant decrease in squared trade imbalances and a rate of change of -43.7%. This suggests that trade imbalances in raw materials were notably reduced

between 1992 and 2020. In summary, the analysis shows that all products and consumer goods experienced an increase in squared trade imbalances during the period, while capital goods, intermediate goods, and raw materials all exhibited a decrease in trade imbalances from 1992 to 2020. The largest decline concomitant with 9/11 in 2001 was observed in capital goods, followed by raw materials (Fig 2). All products also significantly decreased, ranking third. Consumer goods showed little decrease in linkages compared to the previous year in a wide range of links. However, intermediate goods slightly increased in 2001 (S1–S5 Tables).

Table 3

Rate of change 2020/1992.

All products	14.3%
Capital goods	-53.8%
Consumer goods	2.8%
Intermediate goods	-6.6%
Raw materials	-43.7%

Following the analysis of the time series variation in trade balance between partners, the study observes an overall increase in squared trade imbalances for all products and consumer goods, but a decrease in the squared trade imbalances for capital goods, intermediate goods, and raw materials. This could potentially be due to economic factors such as changes in production capacities and consumption habits of different regions, or shifts in international policies and agreements affecting trade. It also indicates a shift towards a more reciprocal network structure in each product category excluding all products and consumer goods, which may suggest an increasingly interdependent global economy. However, it is important to note that this trend does not necessarily equate to a fairer or more balanced trade system, as the imbalance is initially low at the all-products level, but does not decrease further; instead, it exhibits a slight increasing trend (Table 3).

CONCLUSION

This study elucidates the dynamic landscape of international trade networks by scrutinizing the evolution of trade relationships between major exporting economies—U, C, I, J, and K—from 1992 to 2020. The key conclusions are threefold: First, the network structure has progressively become more balanced for most product categories, as evidenced by diminishing squared trade imbalances for capital goods, intermediate goods, and raw materials, while such imbalances have expanded for all products and consumer goods.

Second, there has been a shift in the network's nucleus from U to C for all product categories excluding consumer goods and raw materials, underscoring C's burgeoning global influence in tandem with its economic growth and industrial expansion. Third, global events and crises, including the 9/11 attacks and the global financial crisis, wield a substantial influence on the international trade network structure. This emphasizes the necessity of factoring in geopolitical events and economic shocks in the analysis of trade dynamics. These findings carry significant implications for international trade policy and economic development. Policymakers need to recognize the evolving nature of trade networks and the influence of global events in molding trade relationships when crafting strategies to stimulate growth and bolster resilience. Businesses should prepare for potential shifts in trade dynamics and adjust their strategies accordingly.

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