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Global Connectivity and Ethnic Fractionalization: New Frontiers of Global Trade Agenda

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ABSTRACT

International trade is an exchange that involves goods and services between countries or international territories, and it signifies a significant share of gross domestic product. Global trading provides opportunities for the country to show its products and services through imports and exports. While this international event gives rise to a world economy, global connectivity and ethnic heterogeneity play a significant role. This paper aims to determine whether the ruggedness of a country supports international trade and global connectivity and whether the ruggedness of ethnic heterogeneity supports global trading. This paper uses the non-experimental quantitative inferential design utilizing Fractal Analysis to determine the self-similarity of countries engaging in international trade in terms of their global connectivity index and ethnic fractionalization. The International Trade data provided by the World Integrated Trade Solutions and the Global Connectivity Index (GCI) data through Huawei Technologies are plotted in a histogram through Minitab Software to determine the fractality and further apply exponential logarithm. Study shows that global connectivity and ethnic fractionalization induce the fractal characteristics of the countries' international trade ruggedness. Specific to the behavior is that countries with very high international trade also behave similarly with high global connectivity and very low ethnicity fractionalization. As countries sustain a progressive economic stance, their societies maintain very few ethnic groups to promote social cohesion, much less conflict created by many ethnic groups that vary in their concerns. This paper further explains

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that only countries with digital economic competitiveness and cultural homogeneity survive robust international trade.

Keywords: Ethnic heterogeneity, fractal analysis, Global Connectivity Index, Gross Domestic Product, global connectivity, globalization, international trade, world economy

INTRODUCTION

International trade is considered the engine of world economic growth. Imports and exports become significantly responsible for much of the development and prosperity of the modern industrialized world and even of developing economies. A country maximizes its goods and services for export when sold at a much higher value and sold domestically. A country contributes its needs economically by importing goods and services locally unavailable or insufficient, cheaper, and better quality than domestic supply. World Bank data show that world exports as a percentage of Gross Domestic Product (GDP) have increased from 12% in 1960 to around 30% in 2015.

Through the years, the importance and impact of international trading have been captured in different concepts like technology, innovation, and knowledge (TIK) (Andersson et al., 2016). Much is written about TIK in an international context. Still, the literature has grown to a point where we have seen numerous papers and articles on global connectivity and ethnic diversity pursuing international trading.

International connectivity measured by GCI is a concept that has been at the core of the worldwide economy evolution and international business growth. GCI is an annual report published by Chinese Technology firm Huawei Technologies Co., Ltd. to analyze each country's broad spectrum of indicators based on information and communications technology (ICT) infrastructure and digital transformation. It is a complete guide for the country's policymakers and industry leaders towards a digital economy agenda. Its core methodology analyzes 40 indicators and four technology enablers–Broadband, Cloud, IoT (Internet of Things), and AI (Artificial Intelligence)–that identify progress made in the interplay of four economic pillars: supply, demand, experience, and potential. These indicators involve the entire chain of ICT development a 360-degree view of the digital economy. As a global trademark for digital transformation assessment, GCI annually ranks 79 nations along with an S-curve graph based on their latest GCI scores (Huawei, 2019). The first report, which was published in 2014, covered 25 nations and ten industries. It expanded to 50 nations with 38 indicators in GCI 2015 Report. From 2018 until the present, the GCI broadened the scope from 50 to 79 nations, exhibiting digital competitiveness in ICT investment, ICT maturity, and digital economic performance. Also, this index which benchmarks 79 countries, accounts for 95% of global GDP when combined. Using the ICT components, the S-curve classifies each country into three different GCI clusters: Frontrunners, Adopters, and Starters. Nations with GDP per capita of

$58,100 and a GCI score of 65-85 are called frontrunners, mainly developed economies that focus on enhancing user experience and prioritizing shifts to investment in big data. Countries with average GDP per capita of US$17,200 and GCI score of 40-64 are clustered as the adopter, who experience the most significant GDP growth from investment in ICT Infrastructure and focus on the growing demand for high-speed connectivity to facilitate digitization. Lastly, those with average GDP per capita of US$3,800 and a GCI score of 23-39 are nations in the early stage of ICT infrastructure build-out, which focus is on expanding connectivity to give their people access to the digital economy.

A specific example of international trading vis-à-vis global connectivity, which features their home country as the study context, is the work of Li (2007), which looks at how a Hong Kong theatre expresses its country's relationship and contribution to globalization. Their performances feature global connectivity using responses to the challenges of internationalization and patriotism. Berman et al. (2020) analyze two forms of innovation connectivity in Italy – 'reaching-out' and 'reaching-in' processes. Findings show that the regional innovation system of Italy is rising rapidly in terms of connectivity due to the reaching-in processes managed by foreign entities. Also, the economy of Australia was historically aligned towards international trade (Sigler & Martinus, 2018). Since the early colonial period in the "Land Down Under," export-led growth has paved the way for raw materials to be shipped overseas. According to Dhawan and Zilio (2014), the world is rapidly getting integrated, and China is at the epicenter of this globalization drive. Their study focuses on Chinese global connectivity and its rapidly changing trade relationships in the past few decades. Another study is Nees' (2005) work, which investigates the tenacity and perseverance of New Zealand's trade in commodities, which accounts for a large portion of their export receipts. The country's export returns and income continues to be sourced from bulk commodities. Further, Alkaabi et al. (2013) discuss the promising features of the aerotropolis model in the United Arab Emirates (UAE) developed by Kasarda (2019) in pursuit of a more conventional urban evolution and global connectivity.

On the other hand, there is a rising study on the effect of economic and cultural globalization on local communities featuring international trading and ethnic fractionalization. As defined by mental health research, ethnic heterogeneity or fractionalization can be observed in two ways: ethnic density, or the proportion of immigrants or ethnic minorities in an area (Budescu & Budescu, 2012); and ethnic diversity, measured by the probability of selecting two individuals of different ethnicities in a locality (Erdem et al., 2017). However, does diversity play a significant feature in prosperity? On the other hand, does the globalization of culture create heterogeneity? A striking example of this study is the work of Van Der Bly (2007), which analyzes the data for Leixlip, the most

vital globalized village in Ireland, being one of the world's most globalized economies. The findings show that globalization of culture generates fractionalization, namely as local adaptations of world cultural forms. Another study is from Thailand (Duanmu & Guney, 2013), which attempts to untangle the heterogeneous effect of ethnic networks on international trade. The paper shows the magnitude of outcomes across different ethnicities and their attributes to economic activities. Also, the study of Hirte et al. (2020) reveals that international trade exasperates economic polarity only in nations with steeper within-country diversity in their access to the world market and their within-country trade costs. This study is further proven by the work of Ahmad and Amin (2020), which investigates whether ethnic or religious diversity affects international trade and environmental performance by using the data of 187 countries. The results indicate that ethnic and religious diversity significantly impacts the country's international trade and environmental performance.

There is some evidence on the detrimental impact of ethnic heterogeneity on global connectivity and economic growth. Wunnava et al. (2015) found out that economic globalization has had a significant positive effect on the growth rate over the period under consideration, and ethnic heterogeneity has taken a considerable toll. Interestingly, once we introduce the interaction term between economic globalization and ethnic fractionalization, the coefficient on the ethnic fractionalization variable is more significant than any of the previous specifications and remains so regardless of whether we use the Alesina et al. (2003) or the Fearon (2003) measures of heterogeneity and whether we include or exclude the non-ethnic dimensions of group difference from our model. They also found out that countries marked by a high degree of ethnic fragmentation have, on average, attained lower growth rates than more homogenous societies. According to the study of Hughes (2012), ethnicity often manifests itself in phenomena such as cultural stereotyping and socio-economic and political discrimination. Ethnic identity is a valuable part of the range of "identities." The critical point is that it belongs to our nature to construct this type of identity, and without it, we are less than we can or ought to be. Globalization is a movement that fosters uniformity. It claims to unite people all over the world. In fact, according to Alesina and La Ferrara (2005), it is somehow easy to point to economic failures of fractionalized societies, but it is not a general phenomenon. Prosperous, democratic nations work well with diversity, like in the United States, which is very well in growth and productivity. Even within the developing world, similar levels of ethnic diversity are associated with very different degrees of conflict and inter-ethnic cooperation.

Studying fractal properties on international trade has also been done by many researchers. One good example is Karpiarz et al. (2014) study, which uses two independent methods, the counting method, and the spatial choice method, to capture

the notion of the globalization puzzle. Thus, the fractality of the international trade system provides a simple solution for that puzzle. Fractal stock markets are also being studied by Bianchi and Frezza (2017), which presents an example of a complex system whose dynamics continuously adapt to the decisions of its components such as banks, governments, traders, and the like. Li et al. (2014) also propose a new agent-based model to study the source of liquidity and the emergent phenomenon in the financial market with fractal structure. Another study is the work of Dyck (2006), which uses fractal planning as a new approach to economic development. Finally, the efficiency or inefficiency of the market during COVID-19 also undergone fractal analysis in the study of Frezza et al. (2020). These suggest a rising interest in fractal analysis for international trade, providing a basis for sustained socio-economic welfare within a nation that encourages collaborative democracy and social learning.

This paper investigates the impact of increasing global integration on economic growth through international trading, emphasizing its interaction with international connectivity and ethnic heterogeneity of 79 countries using Fractal Analysis. This paper investigates further the factors which stimulate trade and environmental performance. From a fractal perspective, this study specifically aims to:

1. determine whether the ruggedness of the countries supports international trade;
2. determine whether the ruggedness of the countries supports the pillars of global connectivity; and
3. determine whether the ruggedness of the ethnic heterogeneity supports international trade.

Framework of the Study

Although goods and services undergo trading to serve critical economic purposes, the trade volume also shows how countries increase dependency on each other and allow other broader implications such as technological connectivity and ethnic heterogeneity. In increasing international trade, the value of digital connectivity becomes essential, and the possibility that diversity changes over time. Figure 1 illustrates the framework of this study.

The figure shows three significant components for fractal analysis: global connectivity, ethnic heterogeneity, and international trading. Global connectivity measured by GCI assesses a nation's digital transformation by looking at four economic pillars: ICT supply, demand, potential, and experience, added with four technology enablers: broadband, Cloud, AI, and IoT. Three clusters of nations, using this methodology, are grouped according to their GDP per capita and GCI position: Frontrunners, Adopters, and Starters.

On the other hand, Ethnic Heterogeneity is measured by 1) ethnic density, defined as the proportion of first- and second-generation immigrants with two foreign-born parents; and 2) ethnic diversity, using the fragmentation index (Johnson-Singh et al., 2018).

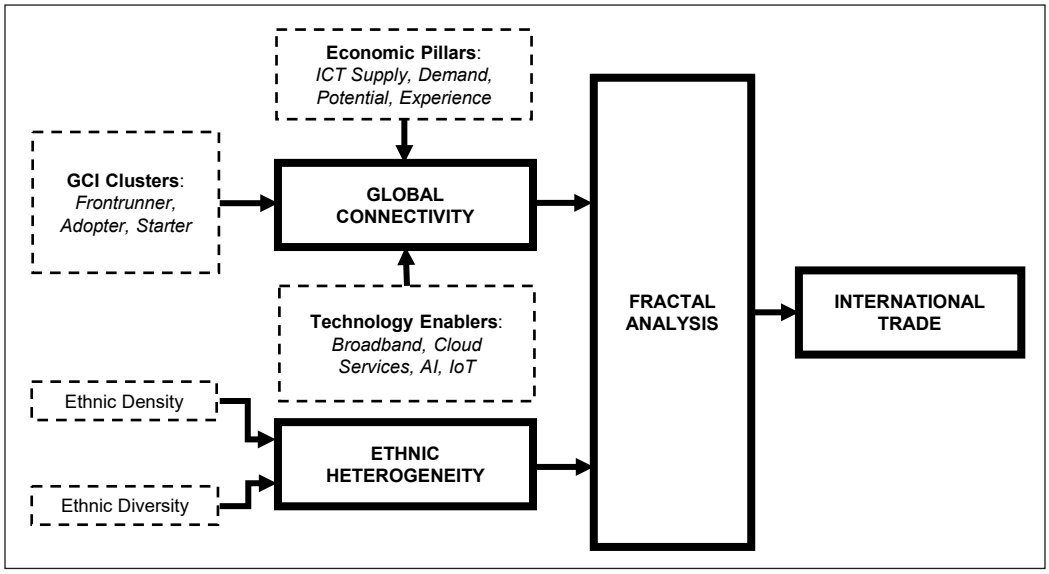

Figure 1. Framework of the study

Global connectivity and ethnic heterogeneity are subjected to Fractal Analysis to determine their ruggedness and support international trading. Thus, in increasing international trade, the value of digital connectivity becomes essential, and the possibility that ethnic diversity changes over time.

METHODS

The research paper employs the non-experimental quantitative inferential design utilizing the Fractal Analysis to determine the self-similarity of countries engaging in international trade, vis-à-vis their global connectivity and ethnic heterogeneity.

International Trading

The data used in the study were extracted from World Integrated Trade Solutions (WITS) TradeStat Database, as shown in Table 1, which displays the International Trade of 79 countries (Bankası, 2019). It provides the latest international merchandise and commercial services trade data and overview of country and region's imports and exports, tariff and non-tariff measures.

The trade data for each nation is divided into four sections. The first section shows a country profile summary that outlines key tariffs, trade indicators, top import and export partners and top exported products. The following section shows trading partners, which outlines the country's leading import or export partners with the trade value and partner share. A final section is a by-product group that provides details of imports and exports of the country by various standard product groups.

WITS permits the user to calculate and illustrate the following trade indicators: country's share of world exports, percentage of product in total exports, the share of the market in total exports, Hirschman

Table 1
Ethnicity fractionalization index, international trade, and global connectivity index of 79 countries

Country	Ethnicity Fractionalization	International Trade	Global Connectivity Index	Country	Ethnicity Fractionalization	International Trade	Global Connectivity Index
Algeria	0.3394	77.08	29	Lithuania	0.3223	52.37	48
Argentina	0.255	113.34	36	Luxembourg	0.5302	31.96	61
Australia	0.0929	379.04	59	Malaysia	0.588	357.79	44
Austria	0.1068	293.22	58	Mexico	0.5418	760.94	38
Bahrain	0.5021	27.64	44	Morocco	0.4841	64.56	30
Bangladesh	0.0454	79.79	23	Namibia	0.6329	11.54	26
Belarus	0.3222	51.15	39	Netherlands	0.1054	803.21	64
Belgium	0.5554	770.74	58	New Zealand	0.3969	70.08	58
Bolivia	0.7396	18.5	22	Nigeria	0.8505	149.41	26
Botswana	0.4102	13.42	27	Norway	0.0586	162.44	61
Brazil	0.5408	322.79	39	Oman	0.4373	47.71	42
Bulgaria	0.4021	54.97	41	Pakistan	0.7098	67.53	22
Canada	0.7124	792.04	57	Paraguay	0.1689	18.25	23
Chile	0.1861	118.68	46	Peru	0.6566	72.23	35
China	0.1538	3685.56	45	Philippines	0.2385	142.22	33
Colombia	0.6014	75.87	38	Poland	0.1183	384.98	43
Croatia	0.369	35.48	42	Portugal	0.0468	123.31	50
Czech Republic	0.3222	301.57	47	Romania	0.3069	138.18	42
Denmark	0.0819	179.49	64	Russia	0.2452	467.75	43
Ecuador	0.655	32.99	29	Saudi Arabia	0.18	365.31	44
Egypt	0.655	80.56	32	Serbia	0.5736	33.7	36
Estonia	0.5062	29.64	49	Singapore	0.3857	612.88	71
Ethiopia	0.7235	20.84	22	Slovakia	0.2539	152.73	45
Finland	0.1315	117.83	66	Slovenia	0.2216	52.16	48
France	0.1032	1049.44	58	South Africa	0.7517	148.85	39
Germany	0.4923	2401.42	59	South Korea	0.0392	901.6	62
Ghana	0.6733	22.02	27	Spain	0.4165	584.32	51
Greece	0.1576	75.41	43	Sweden	0.06	280.34	69
Hungary	0.1522	195.11	47	Switzerland	0.5314	573.85	67
India	0.4182	617.03	31	Tanzania	0.7353	12.62	24
Indonesia	0.7351	280.14	32	Thailand	0.6338	412.9	37
Ireland	0.1206	206.32	59	Turkey	0.32	341.15	38
Italy	0.1145	866.11	46	Uganda	0.9302	7.8	24
Japan	0.0119	1251.85	62	Ukraine	0.4737	75.65	36
Jordan	0.5926	26.72	32	United Arab Emirates	0.6252	569.53	51
Kazakhstan	0.6171	61.95	40	United Kingdom	0.1211	1047.83	64
Kenya	0.8588	21.93	27	United States	0.4901	3698.67	73
Kuwait	0.6604	87.07	44	Uruguay	0.2504	15.1	38
Lebanon	0.1314	23.8	32	Venezuela	0.4966	132.91	32
				Vietnam	0.2383	327.8	31

Herfindahl index, comparative advantage index, trade complementarity index, trade intensity index, export specialization index, export diversification index, index of export market penetration, Hummels-Klenow (products) intensive and extensive margin, and Hummels-Klenow (markets) intensive and extensive margin.

For example, we can now compute the terms of trade (TOT). The TOT refers to the measure of a nation's export prices relative to its import prices. It is calculated by the ratio of export price to import price. Let *Px* be the index of export prices and *Pm* be the index of import prices. Hence, the (barter or commodity) TOT is defined as Px/Pm, as shown in the formula below:

$$TOT = (Px / Pm) \times 100$$

To compute the export and import prices index, we choose the base year and the current period. Suppose, export price index rises to 150 and the import price index rises to 120. Thus, TOT rises to 125.

Global Connectivity Index

The GCI was designed to assess the nation's digital transformation in terms of its economy by looking at several indicators for ICT infrastructure (Huawei, 2020). First published in 2014, it offers a comprehensive guide for policymakers and industry leaders to develop a plan for the digital economy. Over time, the index has adapted its methodology to capture how technology evolves and evaluate the correlation between ICT investment and GDP growth.

The index tracks and benchmarks the progress of 79 economies deploying digital infrastructure and capabilities, looking into core technologies and future growth. The index value is computed in terms of four economic pillars, four technology enablers, and 40 indicators, which are described below:

The Four Economic Pillars. The four economic pillars of the GCI Index are Supply, Demand, Experience, and Potential or popularly known as SDEP. It measures the level of supply of ICT products and services, connectivity demand, experience, and potential for future development of the digital economy.

The Four Technology Enablers. In GCI 2019, notable changes were made when the Data Centers parameter was merged with Cloud and put Big Data under the newly created AI parameter. Although the research methodology expanded in 2019, Huawei integrated the five enabling technologies of "Intelligent Connectivity" into four technology enablers: Broadband, Cloud, IoT, and AI. Aside from the four pillars, the GCI analyzes the technology enablers' crucial role to benchmark the strengths, weaknesses, opportunities, and difficulties facing digital economies. Further, these technology enablers must function on a platform of robust measurements of ICT fundamentals for a nation to transform into a new digital economy. Broadband provides connectivity to feed data and information to AI and carry instructions to IoT and decision-makers. Cloud stores data and

information while providing computing capabilities to run. AI impacts broadband and cloud services by minimizing network congestion and optimizing resources. Finally, IoT creates and collects data to feed AI systems.

The 40 Indicators. The 40 indicators can be analyzed vertically (Supply, Demand, Experience, Potential) and horizontally (Broadband, Cloud, IoT, and AI), as shown in Table 2.

Measurement and Normalization. These variables are measured against GDP PPP (Purchasing Power Parity), the number of households, and the total population. These factors assess the connectivity capability for each country (e.g., app downloads per person or fiber optic penetration against total households). It also gauges nations according to their overall rate of acclimatization with ICT across the economy and entire population.

The data inputs are first computed against a normalizing variable like the country's population size in all instances. Thus, the index can measure nations according to relative levels of connectivity rather than absolute market sizes, which

Table 2
The 40 indicators interplaying with economic pillars and technology enablers

	Supply *It assesses current levels of supply for ICT products and services used for digital transformation.*	**Demand** *It benchmarks demand for connectivity in the context of users and activities relating to digital transformation initiatives.*	**Experience** *It contains variables for analyzing the experience of connectivity for end-users and organizations in today's digital economy.*	**Potential** *It covers a forward-looking set of indicators that point towards the future development of the digital economy.*
Fundamentals	ICT Investment Telecom Investment ICT Laws International Internet Bandwidth Security Software Investment	App Downloads Smartphone Penetration e-Commerce Transactions Computer Households Secure Internet Servers	E-Government Services Telecom Customer Services Internet Participation Broadband Download Speed Cybersecurity Awareness	R&D Expenditure ICT Patents IT Workforce Software Developers ICT Influencing New Business Models
Broadband	Fiber Optic 4G/5G Connections	Fixed Broadband Subscriptions Mobile Broadband Subscriptions	Fixed Broadband Affordability Mobile Broadband Affordability	Broadband Potential Mobile Potential
Cloud	Cloud Investment	Cloud Migration	Cloud Experience	Cloud Potential
IoT	IoT Investment	IoT Installed Base	IoT Analytics	IoT Potential
AI	AI Investment	AI-enabled Robotics/Demand	Data Creation	AI Potential

would be more contemplative of economy size.

Scoring and Aggregation. A country receives a rating of 10 being high and 1 being low for each variable, based on the data input. Each indicator has a scale equivalent based on a realistic target value for 2025 and beyond, with a score of "10," which implies that the target value has been reached.

These target values are deduced from market penetration projections based on the highest-ranked countries, historical market performance, and expert opinions. Its normalized raw data value then computes each nation's score with this scale. Finally, a percentage of the target value is allocated a particular GCI score, as shown in Table 3.

Suppose the average values are significantly lower than the median. In that case, the formula is adjusted to include meaningful differentiation at the lower end of the scale and avoid excessive clustering of countries with equal (low) GCI scores. The final index score is then computed by accumulating the four segments using the formula:

$$GCI\ Total = (Supply + Demand + Experience + Potential) / 4$$

Table 3
Percentage of target value and their corresponding GCI score

Value (% of target value)	GCI Score
1-10%	1
11-20%	2
21-30%	3
31-40%	4
41-50%	5
51-60%	6
61-70%	7
71-80%	8
81-90%	9
91-100%	10

Ethnic Fractionalization Index

Ethnic Heterogeneity, determined by the Ethnic Fractionalization Index, is a nominal measurement of diversity. It is the most commonly employed measure of aggregate ethnic diversity. It is also the probability that two individuals selected randomly from a country will be from different ethnic groups. It pertains to the pattern of ethnic diversity across countries and measures cultural and ethnic heterogeneity, showing how ethnically homogeneous or heterogeneous countries have become over time.

In Fearon's (2003) analysis, ethnic fractionalization is approximated by a measure of similarity between languages, varying from 1, where the population speaks two or more unrelated languages, or 0, where the entire population says the same vocabulary. Alesina et al. (2003) also compiled various measures of ethnic heterogeneity, which try to tackle the fact that the difference amongst groups manifests itself in different ways and different places. Finally, the dataset is calculated based on the degree of ethnic fractionalization using the most universally applied formula in the empirical literature, which is a decreasing transformation of the Herfindahl concentration index measured by:

$$EFc = 1 - \sum Si^2 \; n \; i=1$$

where *EFc* is the level of ethnic fractionalization in country *c*, *i* is the index of ethnic groups, and *Si* is the proportion of the population in unit c belonging to ethnic group *i (i = 1, ..., n).*

All data undergo Fractal Analysis, where they are plotted in a histogram to determine the fractality and further apply exponential logarithm. Finally, the log method presents the exponential data to find self-similarities among countries. Self-similarity is defined when the pieces of an object in space, or parts of a process in time, are smaller versions of the whole object or process (Liebovitch & Shehadeh, 2003; Patac Jr. & Padua, 2015).

RESULTS AND DISCUSSION

On the Ruggedness of the Countries in Terms of their International Trade

Among the 79 countries in the study, the international trade volume ranges in millions of dollars countries with the lowest 20 from 7 to 51; 39 countries with 52 to 379 volume; and the highest 20 with 380 and above. The histogram in Figure 2 shows outliers or countries with international trade volume much higher than other countries.

Table 4 shows the international trade of 79 countries. The World Economic Forum (Desjardins, 2018) describes the international trade behavior of countries on the following merchandise: automobile and car parts; refined and crude petroleum; broadcasting equipment, computers, telephones, and integrated circuits; pharmaceuticals, human or animal blood; gold and diamonds as the top-most traded goods.

Although economies in world trade conferences try to push further global trade liberalization, economic protectionism prevails. Highly developed countries trade most with each other while developing countries also trade most with each other. In particular, the United States has become the second largest export economy globally, and trades most to Canada, Mexico, China, Japan, and Germany; and the top import origins from the same four countries. The United States topped in 8 out of 12

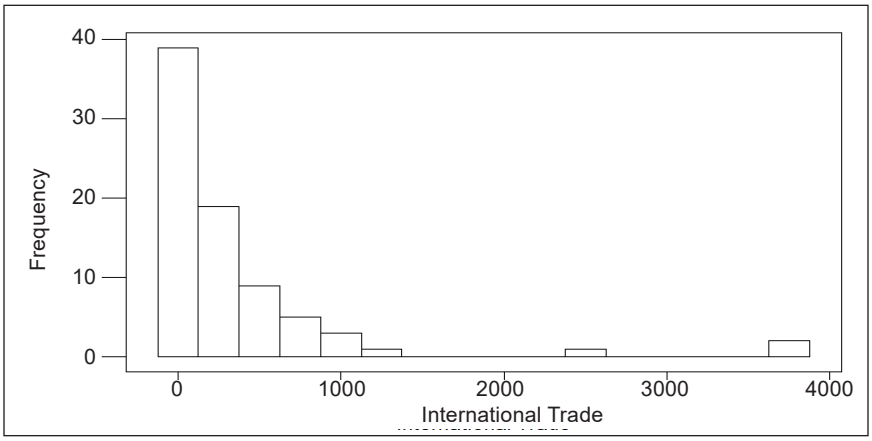

Figure 2. Histogram of 79 countries making international trade with fractal dimension of 1.202

Table 4
The 79 countries and their international trade

Country	International Trade	Country	International Trade	Country	International Trade
Uganda	7.80	Slovenia	52.16	Poland	384.98
Namibia	11.54	Lithuania	52.37	Thailand	412.90
Tanzania	12.62	Bulgaria	54.97	Russia	467.75
Botswana	13.42	Kazakhstan	61.95	United Arab Emirates	569.53
Uruguay	15.10	Morocco	64.56	Switzerland	573.85
Paraguay	18.25	Pakistan	67.53	Spain	584.32
Bolivia	18.50	New Zealand	70.08	Singapore	612.88
Ethiopia	20.84	Peru	72.23	India	617.03
Kenya	21.93	Greece	75.41	Mexico	760.94
Ghana	22.02	Ukraine	75.65	Belgium	770.74
Lebanon	23.80	Colombia	75.87	Canada	792.04
Jordan	26.72	Algeria	77.08	Netherlands	803.21
Bahrain	27.64	Bangladesh	79.79	Italy	866.11
Estonia	29.64	Egypt	80.56	South Korea	901.60
Luxembourg	31.96	Kuwait	87.07	United Kingdom	1047.83
Ecuador	32.99	Argentina	113.34	France	1049.44
Serbia	33.70	Finland	117.83	Japan	1251.85
Croatia	35.48	Chile	118.68	Germany	2401.42
Oman	47.71	Portugal	123.31	China	3685.56
Belarus	51.15	Venezuela	132.91	United States	3698.67
		Romania	138.18		
		Philippines	142.22		
		South Africa	148.85		
		Nigeria	149.41		
		Slovakia	152.73		
		Norway	162.44		
		Denmark	179.49		
		Hungary	195.11		
		Ireland	206.32		
		Indonesia	280.14		
		Sweden	280.34		
		Austria	293.22		
		Czech Republic	301.57		
		Brazil	322.79		
		Vietnam	327.80		
		Turkey	341.15		
		Malaysia	357.79		
		Saudi Arabia	365.31		
		Australia	379.04		

import merchandise traded but transcended 2 out of 12 export merchandise. As imports increase more than exports, the international trade of the United States reaches an imbalance. Such behavior of opening a highly developed economy to more imports may be politically motivated to gain global control than global goodwill. For Germany, almost two-thirds of German merchandise exports (58.1%) went to other European Union, and 65.6% of the German imports from European countries. This international trade behavior underlines the continuing centrality of the European markets for Germany. In the case of China, it is the largest export economy in the world to top export destinations, the United States, Hong Kong, Japan, Germany, and South Korea, and the top import origins from the same four counties.

The international trade behavior of top trading countries demonstrates protectionism and reciprocity. This behavior affects the international trade of developing and least developed countries that trade among themselves because of the tariff issues such as high export barriers on agricultural products and preferential markets of industrialized nations that offer some entrenched interests other than trade.

On the Ruggedness of the Countries to Support the Pillars of Global Connectivity

The fractal dimension of 1.268 for the GCI explains only a little ruggedness, as shown in Figure 3. The countries have very close self-similarities in making themselves connected digitally, although the progress or pace of digital transformation may vary from one country to another.

Of the 79 economies, 56 are already adopters and frontrunners of digital economic technology, and only 23 countries as starters. Also, 17 of these countries are outliers, as shown in Table 5.

The GCI study includes 79 countries that deploy broadband networks and invest in different enabling technologies. The GCI is an authoritative source that informs policymakers and industry leaders on the status of digital transformation in their countries by looking at the four technology enablers that collectively impact the digital

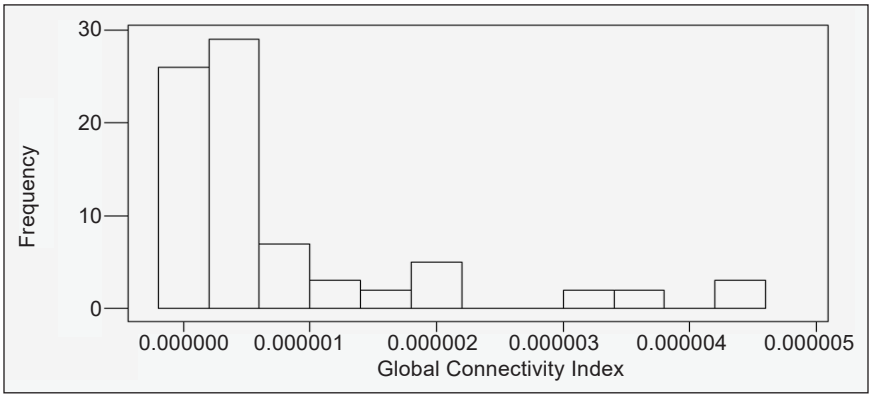

Figure 3. Histogram of GCI of 79 countries making international trade with fractal dimension of 1.268

Table 5
The outlier of 79 countries in terms of GCI

Country	Global Connectivity Index	Global Connectivity Index(1/GCI^4)
Bolivia	22	0.0000043
Ethiopia	22	0.0000043
Pakistan	22	0.0000043
Bangladesh	23	0.0000036
Paraguay	23	0.0000036
Tanzania	24	0.000003
Uganda	24	0.000003
Namibia	26	0.0000022
Nigeria	26	0.0000022
Botswana	27	0.0000019
Ghana	27	0.0000019
Kenya	27	0.0000019
Algeria	29	0.0000014
Ecuador	29	0.0000014
Morocco	30	0.0000012
India	31	0.0000011
Vietnam	31	0.0000011

economy. In addition, the GCI includes other indicators such as workforce, ICT laws, and e-Government services.

Table 6 shows GCI scores and clusters of 79 nations. Countries that belong to the Starter category show similar characteristics. ICT investment of these countries is less than 2% of their GDP; E-commerce is valued at only 5,000 USD per capita in a year, and Internet users are only 40% of the population. Adopters increase their ICT investment due to their GDP to speed up their broadband coverage, render subsidies for smartphones, and many others. Frontrunners are highly developed economies, and they consistently use big data analytics and the IoT to create an intelligent, more productive society. The countries that remained in the top Four (4) with 70 and above GCI for the past three years are United States, Singapore, Sweden, and Switzerland. Interestingly the Philippines scored highest among the "Starter" category of the GCI.

On the Ruggedness of Ethnic Heterogeneity to Support the International Trade

Homogeneity and heterogeneity denote the amount of differing ethnicity among individuals. Finally, the ethnic fractionalization index measures the possibility that two randomly selected individuals belong to the same ethnic group. The higher the ethnic fractionalization, the nation has high ethnic heterogeneity, while the lower the ethnic fractionalization, the country has low ethnic heterogeneity or high ethnic homogeneity. Figure 4 shows

Table 6
GCI of countries by cluster and score

Starters		**Adopters**		**Frontrunners**	
(GCI Score 20-34)		(GCI Score 35-55)		(GCI Score 56-85)	
Philippines	33	Spain	51	Singapore	71
Egypt	32	United Arab Emirates	51	Sweden	69
Indonesia	32	Portugal	50	Switzerland	67
Jordan	32	Estonia	49	Finland	66
Lebanon	32	Lithuania	48	Denmark	64
Venezuela	32	Slovenia	48	Netherlands	64
India	31	Czech Republic	47	United Kingdom	64
Vietnam	31	Hungary	47	Japan	62
Morocco	30	Chile	46	South Korea	62
Algeria	29	Italy	46	Luxembourg	61
Ecuador	29	China	45	Norway	61
Botswana	27	Slovakia	45	Australia	59
Ghana	27	Bahrain	44	Germany	59
Kenya	27	Kuwait	44	Ireland	59
Namibia	26	Malaysia	44	Austria	58
Nigeria	26	Saudi Arabia	44	Belgium	58
Tanzania	24	Greece	43	France	58
Uganda	24	Poland	43	New Zealand	58
Bangladesh	23	Russia	43	Canada	57
Paraguay	23	Croatia	42	**20 "Frontrunner" countries**	
Bolivia	22	Oman	42		
Ethiopia	22	Romania	42		
Pakistan	22	Bulgaria	41		
23 "Starter" countries		Kazakhstan	40		
		Belarus	39		
		Brazil	39		
		South Africa	39		
		Colombia	38		
		Mexico	38		
		Turkey	38		
		Uruguay	38		
		Thailand	37		
		Argentina	36		
		Serbia	36		
		Ukraine	36		
		Peru	35		
		36 "Adopter" countries			

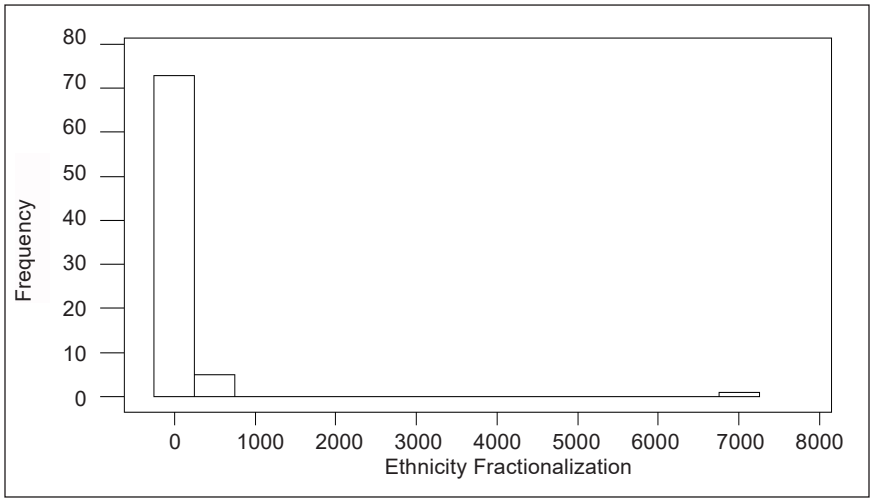

Figure 4. Histogram of ethnicity fractionalization of 79 countries with fractal dimension of 1.3

the histogram of the ethnic fractionalization of 79 countries.

As shown in Table 7, among the 79 countries, 48% of the countries retained their ethnic homogeneity while 52% of the countries experienced ethnic heterogeneity. Thirty-eight countries have low ethnic fractionalization (20% or less), and 41 countries have average to high ethnic fractionalization (above 20%).

Uganda is the most ethnically heterogeneous country in the world, with an ethnic fractionalization index of 0.93. The other top three with the highest ethnic fractionalization are Kenya, Nigeria, and South Africa. Thus, countries with almost complete heterogeneity (index close to 1) are found in Africa.

There are 37 countries, or 47%, that have very low to low ethnicity fractionalization. Thus, these countries are ethnically homogenous. The least ethnically diverse countries are Japan and South Korea in Asia, with an ethnic fractionalization index of 0.0119 and 0.0392, respectively. Thus, these countries have an almost complete ethnic homogeneity (index close to 0). Likewise, most European countries, namely Portugal, Norway, Sweden, Denmark, France, Netherlands, Austria, Italy, Poland, Ireland, United Kingdom, and Finland, are ethnically homogenous.

There are 41 countries or 53% that have average to very high ethnicity fractionalization. Hence, these countries are ethnically heterogeneous. The most ethnically diverse countries are South Africa, Nigeria, Kenya, and Uganda an ethnic fractionalization index of 0.7517 to 0.9302. Thus, these countries have an almost complete ethnic heterogeneity (index close to 1). Also, most Middle Eastern countries, Latin American countries, some countries in Africa have an average to high ethnicity fractionalization index. Table 8 shows the outlier countries making international trade with their fractal dimension.

Table 7
Ethnicity fractionalization index of countries by cluster

Very Low Ethnic Fractionalization		Low Ethnic Fractionalization		Average Ethnic Fractionalization		High Ethnic Fractionalization		Very High Ethnic Fractionalization	
0-0.0194 23 Countries		**0.195-0.0374 14 Countries**		**0.375-0.0554 18 Countries**		**0.555-0.745 19 Countries**		**0.755-1.00 4 Countries**	
Chile	0.1861	Croatia	0.3690	Mexico	0.5418	Bolivia	0.7396	Uganda	0.9302
Saudi Arabia	0.1800	Algeria	0.3394	Brazil	0.5408	Tanzania	0.7353	Kenya	0.8588
Paraguay	0.1689	Lithuania	0.3223	Switzerland	0.5314	Indonesia	0.7351	Nigeria	0.8505
Greece	0.1576	Belarus	0.3222	Luxembourg	0.5302	Ethiopia	0.7235	South Africa	0.7517
China	0.1538	Czech Republic	0.3222	Estonia	0.5062	Canada	0.7124		
Hungary	0.1522	Turkey	0.3200	Bahrain	0.5021	Pakistan	0.7098		
Finland	0.1315	Romania	0.3069	Venezuela	0.4966	Ghana	0.6733		
Lebanon	0.1314	Argentina	0.255	Germany	0.4923	Kuwait	0.6604		
United Kingdom	0.1211	Slovakia	0.2539	United States	0.4901	Peru	0.6566		
Ireland	0.1206	Uruguay	0.2504	Morocco	0.4841	Ecuador	0.655		
Poland	0.1183	Russia	0.2452	Ukraine	0.4737	Egypt	0.655		
Italy	0.1145	Philippines	0.2385	Oman	0.4373	Thailand	0.6338		
Austria	0.1068	Vietnam	0.2383	India	0.4182	Namibia	0.6329		
Netherlands	0.1054	Slovenia	0.2216	Spain	0.4165	United Arab Emirates	0.6252		
France	0.1032			Botswana	0.4102	Kazakhstan	0.6171		
Australia	0.0929			Bulgaria	0.4021	Colombia	0.6014		
Denmark	0.0819			New Zealand	0.3969	Jordan	0.5926		
Sweden	0.0600			Singapore	0.3857	Malaysia	0.588		
Norway	0.0586					Serbia	0.5736		
Portugal	0.0468								
Bangladesh	0.0454								
South Korea	0.0392								
Japan	0.0119								

Table 8
Outlier countries making international trade with their fractal dimension

Country	International Trade	Ethnicity Fractionalization	Global Connectivity Index
United States	3698.67*	0.2383**	73***
China	3685.56	0.1538	45
Japan	1251.85	0.0119	62
France	1049.44	0.1032	58
United Kingdom	1047.83	0.1211	64

CONCLUSIONS

On International Trade, Global Connectivity and Ethnic Fractionalization

Global connectivity and ethnic fractionalization induce the fractal characteristics of the ruggedness of international trade of countries. Specific to the behavior is that countries with very high international trade also behave similarly with high global connectivity and very low ethnicity fractionalization. As countries progress in the same economic stance, they engage in international trading with similar trade policies, reforms, and practices. Moreover, as countries sustain a progressive economic stance, their societies maintain very few ethnic groups to promote social cohesion, much less conflict created by many ethnic groups that vary in their concerns. This progress further explains that only countries with digital economic competitiveness and cultural homogeneity survive robust international trade.

According to the Law of Increasing Returns for ICT infrastructure investment, every additional 1 USD invested could pay off up to 5 USD in GDP growth by 2025. A multiplier effect of an additional US$17.6 trillion in GDP to the global economy is forecast by 2025 for 10% of ICT infrastructure investment each year. Only countries with digital economic competitiveness, such as the forerunners, thrive in international trade. Overall, cutting-edge technologies make trading more efficient, more inclusive, and less costly.

However, the Starters countries need to ensure ICT maturity in Internet Innovation for e-commerce can forge economic improvement. This move can be realized with faster broadband expansion. Broadband, data centers, cloud services, big data, and IoT have become an emerging digital economy landscape. Among the ASEAN partners of the Philippines, Malaysia rose in its GCI ranking the most, increasing by five positions. The Malaysian government consistently increased investment in ICT infrastructure, with emphasis on cloud computing investment and application. By formulating an ICT industry policy, Malaysia provided policy support for cloud services, extensive data analysis, IoT, and other innovative technological applications and infrastructure in the ICT sector. In international trade, Malaysia has

the highest global trade volume and the only economy among the ASEAN nations to attain the Top 23rd in international trade.

For countries with the highest volume of international trade, their ethnic fractionalization indexes are the lowest. Study shows that greater ethnic diversity is associated with weaker economic performance (Alesina et al., 2004; Easterly & Levine, 1997). Montalvo and Reynal-Querol (2005) find a negative effect of measures of ethnic diversity on economic growth. When there is less cultural diversity, the more cohesive a society remains. Strong social cohesion creates a strong sense of commonality and belonging for all regardless of different backgrounds. Strong social cohesion also facilitates group conflict resolution and policy formulation. A high ethnic fractionalization indicating cultural heterogeneity becomes socially divisive and alienates one ethnic group from another—social divide cascades to other social-political institutions and their economic functions.

On International Trade and Global Connectivity

International trading and technological advancements have made world economies more inter-connected. To enable policymakers to tap into the $23 trillion value of the global digital economy, GCI 2018 includes AI Readiness Index, based on three significant components: data, algorithms, and computing power. The scarcity of AI developer talent will become a big challenge for all nations in the three GCI clusters.

AI will be at the forefront in preparing for the digital economy and reaching $23 trillion by 2025. Frontrunner like Ireland has been investing in AI considerably, thus gaining a competitive edge in the digital economy. At year-end 2017, Ireland had 66 companies working on AI, employing 2,500 people and taking advantage of its growing computing power, thus leading the way to becoming the EU's AI Hub. Another Frontrunner, the UK, has been deploying ICT infrastructure significantly in recent years and has focused on becoming a global leader in 5G.

Literature indicates that by 2025, there will be 100 billion connections from intelligent sensors producing 175 zettabytes of data per year. Most enterprises leverage connectivity to streamline their business processes, reduce costs, improve efficiency as they technological innovation, and move the focus from a consumer-driven internet to an industrial one.

Countries with low ethnic fractionalizations demonstrate cultural homogeneity than heterogeneity. Cultural homogeneity looks upon as "Closed" societies and as a "closed system." Social protectionism is demonstrated in trade protectionism as highly developed countries trade with each other. Countries with high ethnicity fractionalization look upon cultural heterogeneity that divides societies and restrains economic progress.

RECOMMENDATIONS

For countries to advance the global connectivity to sustain or increase their

international trade will need to pursue investments in adopting the five (5) technologies that will disrupt the future of global trading. First, blockchain and blockchain-based distributed ledger technologies can significantly impact the global trade supply chain. Second, AI and Machine Learning can improve trade shipping courses, manage traffic at ports, and many others. Third, trading services via digital platforms make it increasingly more accessible and faster to trade services online. Fourth, high-speed 3D printing on world trade is mass-adopted since it requires less labor and lessens the need for imports. Fifth, mobile payments must be embraced to allow market opportunities and facilities for e-payments. Finally, mobile money accounts are now a prime factor for financial inclusion or deepening, especially in emerging market economies.

For countries with trade protectionism but low global connectivity, this is usually observed among developing nations trading only. This action is the "Matthew Effect" phenomenon that explains how this trading behavior makes developing countries poorer. It is alarming when poor economies have little progress in digitization. Poverty will continue to threaten international trade. Armed conflict, armed piracy, and terrorism will continue and may worsen as different ethnic groups fight for rivalry and survival. Perhaps, this could be the new frontier in the global trade agenda.

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