© *Pakistan Journal of Economic Studies*
https://journals.iub.edu.pk/index.php/pjes
Vol. 4, No. 1, June 2021, Pages: 63-98

ISSN 2708-1486 (E)
ISSN 2708-1478 (P)

Trade Openness, Innovation, and Economic Growth: A causal Effect Analysis of OECD and Non- OECD Countries

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Abstract

The purpose of this paper is to examine the causal relationship between a country's economic growth and its trade openness, innovation, and technological advancement. We discover evidence that public policies that promote increased trade openness have a significant impact on a country's level of innovation. The positive correlation between openness to trade and innovation is significantly stronger in developing countries. We dissect the causal relationship between economic growth and trade precisely by applying for new advances in the econometric method for heterogeneous panel data to 127 OECD non-OECD countries which has been the part of Global Innovation index, divided into developed and emerging economies. We examine Granger causality using a test for heterogeneous board knowledge. The findings contradict the hypothesis that trade openness and economic growth have a general, unidirectional, and even homogeneous relationship in developing countries and the OECD, but not in developed countries. Opening the economy to international trade more for developing countries is a natural route to stimulate innovation in business.

Key Words: OECD, Public policy, trade openness, innovation. Economic growth, Panel VAR
JEL Codes: O57, F14, O47, O31, C23

1 Introduction

It is widely accepted that nations benefit from innovation. We take a broad view of innovation, which we define as the

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effective application of clever ideas. Thus, innovation encompasses the generation of novel ideas and their appropriation (Duggan, 1996). Additionally, nations with a higher level of creativity have a higher per capita income (Cheung, 2014). To be completely candid, the Global Innovation Index and per capita income have a correlation of between 0.7 and 0.8. However, it is unknown how a nation can foster organizational development. The optimal combination of public policies for attaining a higher level of development remains a point of contention.

For a long time, the connection between trade openness and innovation was easily refuted in general exchange writing. Numerous nations have opened their economies in the hope of achieving financial success and innovation. Over the last several years, annual growth in world exchange has averaged at the midpoint of the level of 6. This is near twice the rate of innovation on the planet. When the General Agreement on Tariffs and Trade (GATT) was ratified in 1947, it benefited all members of the world trading framework from the eight rounds of multilateral trade progress.

This investigation focuses on a macroeconomic policy: trade openness. Trade openness is a term that refers to a country's outward (versus inward) movement. An outward-oriented market economy (open) maximizes trade opportunities with other nations. However, an internally organized (closed) heading disregards or is incapable of utilizing other nations' freedoms of exchange. Reduced trade barriers, tariffs on imports and exports, infrastructure investment, and restrictive market-competitiveness regulations are all examples of public policy decisions that affect trade openness.

Economic research on the relationship between innovation, financial development, trade openness, and economic growth has exploded in recent years. Financial development, innovation, and trade liberalization have all been identified as critical variables for achieving manageable economic growth. (Kim, 2011; Levine, 1997; Pradhan et al., 2018; Rajan & Zingales, 1998; Romer, 1986). A few creators contend that financial development and trade openness cultivate innovation (Hsu et al.,

2014; L. Rivera-Batiz & Romer, 1991). A few ongoing types of research have likewise analyzed the connection between trade openness and financial development events (Do & Levchenko, 2004; Kim et al., 2010).

(Dotta & Munyo, 2019) investigates the public policy on macro level by using the trade openness and innovation as main factors having the geographical proximity index as instrumental variable to control the reverse causality among the factors. And find the relationship among the factors by utilizing the data from OECD countries which are developed and emerging nations.

This study based on main three indicators, Trade openness, innovation, and economic growth, the literature and theoretical background of this indicators has been discussed literature section . The main focus in this study is on the long term and causal effects these factors on the basis on first, second and third world countries comparatively.

1.1 Research Question and Background

Numerous economic researchers believe that trade openness is a critical factor in economic growth. Observatory The empirical studies (Chang et al., 2009; Chen, 1999; Soltani et al., 2013; Tavares & Wacziarg, 2001), and theoretical models have demonstrated that trade openness has a positive and significant effect on economic development. Additionally, endogenous models shed light on the impact of openness on growth, which may be beneficial. (Grossman & Helpman, 1990; L. Rivera-Batiz & P. Romer, 1991; Young, 1991) Trade openness has benefited development and economic growth, which has occurred as a result of increased competition and technological advancement. (Grossman & Helpman, 1990). (Loewy & Ben-David, 1998, 2000, 2003) models extend the neoclassical model by incorporating open economy endogenous development features. According to them, trade advancement accelerates the accumulation of information, which results in economic development. In a nutshell, these models conclude that trade openness benefits all nations.

In terms of foreign trade income, developing countries benefited more from trade progression with developed countries;

they gained access to high-tech products and intermediate goods through imports. (Sakellaris & Spilimbergo, 2000). Whatever the case, the conflict arises when the findings of observational studies demonstrate a lack of connection between openness and growth. (Sarkar, 2007). It exists just in middle-income nations (Sarkar, 2007) and exists in the long run; in the short run, this relationship doesn't exist (Sakyi et al., 2012). Additionally, the effect of free trade on GDP growth and technological advancement varies between developed and developing countries (Young, 1991). Each investigation has its own significant findings that are unquestionably true.

The purpose of this study is to determine the causal relationship between trade openness, innovation, and growth. Trade liberalization is viewed as a critical development tool in both developing and developed countries. (Dar & Amirkhalkhali, 2003). Increased openness is widely accepted to significantly affect productivity, which results in increased employment and real wages as a result of new ventures (Krueger, 1985). Causality may run from economic growth to openness as well. Foreign direct investment, imports, exports, and competition are the primary channels through which trade openness policies influence innovation in nations.

Previously the literature does not focus on the causality and the impact of developing nation's pattern on overall world economy. Causal effect among these parameters can play a quite important role to understand whether for innovation, for economic growth which is necessary, FDI, or the development of domestic markets and products. The basic object of this study is enhanced to catch the real time causality among the factors which are associated with the public policy not just depends on trade openness but also on economic growth. Having panel data, VAR model and finding long term causality is important endogenously. This econometric technique allows to investigate the causal influence logarithm of time on corresponding variables. Which helps to find the unidirectional or bidirectional causality among the trade openness, innovation, and the economic growth at macro level of respective categories.

Secondly, from the sample of 127 Countries, the number of emerging nations is greater than the developed nations, so by estimating all countries in one model gives us bias results toward emerging nations, here to do the compatible analysis, in this study the estimation has been done with respect to developed and developing nations. Because the domestic pattern is different from the world trade pattern, this study allows the policy maker to identify the methods to increase the positive effect of innovation for emerging economies which has huge impact on the world innovation and trade policy pattern.

2 Literature Review

There is some empirical evidence about the relationship or causality among trade openness, innovation, and economic growth from the recent previous literature. Some will be discussed here to second my empirical results.

The topic granger causality has been used by many economist in different ways to determine the causal effect of innovation , trade on different factors of economy, like FDI, economic growth, innovation etc. Yonghua & Yongsheng (2011) investigates the hypothetical effects of innovation advancement on global trade and global trade advancement on innovation advancement, and establishes the precise relationship between China's foreign trade and innovation advancement using China's economic data. The findings indicate that China's fare and import exchanges have accelerated China's innovation growth, while China's foreign trade has had an impact on innovation overflow. Then, as R&D costs and licenses rise, China's export and import trade grow, owing to the increased participation of Chinese goods in global trade as a result of China's innovation improvement. (Seyoum et al., 2013) In Sub-Saharan economies, empirical evidence demonstrates a bidirectional causal relationship between trade openness and FDI. Continually promoting intra-African trade and establishing a continental free-trade zone are unquestionably the right direction to take. Johnson & Van Wagoner (2014) justification for your inquiry keeper of the barn. The causality between trading and innovation, which supports the literary premise that imports result in progress, which results in

trade, is disrupted more at the industry level by the causality from and to development in the two headings. (Roquez & Escot, 2018) By examining the causal relationship between economic growth and international trade using heterogeneous panel data for Latin American countries, this article argues that the findings refute the theory of a general, unidirectional, and homogeneous relationship between trade openness and financial development in Latin American nations as a group.

Amidi & Majidi (2020) The relationship between trade and growth is explained using spatial econometrics, which takes the instrument vector's geographical proximity into account. He explained that the behavior of a country's neighbors and trading partners has a significant impact on its financial growth. This finding implies that the spillover effects of a country's geological position and trading partners play an important role in determining economic growth. Indeed, omitting these variables can result in model misspecification.

Additionally, the findings confirmed that, while the rate of workforce growth is detrimental to financial development, the distribution of gross fixed capital is significantly beneficial (Aldieri, 2011; Robst et al., 2007). The effects of distance, trade, international conflicts, and cooperation have been discussed. The impact on trade depends on geographical distance and geographic distance. The effect of trade differs. Trade is decreased if dyads are closer, but if nations are farther away, they will significantly impact. The geographical area expands the fight between the non-exchange dyads and the participation. Yegana (2020) argues that there is a causality impact between GDP development and export. However, there is not substantial causality impact between FTO, FTF and economic growth.

Belazreg & Mtar (2020) By modelling the causal relationship between trade openness, innovation, financial development, and economic growth in OECD countries, he establishes an unbiased link between trade openness and innovation, development and financial development of events, and innovation and trade. Additionally, a one-way relationship was identified between financial development and financial development of events, as well as a one-way relationship between

financial development of events and trade. Finally, our findings suggest that economic growth and trade mutually reinforce one another.

Here another question arises that Does trade cause growth or not? It has been answered by Frankel & Romer (1999), and he clarifies that analyzing the relationship between trade and income does not reveal the causal relationship between the two. However, nations' geographic characteristics significantly impact trade and may be unrelated to other income determinants. The findings do not support the notion that standard least-squares models exaggerate the effects of trade. Additionally, they argue that trade has a quantitatively massive and robust impact on income, if not a truly massive effect.

Maritime trade is a historic and oldest way of trade, which has been updated with the passage of time. After different projects like CPEC, OBOR, the transaction cost on maritime has been decreased. And it also affects the growth of a country. After investigation, this scenario (Osadume & Uzoma, 2020) To summarize, while most researchers believe that opening up marine trade will transform an economy into a developed one, some disagree. Nonetheless, the study concludes that marine trade contributes to economic growth in a bidirectional causal relationship and that there is critical cohesion between them; and recommends, among other things, the establishment of a favorable climate and modest public financing to facilitate the development of marine trade.

Idris et al. (2016) argues for a causal relationship between trade openness and the growth rates of the OECD and developing countries. Using the GMM panel method, the author concludes that a bidirectional causal relationship exists between developing and OECD countries. The findings support the endogenous hypothesis that increased transparency promotes development, which in turn fosters receptiveness.

There are different types of causality in econometrics, and the basic two types are linear and non-linear causality among indicators. And this has been used by Kar et al. (2013) for Turkey's trade liberalization, economic growth, and financial development.

He argued that both linear and non-linear causality approaches demonstrate (i) bidirectional causality between economic development and trade liberalization, (ii) financial development causes Financial Growth of events, and (iii) financial development prompts trade liberalization. As a result, both linear and non-linear methodologies establish strong causal relationships between monetary events, exchange receptiveness, and financial development. As For Muslim-majority countries, and with religion serving as the primary instrument (Muhammad, 2016), The result demonstrates that the Pedroni Cointegration test established a long-standing relationship between factors by utilizing two distinct methods.

Nonetheless, the Kao Cointegration test does not detect this long-standing run relationship. The RE and FE models have established that receptiveness is critical for development. Additionally, unfamiliar direct speculation, population growth, and human resource availability all impact development in Muslim countries.

The trade openness variable is the combination of imports and exports. To understand the link between imports and economic growth having the frequency domain. Aluko & Olufemi (2020) examines it for 41 African countries and concludes that (i) unidirectional causality exists between imports and economic development in seven countries in the short run and five in the long run, (ii) unidirectional causality exists between economic development and imports in four countries in the short run and ten in the long run, and (iii) bidirectional causality exists in only a small number of countries. Our findings indicate that the absence of bias theory is, on average, significant in the short and long run.

Previously, the literature did not place a premium on the causality and long run impact of developing nation's patterns on the global economy as a whole. The causal relationship between these criteria can be highly significant in determining whether for innovation, necessary economic growth, FDI, or the development of native markets and products.

3 Data and Econometric Modeling

The variables which have been included in this study according to the theoretical background are as follow: The data for these variables has been chosen from 2009 to 2020 for 127 OECD and non-OECD countries. The TO is calculated as Exports Plus Imports, and the trade openness proportion (TO) is empirically calculated as Nominal Exports multiplied by Nominal Imports and divided by Nominal GDP. This Ratio is frequently used in works of literature. The other trade indicator is genuine openness (RO). RO is calculated as the sum of imports and exports in US dollars in relation to Gross Domestic Product (GDP) in US dollar Purchasing Power Parity (PPP) terms (real GDP). By using RO rather than Nominal Openness, we can eliminate distortions caused by the total cost of non-tradable products in cross-country comparisons.

For the economic growth for a country, I choose the GDP growth rate on annual basis. The Global Innovation index (GII) a variable which has been used to measure the total innovation for a nation having two sub- indexes, input sub-index (ISI) which make it possible to take it, and output sub-index(OSI) which tells the final output of innovation.

There are some instrumental variables, The geographical proximity variable has been taken from (Frankel & Romer, 1999) and it contains information about the distance between countries, their size, whether they have direct access to the ocean, and whether they have land borders. The variable population and the area of country is also taken from World bank (WDI). All these variables are critical for establishing a causal relationship between innovation and trade openness. The key sub-factors are output sub-index and input subindex for innovation, and for trade, exports, and imports are the main indicators.

The following sections comprise the paper: By using The OLS method, The first relationship between innovation, growth, and openness has been described based on a review of the relevant literature. Following the data sources, the following section describes the Econometric Causality modelling. The concluding

sections demonstrate and discuss the estimation results and conclusion, along with their policy implications.

To examine the relationship between advancement and public policies that promote trade transparency, we hypothesis that there is a direct linear relationship between innovation (Ii) and trade openness (TOi) for each country i:

$$I_i = \beta_0 + \beta_1 TO_i + \varepsilon_i \quad (1)$$

If we gauge the estimation of boundary utilizing conventional least squares, we get the first guess of the impact of global exchange on advancement. In any case, we were unable to distinguish this as a causal impact. In addition to the fact that innovation is controlled in terms of professional career transparency, the level of exchange receptiveness is dictated by more noteworthy degrees of advancement.

Assume, as illustrated in the instrument model, that a linear relationship exists between trade openness and geographic proximity:

$$TO_i = \alpha_0 + \lambda GPI_i + \mu_i \quad (2)$$

By combining equation 1 and 2 We get

$$I_i = \beta_0 + \alpha_0\beta_1 + \beta_1\lambda GPI_i + \beta_1\mu_i + \varepsilon_i \quad (3)$$

By Solving equation 3 more, we got the model for each country.

$$I_i = \tilde{\beta}_0 + \tilde{\beta}_1\lambda GPI_i + \tilde{\varepsilon}_i \quad (4)$$

The fundamental OLS model is used to determine the effect of trade openness, population, and growth on innovation; we obtain the coefficient of result from equation 4 model.

$$I_i = \alpha_0 + \alpha_1 TO_i + \alpha_2 lnPOP_i + \alpha_3 lnArea_i + \alpha_4 GDPG_i + \omega_i \quad (5)$$

As we know that Geographical proximity are correlated to the size of country, then in equation 5 we use the area and population of countries as controlled variables in order to elaborate the pure effect of trade, which is different to different countries, and that is fact that larger countries has less openness

due to diversion towards their domestic markets (Frankel & Romer, 1999).

This study explores the correlation between carbon dioxide secretion and vital financial indexes. Pakistan's economic growth, foreign direct investment, trade openness, domestic investment, and labor. The data is based on the period from 1972 to 2019. We use a fully modified OLS cointegration technique. Explore long-term relationships.

The functional form of model is following:

$$\mathrm{GDPG_t} = \mathrm{f}(\mathrm{CO_{2,t}}, \mathrm{FDI_t}, \mathrm{TO_t}, \mathrm{LF_t}, \mathrm{DI_t}) \quad (6)$$

After introducing interaction terms, the function form is following:

$$\mathrm{GDPG_t} = \mathrm{f}(\mathrm{CO_{2,t}}, \mathrm{FDI_t}, \mathrm{TO_t}, \mathrm{LF_t}, \mathrm{DI_t}, \mathrm{CO_{2,t}} * \mathrm{FDI_t}, \mathrm{CO_{2,t}} * \mathrm{TO_t}) \quad (7)$$

It can be written in econometrics form,

$$\mathrm{GDPG_t} = \beta_0 + \beta_1 \mathrm{CO_{2,t}} + \beta_2 \mathrm{FDI_t} + \beta_3 \mathrm{TO_t} + \beta_4 \mathrm{LF_t} + \beta_5 \mathrm{DI_t} + \beta_6 \mathrm{CO_{2,t}} * \mathrm{FDI_t} + \beta_7 \mathrm{CO_{2,t}} * \mathrm{TO_t} + \varepsilon_t \quad (8)$$

Where, GDPG is per capita gross domestic product (constant US$). The CO2 emission is Carbon dioxide emission (metric tons per capita). The FDI is foreign direct investment, net inflows (constant US$). The TO is trade openness (constant US$). The DI is domestic investment (constant US$). The LF is labor force (total). The ε_t is error term.

3.1 VAR model:

Numerous investigations on the connection between innovation and global exchange additionally contain the impacts of innovative worldwide exchange. Coe & Helpman (1995) and Coe et al. (1997) investigated the manners in which how the global exchange advanced mechanical advancement.

We use a panel vector autoregressive model PVAR to examine the relationships between trade, innovation, and growth in 127 OECD countries. Following that, we look at the causal

relationship between these variables to ascertain whether they have a unidirectional or bidirectional causal relationship with one another. Additionally, we examine cointegration to determine its long-run effectiveness.

Technology is endogenously determined in our model via innovation, economic growth, and trade openness. The following are the reduced form equations for the generalized VAR model:

$$GII_{it} = \Phi + \sum_{K=1}^{P} \Phi_{1k}\, GII_{it-k} + \sum_{K=1}^{P} \Phi_{2k}\, GDPG_{it-k} + \sum_{K=1}^{P} \Phi_{3k}\, TO_{it-k} + \sum_{K=1}^{P} \Phi_{4k}\, lnPOP_{it-k} + \varepsilon_{it} \quad (9)$$

In Equation 9 GII_{it} is the global innovation index depends on its lags, the lag of GDP growth ($GDPG_{it-k}$), Trade openness (TO_{it-k}) and a controlled variable the population of the countries ($lnPOP_{it-k}$).In VAR model, all factors are taking as the exogenous variables, so the models for other factors are in equations 10, 11and 12:

$$GDPG_{it} = \Phi + \sum_{K=1}^{P} \Phi_{1k}\, GDPG_{it-k} + \sum_{K=1}^{P} \Phi_{2k}\, GII_{it-k} + \sum_{K=1}^{P} \Phi_{3k}\, TO_{it-k} + \sum_{K=1}^{P} \Phi_{4k}\, lnPOP_{it-k} + \varepsilon_{it} \quad (10)$$

$$TO_{it} = \Phi + \sum_{K=1}^{P} \Phi_{1k}\, TO_{it-k} + \sum_{K=1}^{P} \Phi_{2k}\, GII_{it-k} + \sum_{K=1}^{P} \Phi_{3k}\, GDPG_{it-k} + \sum_{K=1}^{P} \Phi_{4k}\, lnPOP_{it-k} + \varepsilon_{it} \quad (11)$$

$$lnPOP_{it} = \Phi + \sum_{K=1}^{P} \Phi_{1k}\, lnPOP_{it-k} + \sum_{K=1}^{P} \Phi_{2k}\, GII_{it-k} + \sum_{K=1}^{P} \Phi_{3k}\, GDPG_{it-k} + \sum_{K=1}^{P} \Phi_{4k}\, TO_{it-k} + \varepsilon_{it} \quad (12)$$

3.2 Granger Causality

According to Granger (1969), if X causes Y, then changes in X occurred before changes in Y. At that point, X can contribute to the forecasting of Y. That is, if previous estimations of yon Y recur, add previous estimates of x as a self-contained clarified variable, which should significantly increase the relapse's capacity for clarification. This demonstrates that X has the effect of Y. Additionally, because Y results in X, X can be described in a manner analogous to that of Y. To test numerically whether X causes Y, the invalid hypothesis is: "X does not cause Y." The invalid theory demonstrates that X and Y are not causally related. Once the null speculation is discarded, there is evidence for the existence of Granger causality.

4 Results and Discussion

4.1 Summary Statistics

The summary statistics for the data used in our estimation are presented in Table 1.

Table 1
Summary Statistics

	GDP	GII	GPI	ISI	OSI	LAREA	LPOP	TO
Mean	2.63E+08	31.8302	889582.9	37.4232	25.5644	11.1458	2.60626	91.3149
Median	3.213134	32.2000	786730.6	39.4700	25.0000	11.4300	2.41527	77.1157
Maximum	4.53E+10	68.4000	184250	74.9000	68.6000	15.7028	7.24821	442.620
Minimum	-27.99444	1.97000	626861.0	2.05000	1.46000	4.80402	-1.14557	-5.36996
Std. Dev.	3.03E+09	16.6170	271155.3	18.6871	15.1900	2.01032	1.55902	60.4115
Observations	1521	1521	1521	1521	1521	1521	1521	1521

Source: Calculation are carried out from stata-16

First, we investigate the instrument's nature (the initial phase in two-stage OLS gauges) by plotting the variable receptiveness against geological proximity. Given that topographical proximity is proportional to country size, we use geographic zone and population to isolate any unaccounted-for impact and take that may have occurred in terms of trade that was relocated abroad as a result of the majority of businesses in the

country's activities being directed to their domestic market (Frankel & Romer, 1999).

Table 2
Quality of Instruments

Dependent Variable	TO – Trade openness					
Variables	Developed		Developing		World	
	Coefficient	t-Prob	Coefficient	t-Prob	Coefficient	t-Prob
C	385.724*** (9.5789)	0.0000	120.351*** (3.3047)	0.000	258.894*** (4.6902)	0.000
LAREA	-27.551*** (0.7267)	0.000	-1.851** (0.212)	0.000	-14.161*** (0.2716)	0.000
LPOP	5.867*** (0.5240)	0.0000	-7.964*** (0.2240)	0.000	-1.9806 (0.1104)	0.000
GPI	6.15E-06* (0.000003)	0.0655	-5.02E-06 (0.000001)	0.001	-1.04E-05 (0.00000224)	0.000
R2	0.7962		0.7795		0.743	
Sample						
F-Stat	760.7147		1098.610		1465.393	
(Prob)	(0.0000)		(0.0000)		(0.0000)	

Source: Author's own calculation

The results for developed countries demonstrate that geological proximity is a variable that clarifies the measure of international trade, even after accounting for the effect of size. Similar outcomes hold when we think about the developing nations and the World, but the impact has been negative.

Before estimating the model, a panel unit root test should be performed to ensure that the relevant factors are stationary. We used two-panel unit root tests to confirm the stationarity of the elements in our model: LLC (Levin et al., 2002) and IPS (Im & Pesaran, 2003).

Table 3 illustrates the unit root board's aftereffects, demonstrating that all factors are integrated to order zero, I (0).

Table 3
Unit root test

	LLC Test		IPS Test	
Variable	Level T-stat	p- Value	Level T-stat	p- Value
TO	-6.56291	0.0000	-2.42327	0.0077

GDP	-8.07037	0.0000	-8.93445	0.0000
POP	-22.8385	0.0000	-2.27394	0.0115
GII	-372.341	0.0000	-248.637	0.0000

Table 4 summarizes the OLS main findings for countries classified as Developed, Developing, and World, demonstrating the relationship between trade openness, GDP growth, and instrumental variables such as country area and population. Trade openness has a statistically significant positive effect on innovation when all these factors are considered.

When we use specific details to demonstrate the unadulterated impact of transparency on advancement, the effect becomes more grounded. As a result, as nations increase their trade with the rest of the World, they increase their level of innovation. The greatest impact is felt in the world segment and, more specifically, in emerging nations. It is proposed that developing countries, which are the most reliant on foreign innovation, can benefit the most from innovation transactions conducted through global business. According to (Soubbotina, 2004), countries with a limited capacity for innovation benefit the most from introducing products with a high level of innovative substance.

Table 1 shows the VIF results, which show the relationship between all explanatory variables. The result of the coefficient of increased variance shows that there is no multicollinearity in the variables because the impulse rule is that the VIF value should not exceed 10, and all values should be less than 10. The conclusion is that there is no multicollinearity in the variables data.

Table 4
Main OLS Result

Dependent Variable		GII – Global Innovation Index	
Variables	Developed	Developing	World
C	19.09400***	17.57353***	19.44867***
	(6.4666)	(3.5644)	(4.2493)
TO	0.049111***	0.082924***	0.096412***
	(0.0130)	(0.0136)	(0.0098)
GDP	1.335548***	2.87E-10***	1.10E-10

	(0.2197)	(9.92E-11)	(1.54E-10)
LPOP	2.135708***	1.258816***	0.149657
	(0.6818)	(0.3932)	(0.4408)
LAREA	0.875529	-0.137414	0.783355**
	(0.5865)	(0.3305)	(0.3850)
Sample	49	78	127
R2	0.119974	0.045565	0.069309
F- Stat (Prob)	19.87014	11.07565	28.24286
	(0.0000)	(0.0000)	(0.0000)

Source: Author's own calculation

Apart from determination, a country's size, whether in terms of geographical territory or population, has a significant impact on the degree of innovation, even though it is not critical. This outcome gives the impression of being highly intuitive, which fits the writing. According to Boserup et al. (1981), segmentation factors can help explain failures in innovation transmission, a critical component of development. For example, certain technological advancements, products, and methodologies are incompatible with areas of low population density.

The Global Innovation Index, which is used to quantify innovation, is composed of two sub-indices: The Output Sub-Index, which measures innovation outcomes, and the Input Sub-Index, which considers the data sources that enable innovation to occur.

Given that information sources such as human resources, organizational nature, and political strength, among others, all require significant changes over time; it is critical to focus exclusively on the effect of exchange receptiveness on the outcomes of creative strategies. This is accomplished by utilizing the Output Sub-reliant Index's variable, which quantifies nations' mechanical, information, and innovative creation. Similarly, we accounted for nation size in the remaining models.

Openness of trade has a greater effect than in previous models, retaining its positive sign and significance (see Table 5). Trade has the greatest impact on innovation when only emerging economies are considered.

Table 5
Alternative results: OLS results with OSI

Dependent Variable		OSI – Output Sub Index	
Variables	Developed	Developing	World
	13.33466**	10.95050***	9.642445***
	(5.9343)	(3.1359)	(3.4063)
TO	0.049213***	0.092854***	0.091863***
	(0.0119)	(0.0120)	(0.0078)
GDP	1.146572***	3.15E-10***	1.80E-10
	(0.2016)	(8.73E-11)	(1.23E-10)
LPOP	2.007387***	2.048706***	0.905863*
	(0.6257)	(0.3460)	(0.3533)
LAREA	0.829812	-0.340694	0.458603
	(0.5382)	(0.2907)	(0.3086)
Sample	49	78	127
R2	0.118316	0.082174	0.094271
F- Stat (Prob)	19.55866	20.79362	39.47359
	(0.0000)	(0.0000)	(0.0000)

Source: Author's own calculation.

To assess the robustness of these findings, we relapsed the Input Sub-Index in response to trade openness (Table 6). The coefficient for exchange transparency is enormous when OLS analysis is used. While the coefficients obtained when the Input Sub-Index is used as the dependent variable are not critical, they frequently differ from those obtained when the Output Sub-Index is used.

Table 6
Alternative results: OLS results with ISI

Dependent Variable		ISI – Input Sub Index	
Variables	Developed	Developing	World
C	23.76812***	21.92248***	19.44867***
	(7.2481)	(4.2024)	(4.2493)
TO	0.050052***	0.082352***	0.096412***
	(0.0145)	(0.0161)	(0.0098)
GDP	1.486700***	2.38E-10**	1.10E-10
	(0.2462)	(1.17E-10)	(1.54E-10)
LPOP	2.425755***	0.655473	0.149657
	(0.7642)	(0.4636)	(0.4408)
LAREA	0.930626	0.090574	0.783355**
	(0.6574)	(0.3896)	(0.3850)
Sample	49	78	127
R2	0.115463	0.03206	0.069309
F- Stat (Prob)	19.02548	7.233759	28.24286

	(0.0000)	(0.0000)	(0.0000)

Source: Author's own calculation.

4.2 VAR model and causality

The evaluated VAR model necessitates the selection of the optimal lag numbers (p). The Schwarz rule (SC) and the Akaike data measure to control the amount of lag k in each VAR model (AIC). The ideal lag length (p) was three using the Schwarz and Akaike information standard based on Tables 4 with all parts.

Table 7
Lag length Criteria

			Developed			
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-5227.802	NA	4599052.	26.692 87	26.733 39	26.70 893
1	-1814.244	6740 .037	0.136270	9.3583 86	9.5610 01	9.438 687
2	-1528.070	559. 2070	0.034337	7.9799 48	8.344 656*	8.124 491
3	-1499.288	55.6 5433 *	0.032171 *	7.914 735*	8.4415 35	8.12 3520*
4	-1489.707	18.3 3072	0.033247	7.9474 86	8.6363 78	8.220 512
Developing						
0	-20675.56	NA	9.87e+23	66.600 84	66.629 38	66.61 194
1	-13685.46	1386 7.64	1.74e+14	44.139 96	44.282 68	44.19 544
2	-12931.00	1487 .055	1.61e+13	41.761 67	42.018 55	41.86 151
3	-12825.53	206. 5144	1.21e+13	41.473 53	41.84 459*	41.61 776
4	-12795.54	58.3 3464 *	1.15e+13 *	41.42 848*	41.913 72	41.6 1708*
World						
0	-34840.17	NA	8.85e+24	68.794 02	68.813 45	68.80 140
1	-22308.06	2494 0.50	1.64e+14	44.083 05	44.180 20	44.11 995
2	-21042.85	2507 .941	1.39e+13	41.616 69	41.791 56	41.68 311
3	-20886.18	309. 3221	1.06e+13	41.338 96	41.59 155*	41.4 3490*

4	-20860.72	50.05864*	1.04e+13*	41.32029*	41.650 60	41.44575

** indicates lag order selected by the criterion*
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The estimated panel results for the four models for developed, Developing and all OECD nations are introduced in Table 8-10. The estimated consequences for developed countries are shown in model 1 that the GDPG lagged by three periods, and the third lag is impacting the innovation with a negative sign. The outcomes in Table 9 for Developing countries show the same result as for developed countries. Still, here it is a huge difference in this result: the population is impacting the innovation with its all lags and negatively impacts innovation. And for the OECD countries, the result in table 8 are reliable with the outcomes found in developed nations. The outcomes additionally show that innovation is also affected by all three lags. This is reliable with the results found by Ulaşan (2015).

The outcomes of Model 1 affirm the presumption of neutrality between GDPG first two lags of events and innovation and trade openness. These outcomes are steady with those found by a certain economist (Papalia et al., 2011).

The consequences of Model 2 propose the shortfall of a connection between Innovation, Human resources. The assessed outcomes of Model 2 also show that the third lag of human resources essentially affects GDPG. Out of the total three lags, the third lag of trade openness is not affecting the GDP. For Developing Countries its shows neutrality between innovation, population, and trade openness towards GDP. It is more obvious that GDPG can increase technological innovation progress, which leads to openness in trade. But in the case of emerging nations, this scenario is still in progress, as for the possibility of whole world economies, its seconds the outcomes of developing

countries. This is steady with the results found by (Pradhan et al., 2018).

The estimated consequences of model 3 for developed countries show that the GDPG lagged by three, and the third lag period essentially affects population growth of events. The consequences of Model 3 additionally show that the trade receptiveness lagged by two periods essentially affects population growth of events. The results are the same as those founded by (Rahman, 2017). There is neutrality among Innovation, GDPG, but TO is positively affecting 1st lag but negatively for the second lagged period as there is bidirectional causality among To and Population growth, founded by (Mohsen, 2015). Finally, for the World GDPF, Innovation and TO, no one is affecting the population growth.

The estimation results for Model 4 for developed nations indicate that GDPG, Innovation, and trade openness are all neutral. The same holds for developing countries. However, the results for global data suggest that three years behind innovation has a significant positive effect on trade openness. Model 4's results corroborate the theory of economic growth and trade openness being mutually exclusive.

Table 8
VAR Model Developed Countries

	GII	GDPG	LPOP	TO
GII (-1)	1.000345 [76.7458]***	-0.001590 [-0.11493]	-5.98E-05 [-1.29583]	0.056354 [1.09718]
GII(-2)	-0.051923 [-5.01110]***	0.009170 [0.83366]	3.35E-05 [0.91262]	-0.000334 [-0.00818]
GII(-3)	0.017779 [2.57111]***	0.013131 [1.78878]*	-1.23E-06 [- 0.05000]	0.000396 [0.01453]
GDPG(-1)	-0.021020 [-0.49968]	0.469352 [10.510]***	3.06E-05 [0.20499]	-0.014976 [-0.09035]
GDPG(-2)	0.069949 [1.60860]	0.011437 [0.24775]	0.000153 [0.99316]	-0.159051 [-0.92821]
GDPG(-3)	-0.157610 [-4.46367]***	0.130968 [3.49395]***	-0.000410 [-3.27496]***	-0.278729 [-2.00325]
TO(-1)	-0.008578 [-0.65755]	0.039820 [2.87516]***	-0.000103 [-2.21759]**	1.183482 [23.0211]***
TO(-2)	0.015669 [0.78460]	-0.054290 [-2.56081]***	0.000148 [2.08671]**	-0.274912 [-3.49345]***
TO(-3)	-0.006091	0.016822	-4.37E-05	0.088104

	[-0.50164]	[1.30506]	[-1.01587]	[1.84140]*
LPOP(-1)	26.60585	32.23187	2.201957	-110.6501
	[1.03150]	[1.17712]	[24.0929]***	[-1.08865]
LPOP(-2)	-54.87199	-73.41527	-1.486163	219.5084
	[-1.13892]	[-1.43540]	[-8.70556]***	[1.15622]
LPOP(-3)	28.38784	41.07802	0.284341	-109.1609
	[1.24038]	[1.69074]*	[3.50632]	[-1.21042]
C	1.607357	0.252833	0.001947	-0.651459
	[3.26811]***	[0.48424]	[1.11746]	[-0.33614]
R-squared	0.962006	0.418179	0.999982	0.992272
Adj. R-squared	0.960940	0.401866	0.999982	0.992055
Causality Direction	*GDPG → GII*	*GII → GDPG*	*GDPG → LPOP*	*GDPG → TO*
	LPOP → GII	*LPOP → GDPG*	*GII ≠ LPOP*	*LPOP ≠ TO*
	TO ≠ GII	*TO → GDPG*	*TO ≠ LPOP*	*GII ≠ TO*

Source: The t-stat are in the parentheses. *, **, *** denotes rejection of null hypothesis at the 1%, 5%, 10%, level of significance, respectively.

Table 9
VAR Model Developing Countries

	GII	GDPG	LPOP	TO
GII(-1)	0.742585	-1056299	-0.000111	-0.205315
	[15.3928]***	[-0.90738]	[-1.02424]	[-1.38825]
GII(-2)	0.177006	1277862.	0.000118	0.146121
	[3.56990]***	[1.06803]	[1.05367]	[0.96130]
GII(-3)	-0.039649	-99261.65	-4.73E-06	0.057775
	[-3.23232]***	[-0.33535]	[-0.17119]	[1.53641]
GDPG(-1)	-1.74E-09	2.978872	-1.63E-12	-3.09E-10
	[-0.81303]	[57.5225]***	[-0.33685]	[-0.04703]
GDPG(-2)	1.07E-10	-1.814112	1.73E-12	8.45E-10
	[0.04979]	[-35.0968]***	[0.35905]	[0.12868]
GDPG(-3)	2.21E-09	-0.212239	-2.00E-13	-1.64E-09
	[2.03705]**	[-8.09347]***	[-0.08173]	[-0.49094]
LPOP(-1)	-190.5482	1.72E+08	3.097634	-83.20769
	[-2.25176]**	[0.08435]	[16.2529]***	[-0.32074]
LPOP(-2)	495.1114	-3.63E+08	-4.202873	98.37865
	[2.17938]**	[-0.06618]	[-8.21409]***	[0.14126]
LPOP(-3)	-453.4787	2.42E+08	3.053808	-30.67783
	[-2.11109]**	[0.04669]	[6.31212]***	[-0.04659]
TO(-1)	0.007059	223232.6	8.46E-05	0.995440
	[0.50653]	[0.66384]	[2.69439]***	[23.3007]***
TO(-2)	0.019333	-313175.2	-0.000108	-0.016191
	[1.06501]	[-0.71493]	[-2.65169]***	[-0.29094]
TO(-3)	-0.001192	105023.2	3.59E-05	-0.043447
	[-0.07451]	[0.27212]	[0.99752]	[-0.88607]

C	3.261075 [4.91168]***	-3484554. [-0.21749]	0.000803 [0.53712]	0.819384 [0.40256]
R-squared	0.888245	0.999864	0.999990	0.960564
Adj. R-squared	0.885285	0.999860	0.999990	0.959520
Causality Direction	*GDPG ≠ GII* *LPOP → GII* *TO → GII*	*GII ≠ GDPG* *LPOP ≠ GDPG* *TO ≠ GDPG*	*GDPG ≠ LPOP* *GII ≠ LPOP* *TO ≠ LPOP*	*GDPG ≠ TO* *LPOP → TO* *GII → TO*

Source: The t-stat are in the parentheses. *, **, *** denotes rejection of null hypothesis at the 1%, 5%, 10%, level of significance, respectively.

Table 10
VAR Model World

	GII	GDPG	LPOP	TO
GII(-1)	1.005534 [122.043]***	230469.8 [0.79167]	-2.04E-05 [-0.94453]	0.051603 [1.92879]*
GII(-2)	-0.034401 [-4.48302]***	-64425.21 [-0.23762]	-1.11E-05 [-0.55026]	-0.055596 [-2.23122]**
GII(-3)	0.001892 [0.32735]	-104277.7 [-0.51068]	-1.04E-06 [-0.06872]	0.034438 [1.83514]*
GDPG(-1)	1.24E-09 [1.80750]	1.017640 [42.0750]***	3.21E-14 [0.01790]	4.14E-10 [0.18623]
GDPG(-2)	-2.92E-09 [-2.75384]***	-0.086751 [-2.31327]**	1.29E-14 [0.00463]	3.07E-11 [0.00892]
GDPG(-3)	1.72E-09 [2.50766]***	0.148275 [6.11427]***	-4.05E-14 [-0.02256]	-5.29E-10 [-0.23737]
LPOP(-1)	-11.42713 [-0.50336]	29765481 [0.03711]	2.262007 [38.0602]***	-204.2141 [-2.77027]***
LPOP(-2)	5.800927 [0.13235]	-42506774 [-0.02745]	-1.617787 [-14.0984]***	359.8661 [2.52843]***
LPOP(-3)	5.625372 [0.26269]	11949001 [0.01579]	0.355860 [6.34744]***	-155.8567 [-2.24133]**
TO(-1)	0.000470 [0.05491]	-44546.05 [-0.14721]	1.25E-05 [0.55699]	1.061230 [38.1603]***
TO(-2)	0.018680 [1.47430]	-146894.0 [-0.32811]	-1.25E-05 [-0.37571]	-0.092239 [-2.24190]**
TO(-3)	-0.018792 [-2.26694]**	172275.6 [0.58818]	8.35E-07 [0.03847]	0.023560 [0.87527]
C	1.248005 [4.20374]***	1359076. [0.12956]	0.001869 [2.40466]***	0.365198 [0.37883]
R-squared	0.968016	0.999494	0.999988	0.987845
Adj. R-squared	0.967675	0.999488	0.999988	0.987715
Causality Direction	*GDPG → GII* *LPOP → GII*	*GII ≠ GDPG* *LPOP ≠ GDPG*	*GDPG ≠ LPOP* *GII ≠ LPOP*	*GDPG ≠ TO* *LPOP → TO*

	TO → GII	*TO ≠ GDPG*	*TO ≠ LPOP*	*GII → TO*

Source: The t-stat are in the parentheses. *, **, *** denotes rejection of null hypothesis at the 1%, 5%, 10%, level of significance, respectively.

4.3 Causal Relationship

Granger's (1969) fundamental causality test was extended to panel data to assume causal homogeneity across panels. This presumption is frequently incorrect.

Granger's definition of causality is based on two statutes: "the cause preceded the impact, and a causal arrangement contained data about the impact that was not contained in some other arrangement as per the contingent disseminations," as emphasized in (Poon & Granger, 2003) and thus the way the cause results in a more accurate estimation of the impact is merely a ramification of the preceding.

The key points of Granger Causality are following, First, If H0 is not rejected, X does not cause Y from a granger perspective for all panel variables. Second, If H0 is rejected and N1 equals 0, homogeneous causality exists for all units between x and y. Final, If H0 is rejected and 0N1/N1 is true, there is heterogeneous causality; the estimation and causality relations in all units may differ

Tables 8–10 show the causal relationships for each factor for Developed, Developing, and All OECD countries. There is no causal relationship between innovation, trade openness, and population in developed nations (Table 8) but have the unidirectional causal effect of innovation on population. Moreover, innovation, population, and trade have bidirectional causality to GDP.

For Developing nations Table 9, the outcomes are different from Developed nations; there is no causal effect among innovation, trade openness and population to GDP, but have the unidirectional causal effect population to trade and innovation. Moreover, innovation has bidirectional causality to trade.

For OECD nations Table 10, the outcomes are founded somehow relative to Developed nations, POP, TO do not have a causal effect on GDP. Still, there is unidirectional causality among GDP, POP to Innovation, and POP to trade and Trade and Innovation have bidirectional causal effects. The detailed results are in appendixes Table 1.

4.4 Impulse Response Function

The impulse response function addresses the response of the variable over a long time because of irregular shock in another variable. The underlying limitations are utilized to discover more significant outcomes. Figure 1, For developed nations, which shows the response of Innovation, GDP, and trade towards the shock in endogenous variables. In panel A, the shock in GDPG cause innovation to be decreased over time, and in panel B, the shock in innovation causes the GDPG to go down rapidly. In Panel D, the random shock in GDPG cause trade to goes down, but stability in innovation also stabilized the trade openness.

Figure 1
Impulse Response in Developed Countries

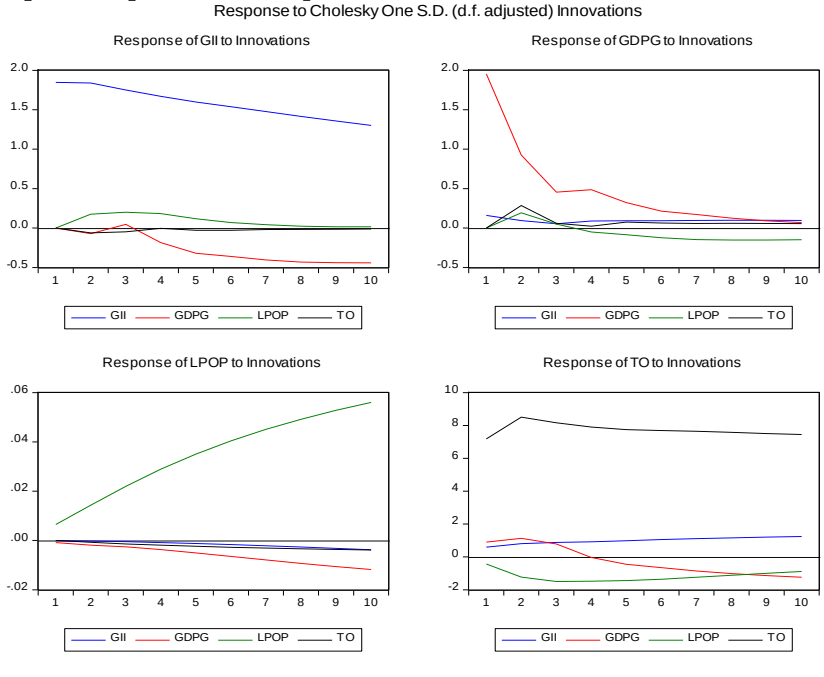


Figure 2: Impulse Response in Developing Countries

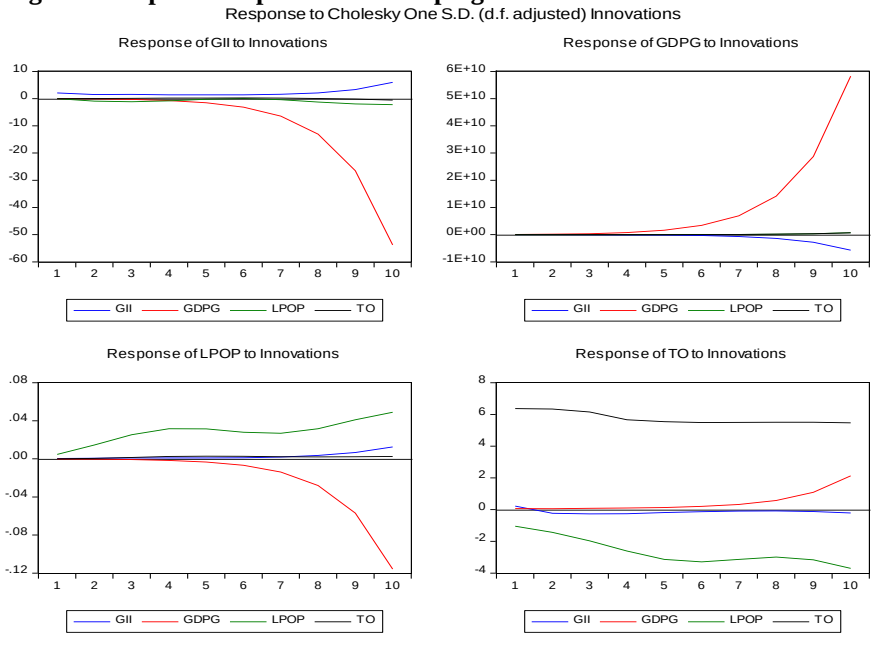
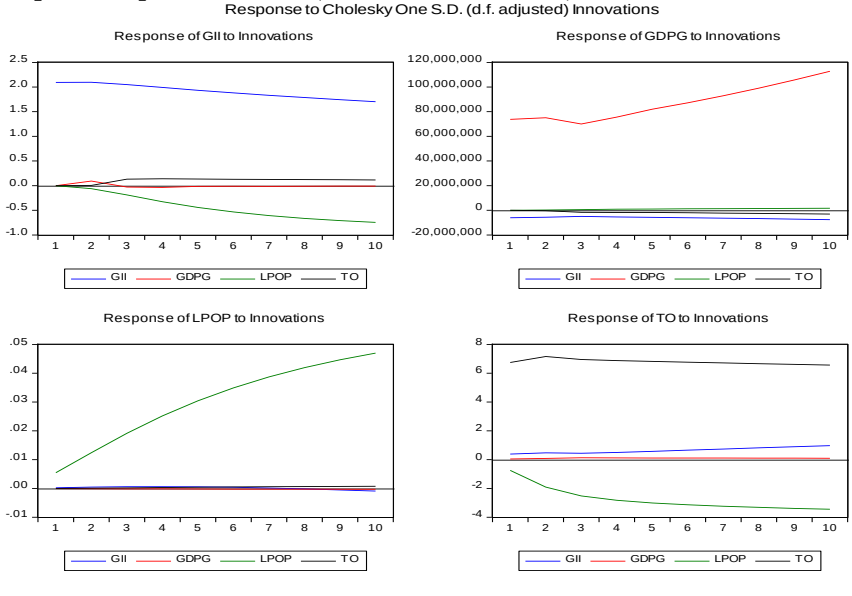


Figure 3

Impulse Response in World (OECD & Non-OECD)



4.5 Cointegration Test

The next step is to perform cross-integration tests. Regression equations can capture long-term relationships frequently occurring in economic theory, so the goal of estimation is to test these against available data regardless of theoretical constraints.

Pedroni arranged a series of univariate tests using multiple data sets to nullify the hypothesis of non-association among samples of different sizes. Statistics: Parametric panel V, parametric rho, PP, panel ADF are all calculated by growing the residual within the dimensions. The remaining three are computed by grouping the residual across dimensions: the groups' rho, PP, and ADF.

Table 11
Pedroni's Cointegration Test

	Developed		Developing		World	
Test Statistics	Without Trend	With Trend	Without Trend	With Trend	Without Trend	With Trend
Panel v	-1.0042	-1.814	-2.073	-2.813	-2.068	-3.2185
Panel rho	3.3641	5.534	5.036	7.765	5.856	9.331
Panel t	-1.330*	-3.384***	-1.241	-3.308***	-1.887**	-4.935***
Panel ADF	-5.049***	-6.375***	-7.6***	-6.909***	-8.794***	-9.650***
Group rho	6.431	7.564	8.647	10.832	10.771	13.181
Group t	-2.623***	-9.416***	-5.66***	-15.497***	-6.0700***	-18.009***
Group ADF	-4.23***	-6.415***	-9.73***	-10.106***	-10.256***	-11.926***

Note: Null Hypothesis No integration and diverges to the negative side (save for panel v). ADF *, **,*** indicate significance at 10%, 5%, and 1%.

Table 12
Westerlund's Cointegration Test

	Case 1: With Constant			Case 2: With Constant and trend		
			Developed Countries			
Statistic	Value	Z Value	p-Value	Value	Z Value	p-Value
Gt	-3.259	-7.615	0.000	-3.600	-7.204	0.000
Ga	-3.616	7.314	1.000	-1.863	11.903	1.000
Pt	.13.198	0.233	0.592	-10.065	7.628	1.000
Pa	-2.852	4.919	1.000	-1.312	9.977	1.000
			Developing Countries			
Statistic	Value	Z Value	p-Value	Value	Z Value	p-Value

Gt	-3.282	-9.826	0.000	-3.828	-11.401	0.000
Ga	-1.275	12.168	1.000	-0.671	16.329	1.000
Pt	-9.051	7.487	1.000	-12.360	9.983	1.000
Pa	-1.518	8.003	1.000	-0.670	13.334	1.000
				World		
Statistic	Value	Z Value	p-Value	Value	Z Value	p-Value
Gt	-3.273	-12.430	0.000	-3.740	13.409	0.000
Ga	-2.179	14.077	1.000	-1.131	20.190	1.000
Pt	-17.023	4.373	1.000	-15.339	13.198	1.000
Pa	-2.263	8.932	1.000	-1.003	16.521	1.000

H0: No Cointegration
Average AIC selected lag length: 1.67

As previously mentioned, Pedroni (1999, 2004) and Wester (2007) utilize the cointegration functions. The results in Table 5.1 conclude that panel and grouped t-statistics and ADF do not reject the null hypothesis of no cointegration between GDP and Innovation.

Regarding developing in the absence of a trend, the null hypothesis is considered accepted. We assert that the results of the world study apply to developed countries. When the model constant and pattern are remembered together, the test is discarded 4 of the 7 variables show clear evidence of being cointegrated.

Westerlund's cointegration test results in Table 12 demonstrate that the null hypothesis cannot be rejected for all data classifications. Thus, we can conclude that there is no cointegration between the variables using this technique.

Our OLSs results about relationship between innovation and TO, geographical areas , population are in line with (Dotta & Munyo, 2019) and for economic growth, the results are in line with (Amidi & Majidi, 2020). The OLS regression is applied to get the information of the relationship between GDPG, Innovation and trade openness.

Similarly, the Var model for long run relationship and granger causality for the unidirectional or bidirectional causal relationship among the main explanatory variables. The results for the world and developing nations are in line with (Johnson & Van

Wagoner, 2014) for innovation, Trade openness and economic growth, and for the (Roquez & Escot, 2018).

The current inquiry about the causal relationship and long run effects of TO, GDP, on innovation was separately analyzed for the developed nations and emerging nations and as well as for the world data. We have learnt about the causality among trade openness and growth but never saw the causality among innovation and the role of economic growth towards technological progress. This research contributes to the literature as the causality among innovation and growth and filling the gap for policy makers about trade openness and innovation on the basis on 1st world countries and 3rd world countries. As mentioned above that the number of emerging nations are more than developed nations, So, here we can analyze according to the results that the overall world's scenario is resemble with the developing nations results. The WTO policies should be in accordance with emerging nations as they can catch the innovation and can get the huge advantage from the trade openness and can increase their economic growth.

5 Conclusion and Discussion

In this article, openness and Innovation was analyzed and examined. Using proximity as a rationale, the research shows that trade-friendly policies significantly affect a nation's development. This phenomenon is more prominent in emerging and developed countries.

With estimated evidence indicating that increased access to international trade has a significant effect on innovation, it is reasonable to investigate the variables underlying this interaction. The World Bank (2008) asserts that the rate of technological advancement in the majority of emerging economies is determined by their capacity to embrace, adapt to, and effectively utilize existing innovation. The disparate rates can be explained by a country's ability to attract investment via qualified labor and a favorable business climate.

Additionally, Di Stefano et al. (2012) proposed that the degree of innovation is contingent on not only adequate

manufacturing conditions but also on demand, which has an effect on the rate of advancement appropriation.

Furthermore, we used trade openness to infer the causal relationship between innovation, economic growth, and population. While there is no evidence of a causal relationship between economic growth and innovation in emerging economies, there is evidence of a bidirectional causal relationship in developed economies. There is no causal relationship between innovation and trade openness in developed countries. Nonetheless, in emerging economies and OECD countries, there is a bidirectional relationship between trade openness and economic growth. Trade openness and economic growth are causally related in both directions in developed countries, but not in emerging economies. Similarly, for emerging and developed economies alike, we discovered a unidirectional relationship between innovation and population. Finally, our findings indicate that economic growth and population growth are mutually reinforcing.

The following are the examination's immediate political ramifications. First, monetary policies should not be solely focused on innovation; however, a well-coordinated and transparent methodology that involves all nations is expected to foster innovation and increase its economic impact. Additionally, governments should strengthen ties between research foundations, industry, and universities, increase their R&D spending capacity, and create more viable R&D arrangements.

Second, pioneers in OECD countries should also tighten their monetary frameworks and strengthen the nature of subsidizing, rather than expanding the financial sector's size.

Since the population is the primary driver of growth in developing countries, thirdly, governments must increase their investments in entrepreneur skill development and make sure that there are the right conditions are creative environments for innovative abilities to be present in place so that innovativeness and growth can flourish.

This research allows the future researcher to extend this study to the depth, the channels of transmission among innovation, openness, and growth by considering the firm level data of different industrial sectors of world economy.

References

Aldieri, L. (2011). Technological and geographical proximity effects on knowledge spillovers: evidence from the US patent citations. *Economics of Innovation and New Technology*, *20*(6), 597-607.

Alikhanli, Y. (2020). Granger causality analysis of foreign trade impact on economic growth: Case of Azerbaijan. *WSEAS Transactions on Environment and Development,16*, 384-389.

Aluko, O., & Olufemi, A. (2020). Imports and economic growth in Africa: Testing for granger causality in the frequency domain. *The Journal of International Trade & Economic Development*, *29*(7), 1-15.

Amidi, S., & Majidi, A. F. (2020). Geographic proximity, trade and economic growth: a spatial econometrics approach. *Annals of GIS*, *26*(1), 49-63.

Belazreg, W., & Mtar, K. (2020). Modelling the causal linkages between trade openness, innovation, financial development and economic growth in OECD Countries. *Applied Economics Letters*, *27*(1), 5-8.

Chang, R., Loayza, N., & Kaltani, L. (2009). Openness Can be Good for Growth: The Role of Policy Complementarities. *Journal of Development Economics*, *90* (1), 33-49.

Chen, B.-L. (1999). Trade Openness and Economic Growth: Evidence in East Asia and Latin America. *Journal of Economic Integration*, *14*(2), 265-295.

Cheung, O. L. (2014). Impact Of Innovative Environment On Economic Growth: An Examination Of State Per Capita GDP And Personal Income. *Journal of Business & Economics Research (JBER)*, *12*(3), 257-270.

Coe, D., Helpman, E., & Hoffmaister, A. (1997). North-South R&D Spillovers. *Economic Journal*, *107*(440), 134-149.

Coe, D. T., & Helpman, E. (1995). International R&D spillovers. *European Economic Review*, *39*(5), 859-887.

Dar, A., & Amirkhalkhali, S. (2003). On the impact of trade openness on growth: Further evidence from OECD countries. *Applied Economics*, *35*(16), 1761-1766.

Do, Q. T., & Levchenko, A. A. (2004).*Trade and financial development*. The World Bank.

Dotta, V., & Munyo, I. (2019). Trade Openness and Innovation. *The Innovation Journal*, *24*(2), 1-13.

Duggan, R. (1996). Promoting innovation in industry, government and higher education. *Long Range Planning*, *29*(4), 503-513.

Frankel, J. A., & Romer, D. H. (1999). Does Trade Cause Growth? *American Economic Review*, *89*(3), 379-399.

Grossman, G., & Helpman, E. (1990). Comparative Advantage and Long Run Growth. *American Economic Review*, *80*(4), 796-815.

Hsu, P.-H., Tian, X., & Xu, Y. (2014). Financial development and innovation: Cross-country evidence. *Journal of Financial Economics*, *112*(1), 116-135.

Idris, J., Yusop, Z., & Habibullah, M. S. (2016). Trade openness and economic growth: A causality test in panel perspective. *17*(2), 281-290.

Im, K. S., & Pesaran, M. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53-74.

Johnson, D. K. N., & Van Wagoner, H. (2014). *The Chicken or the Egg: Granger-Causality between Trade and Innovation*. Colorado College Working Paper 2014-04.

Muhsin, K. A. R., Nazlioğlu, Ş., & Hüseyin, A. Ğ. I. R. (2014). Trade openness, financial development and economic growth in Turkey: Linear and nonlinear causality analysis. *BDDK Bankacılık ve Finansal Piyasalar Dergisi*, *8*(1), 63-86.

Kim, D.-H. (2011). Trade, growth and income. The Journal of International Trade & Economic Development, 20(5), 677-709.

Kim, D.-H., Lin, S.-C., & Suen, Y.-B. (2010). Dynamic effects of trade openness on financial development. Economic Modelling, 27(1), 254-261.

Krueger, A. O. (1985). Importance of General Policies to Promote Economic Growth. The World Economy, 8(2), 93-108.

Levin, A., Lin, C.-F., & Chu, C.-S. (2002). Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties. *Journal of Econometrics*, *108*(1), 1-24.

Levine, R. (1997). Financial Development and Economic Growth: Views and Agenda. *Journal of Economic Literature*, *35*(2), 688-726.

Loewy, M., & Ben-David, D. (1998). Free Trade, Growth, and Convergence. *Journal of Economic Growth*, *3*(2), 143-170.

Loewy, M., & Ben-David, D. (2000). Knowledge Dissemination, Capital Accumulation, Trade, and Endogenous Growth. *Oxford Economic Papers*, *52*(4), 637-650.

Loewy, M., & Ben-David, D. (2003). Trade and the Neoclassical Growth Model. *Journal of Economic Integration*, *18*(1), 1-16.

Mohsen, A. S. (2015). Effects of Trade Openness and Economic Growth on the Private Sector Investment in Syria. *Journal of Applied Management and Investments*, *4*(3), 168-176.

Muhammad, F. & Jian, Z. (2016). The Relationship Between Trade Openness and Economic Growth in Muslim Countries: An Empirical Investigation. *Economics*, *5*(2), 15-19.

Osadume, R., & Uzoma, C. (2020). Maritime Trade and Economic Development: A Granger Causality and Bound Test Approach. *LOGI – Scientific Journal on Transport and Logistics*, *11*(2), 23-32.

Papalia, R. B., Bertarelli, S., & Filippucci, C. (2011). Human capital, technological spillovers and development across OECD countries (No. 15).

Poon, S.-H., & Granger, C. W. J. (2003). Forecasting Volatility in Financial Markets: A Review. Journal of Economic Literature, 41(2), 478-539.

Pradhan, R. P., Arvin, M. B., & Bahmani, S. (2018). Are innovation and financial development causative factors in economic growth? Evidence from a panel granger causality test. Technological Forecasting and Social Change, 132, 130-142.

Rahman, M. M. (2017). Do population density, economic growth, energy use and exports adversely affect environmental quality in Asian populous countries? Renewable and Sustainable Energy Reviews, 77, 506-514.

Rajan, R. G., & Zingales, L. (1998). Financial Dependence and Growth. The American Economic Review, 88(3), 559-586.

Rivera-Batiz, L., & Romer. (1991). International trade with endogenous technological change. European Economic Review, 35(4), 971-1001.

Rivera-Batiz, L., & Romer, P. (1991). International trade with endogenous technological change. European Economic Review, 35(4), 971-1001.

Robst, J., Polachek, S., & Chang, Y.-C. (2007). Geographic Proximity, Trade, and International Conflict/Cooperation. Conflict Management and Peace Science, 24(1), 1-24.

Romer, P. M. (1986). Increasing Returns and Long-Run Growth. Journal of Political Economy, 94(5), 1002-1037.

Roquez, A., & Escot, L. (2018). Relationship between trade openness and economic growth in Latin America: A causality analysis with heterogeneous panel data. Review of Development Economics, 22(2), 658-684.

Sakellaris, P., & Spilimbergo, A. (2000). Business cycles and investment in human capital: international evidence on higher education. *Carnegie-Rochester Conference Series on Public Policy*, *52*(1), 221-256.

Sakyi, D., Villaverde, J., Maza, A., & Reddy Chittedi, K. (2012). Trade openness, growth and development: evidence from heterogeneous panel cointegration analysis for middle-income countries. *Cuadernos de Economía*, *31*(SPE57), 21-40.

Sarkar, P. (2008). Trade openness and growth: Is there any link?. *Journal of economic issues*, *42*(3), 763-785.

Seyoum, M., Wu, R., & Lin, J. (2013). Foreign Direct Investment and Trade Openness in Sub-Saharan Economies: A Panel Data Granger Causality Analysis. *South African Journal of Economics*, *82*(3), 402-421.

Soltani, H., Anis, O., Zaghdoudi, T., & Yosra, S. (2013). Trade Openness and Economic Growth: The Case of Tunisia. *International Journal of Advances in Management and Economics*, *2*(2), 24-32.

Soubbotina, T. P. (2004). *Beyond Economic Growth : An Introduction to Sustainable Development, Second Edition*. Washington, DC: World Bank.

Tavares, J., & Wacziarg, R. (2001). How democracy affects growth. *European Economic Review*, *45*(8), 1341-1378.

Yonghua, Y., & Yongsheng, Y. (2011, November). International Fragmentation of Production and China's Technology Innovation: Empirical Analysis on China's Data. In *2011 International Conference on Information Management, Innovation Management and Industrial Engineering* (Vol. 2, pp. 277-280). IEEE.

Young, A. (1991). Learning by doing and the dynamic effects of international trade. *The Quarterly Journal of Economics*, *106*(2), 369-405.

Appendices

Table 1A

Granger Causality

Granger Causality Test	Lags	3		4		
	Developed		Developing		World	
Null Hypothesis	F- Stat	Prob	F- Stat	Prob	F- Stat	Prob
GDP does not Granger Cause GII	8.82519	1.E-05	1.94322	0.1017	2.77754	0.0401
GII does not Granger Cause GDPG	4.77608	0.0028	0.28680	0.8866	0.20765	0.8911
LPOP does not Granger Cause GII	3.59115	0.0138	4.32756	0.0018	4.64978	0.0031
GII does not Granger Cause LPOP	0.45715	0.7124	0.27741	0.8926	1.54167	0.2020
TO does not Granger Cause GII	0.49962	0.6827	3.52022	0.0075	2.61362	0.0499
GII does not Granger Cause TO	0.65625	0.5794	2.93973	0.0200	3.90261	0.0087
LPOP does not Granger Cause GDPG	3.85437	0.0096	0.00049	1.0000	0.03703	0.9905
GDP does not Granger Cause LPOP	2.72254	0.0440	0.02852	0.9984	0.00880	0.9989
TO does not Granger Cause GDPG	4.80520	0.0026	0.11574	0.9770	0.05876	0.9813
GDP does not Granger Cause TO	4.21958	0.0059	0.06443	0.9924	0.05459	0.9832
TO does not Granger Cause LPOP	1.10279	0.3477	1.91239	0.1068	0.29799	0.8269
LPOP does not Granger Cause TO	1.12010	0.3406	3.38260	0.0095	6.21135	0.0003