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Trade- Growth Nexus: A Study of G20 Countries

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Abstract: *The focus of this paper is to understand the relationship between Trade openness of an economy and its economic growth. An attempt has been made to study the dynamics between trade and growth (T- G) for the G20 countries. In the current study, time series analysis has been used and the individual country- wise study has been performed using cointegration and error correction procedures. The evidence of cointegration and Granger causality have been shown in the results section and the results vary from one country to another. Using the results we have shown whether there is causality between trade and growth or not.*

Keywords: *Causality, Economic growth, Exports, GDP, International Trade, Openness*

I. Introduction

The theory that trade is positively correlated with economic growth goes back to Adam Smith, who argued that trade allows for increased specialization. Specialization permits increased attainment of economies of scale, especially from countries with relatively small domestic markets. The starting point for a discussion of trade is the theory of Comparative Advantage. According to that, trade allows a more efficient use of the economy's resources by enabling imports of goods and services that could otherwise only be produced at home at higher resource costs. The Ricardian model explains the welfare gains if any country specializes in producing goods in which it has a comparative advantage. The Hecksher-Ohlin-Samuelson (H-O-S) model, on the other hand, shows the welfare gains in the two-country model that each country specializes based on their factor endowments. The keystone of these theories is that international trade is the way to achieve static productivity efficiency and international competitiveness. On the other hand, the Stolper-Samuelson theorem leads to the generalization of H-O model (the so-called Hecksher-Ohlin-Samuelson model). The Hecksher-Ohlin-Samuelson (H-O-S) model analyses the consequences of international trade on employment and income distribution. Following this model, international trade leads to a higher Pareto-efficient equilibrium by means of reallocation of resources between sectors.

Although classical economists recognized the role of free trade in economic growth, the neo-classical economists, however, have given little emphasis on role of trade in their incredible contribution to growth literature. Rather, they have given due importance to the role of factors like capital, labour, technology and latter human capital on economic growth. In response to the weaknesses of neoclassical growth models, some economists, while preserving most of the model, have introduced new features, which consider growth to be endogenous. The theory is that there is an "accumulable" factor, technology, which is produced by intermediate inputs. An increase in the productivity of the intermediate inputs leads to an increase in the rate of accumulation and growth of output in subsequent periods. Hence there is an appreciable difference between the neoclassical growth model and endogenous models. These models have focused on different variables, such as degree of openness, real exchange rate, terms of trade and export performance, to verify the hypothesis that open economies grow more rapidly than those that are closed (Edwards, 1998). Further, New growth theory has provided important insights into an understanding of the relationship between trade and growth. For example, if growth is driven by R&D activities, then trade provides access for a country to the advances of technological knowledge of its trade partners. Further, trade allows producers to access bigger markets and encourages the development of R&D through increasing returns to innovation. Especially, trade provides developing countries with access to investment and intermediate goods that are vital to their development processes. In addition, Grossman and Helpman (1994) also show that integration with the world economy can boost a country's productivity, hence trade boosts economic growth. Residents of a country that is integrated into world markets are likely to enjoy access to a larger technical knowledge base than those living in relative isolation, because trade helps disseminate technology.

A strand of the literature emphasizes the importance of institutions, suggesting that trade liberalization will have a positive impact on growth if the appropriate institutions are in place. Otherwise, trade reforms and other structural reforms will be ineffective. According to this strand of literature, trade liberalization thus has a much wider effect than changing relative prices. It also implies multiple institutional changes.

The aim of this paper is to analyze critically the relationship between trade and growth, an essential aspect of any theory of development. Although this connection has been made in several works relating this topic, both theoretical and empirical, the association between them is difficult to be established. The growth

literature leads to problems such as the endogeneity of the variables whereas empirical policy literature has been proved to be weak in trying to make a clear correlation between openness and growth. Although long-run economic growth and technological progress seem to lead to changes in the pattern of international trade, these effects are far from being conclusive.

The question to be addressed in this paper is the relationship between trade and growth in theoretical literature since earlier models of welfare gains of international trade. An assessment of the literature will be done in order to find how it works, if works, the link between trade and growth. With similar objective, the present study also examines the relationship between trade and growth but differs at various angles from earlier studies as discussed earlier.

In the current study, G20 countries have been taken into consideration. The Group of Twenty (G20) is the premier forum for global economic and financial cooperation. It brings together the world's major advanced and emerging economies, representing around 85 per cent of global GDP. G20 is a group of countries consisting of developed and developing countries. The countries in this group are from different geographical areas and continents.

Why G20?

The Group of Twenty (also known as the G- 20 or G20) is an international forum for the governments and central bank governors from 20 major economies. The members include 19 individual countries—Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, South Korea, Mexico, Russia, Saudi Arabia, South Africa, Turkey, the United Kingdom and the United States—along with the European Union (EU). The EU is represented by the European Commission and by the European Central Bank. The G20 was founded in 1999 with the aim of studying, reviewing, and promoting high level discussion of policy issues pertaining to the promotion of international financial stability. It seeks to address issues that go beyond the responsibilities of any one organization. Collectively, the G20 economies account for around 85% of the gross world product (GWP), 80% of world trade (or, if excluding EU intra trade, 75%), and two thirds of the world population. The G20 heads of government or heads of state have periodically conferred at summits since their initial meeting in 2008, and the group also hosts separate meetings of finance ministers and central bank governors.

With the G20 growing in stature after its inaugural leaders' summit in 2008, its leaders announced on 25 September 2009 that the group would replace the G8 as the main economic council of wealthy nations. Since its inception, the G20's membership policies have been criticized by numerous intellectuals, and its summits have been a focus for major protests by anti-globalists, nationalists and others.

The heads of the G20 nations met semiannually at G20 summits between 2008 and 2011. Since the November 2011 Cannes summit, all G20 summits have been held annually.

The group was formally inaugurated in September 1999, and held its first meeting in December 1999. It worked as cooperation of finance ministers and central bank governors formed in the aftermath of the financial crisis of 1997- 1998, which revealed the vulnerability of the international financial system in context of economic globalization and showed that key developing countries were insufficiently involved in discussions and decisions concerning global economic issues.

The presidency of the G20 rotates annually among its members. The presidency leads a three member management group of previous, current and future chairs, referred to as the Troika, the purpose of which is to ensure transparency, fairness, and continuity from one presidency to another. The G20 does not have a secretariat of its own. A temporary secretariat is set up by the country that holds the presidency for the term of chairmanship.

The objectives of the G20 refer to:

1. Policy coordination between its members in order to achieve global economic stability, sustainable growth;
2. Promoting financial regulations that reduce risks and prevent future financial crises;
3. Modernizing international financial architecture.

The Group of Twenty (also known as the G- 20 or G20) is an international forum for the governments and central bank governors from 20 major economies. Collectively, the G20 economies account for around 85% of the gross world product (GWP), 80% of world trade (or, if excluding EU intra trade, 75%), and two thirds of the world population. The G20 consists of developed as well as developing countries. Also, the G20 countries are from different continents and geographical regions. This way it can be a good approximation for the whole world. We can generalize the results that we get here for the whole world, of course, with some limitations.

II. Rationale Of The Current Study

Objectives

In the current study, we have made an attempt to understand the relationship between Trade openness of an economy and its economic growth for the G20 countries. The relationship between trade openness and

growth is a highly debated topic in the growth and development literature. Yet, this issue is far from being resolved. There has been many studies done in past to check the relationship between trade and growth for different set of countries. Researchers have done individual country analysis and panel data analysis in past. G20 group consists of developed as well as developing nations. The G20 economies account for around 85% of the gross world product, 80 % of the world trade and the G20 countries collectively have two third of the entire world population. Also, the group consists of nations at different levels of development. The countries are in different continents and have different geographical conditions. These all make G20 an important and interesting set of countries to study.

III. Literature Review

In this section we review empirical links between trade and growth. Here we will see how researchers in past have attempted this problem of studying relationship between trade openness and economic growth. Reviewing literature, we will get to know what variables have been used by researchers in order to gauge trade openness and economic growth.

The relationship between trade openness and growth is a highly debated topic in the growth and development literature. Yet, this issue is far from being resolved. Theoretical growth studies suggest at best a very complex and ambiguous relationship between trade restrictions and growth. The empirical analysis of the relationship between trade, trade liberalisation and economic growth has generated mixed results. Little, Scitovski and Scott (1970) and Balassa (1971) were first to address this subject. Since then many economists have attempted to relate trade policy variables to economic performance and growth. The research can be divided into two groups: multi-country studies that investigate in detail the experience of some countries that have been subject to trade reforms and cross- country econometric studies that analyze the relationship between openness and trade. Whilst early empirical studies generally supported the idea that openness is positively related to economic growth, more recent contributions have elicited doubts as to whether these results reflect causal influences of trade on growth. The empirical literature on economic growth and trade can be categorized into two categories: (1) trade openness and growth; (2) trade barriers and economic growth.

First, the most basic measure of openness is the simple trade shares, which is exports plus imports divided by GDP. A large number of studies used trade shares in GDP and found, as reviewed in Harrison (1996), a positive and strong relationship with growth. Furthermore, controlling for the endogeneity of trade with the geographic variables, Frankel and Romer (1999) and Irwin and Tervio (2002) recently reported that comparing the IV estimates of cross-country regressions of income on trade and other factors with the OLS estimates indicated that the OLS estimates understate the effects of trade on income. Rodriguez and Rodrik (2001) and Irwin and Tervio (2002), however, showed that significant and higher IV estimates of trade shares are not robust the inclusion of geographical variables such as latitude and tropical climate. More importantly, Rodrik et al. (2002) reported that neither geographical variables nor trade shares hold their significances when entered growth regressions with institutional quality variables measured by the rule of law and property rights.

In addition, export shares and import shares in GDP are also used and enter positively in cross-country growth regressions. As discussed in Edwards (1993), one of the distinct characteristics of earlier literature is that it put too much emphasis on exports. From the standpoint of international trade theory, this view is hard to defend because, according to theory of comparative advantage, international trade leads to a more efficient use of a country's resources through the import of goods and services that otherwise are too costly to produce within the country. Thus, it is probably safe to conclude that imports are as important as exports for economic performance. As a matter of fact, these two should be considered complementary to each other rather than alternatives.

A fundamental problem with empirical analyses of the trade-growth link is how to measure openness. The most obvious approach is to use the simple concept of the total trade volume (exports plus imports) relative to GDP. The OLS estimator is, however, likely to be biased and inconsistent due to endogeneity of the trade volume. The same degree of consensus does not appear to hold for the growth effects of international trade. Many empirical analyses estimate positive growth effects of trade liberalization, but the size of these effects is often rather small, and the empirical methods used to estimate the effects have been subject to substantial criticism.

Cakmak and Temurlenk in their paper studied the causal relationship between export expansion and economic growth in Turkey. The data used in the study is from 1968 to 1993. In this study the authors have performed cointegration tests and Hsiao version of Granger causality. The results of this study do not seem to support the idea of export- led growth for Turkey in the framework of causality testing. The results are contrary to the conventional wisdom, similar results have also been found by many development economists for many developing countries.

Aurangzeb in one of his papers developed a multivariate model to test the causality between exports, investment and economic growth in the case of Pakistan. The author has performed the stationarity checks and

cointegration tests. Aurangzeb has tested the series under study and found that the series were non- stationary at levels and not cointegrated. The author performed the Hsiao's version of the Granger causality method and the order in which the variables were entered into the model has been considered using the SG criterion, which is very important in the multivariate framework and it improves the robustness of the causality results. The results of the study show that there is a strong bi- directional causality between exports growth and investment growth to GDP growth. The results also suggest that the export growth causes import growth, investment growth causes GDP growth and investment growth, but not the opposite. The findings of the paper suggest the fact that both exports and investment are considered as an engine of growth in the case of Pakistan. The causal inferences are fairly stable over the period of study.

Aditya and Roy studied the export- growth relationship taking into account both diversification and nature of export composition. The panel under consideration consists of 65 countries and data from 1965- 2005. GMM and other techniques have been adopted to check the impacts. The dynamic panel suggests that export diversification and composition are important determinants of economic growth after controlling the impacts of other variables like lagged growth, exports, investments and infrastructure. In this study, the relationship between export concentration and income is found to be non- linear. It is also found that economic growth across countries increases with increasing specialization leading to higher growth. These results on export-economic growth relationship have immense implications for growth.

Ghoshal in her paper has made an attempt to study the causal relationship between trade and growth in India with particular emphasis on the effect of introduction of various trade agreements on this relationship. The author has considered Indian annual GDP and exports to gauge the effects. The time span of data is from 1980 to 2013. The author has used Grainger causality test to establish the causality. To check the co- integration, Johansen Co- integration test has been used.

Gries and Redlin examined the short- term and long- term dynamics between per capita GDP growth and openness for 158 countries over a period 1970- 2009. In the paper, panel cointegration tests and panel error correction models (ECM) in combination with GMM estimation has been used to explore the causal relationship between the openness and economic growth. The results of the study suggests that there is a long- run relationship between openness and economic growth with a short- run adjustment to the deviation from the equilibrium for both directions of dependency. The long- run coefficients indicate a positive significant causality from openness to growth and vice- versa, which indicates that international integration, is a beneficial strategy for growth in long term. By contrast the short- run coefficient shows a negative short- run adjustment, suggesting that openness can be painful for an economy undergoing short term adjustments. The authors have also studied the data subdivided into income- related subpanels. While the long run effect remains predominantly positive and significant, the short- run adjustment becomes positive when the income level increases. The results suggest that different trade structures in low- income and high- income countries have different effects on economic growth.

Rahman and Mustafa have attempted to explore the dynamics between real exports and real economic growths in 13 selected Asian countries. They have used the cointegration tests and error correction procedures. The unit root tests reveal that both the time series are non- stationary in each country and individually they depict I(1) behaviour. The authors here have performed individual country- wise analysis. In the results of the study, the evidence of cointegration and short- run as well as long- run Granger causality including the directions thereof vary from one country to another.

Tan in his thesis studied the relationship between GDP growth rates and trade exposure. The author has used a cross- country dataset to gain initial insight into the trade- growth relation, and then used Singapore time series data from 1965 to 2009 to check how the Singapore's trade exposure has led to increased growth for Singapore. Tan has also considered other important determinants of growth which include educational expenditure, inflation, and technological progress. In this study, the author has found a strong cross- country relationship between trade openness and economic growth. The author then examined the time series data from Singapore, a country with high per capita GDP growth rates and trade openness levels, to see if the country's economic growth is indeed driven by its level of trade exposure. For the case of Singapore, the author shows that the exposure to international trade has been beneficial to Singapore's growth.

Cadoret, Rondeau and Tran studied the impact of openness to the international trade on economic performance. In the study they have considered a panel of 130 countries for the year 1975, 1980, 1985, 1990, 1995, 2000, 2005 and 2010. The results of the study show that trade promotes growth differently in different parts of the world. In this paper, the authors have argued that geographical location can play a key role in the trade versus income relationship.

Causality Issues

To address the problem of causality, Frankel and Romer (1999) analyse only the effect of the component of trade that cannot be influenced by growth in the short term, mainly caused by populations, land

areas and distances. They observe that this component accounts for a significant proportion of the differences between countries in income and growth and suggest a general relationship connecting increased trade to increased growth.

IV. Data And Methodologies

Data

In this study, we have used (imports+ exports) to gauge the openness of an economy. For economic growth we have taken GDP as a parameter. All these variables are nominal. We have taken all the data from WDI database. All the analysis has been performed on logarithmic values of the variables. In the study LGDP denote the parameter to gauge economic growth which is log value of nominal GDP and LTRADE denote the parameter to gauge openness of the economy. LTRADE is log value of sum of imports and exports for that country in that year.

For individual country- wise analysis we have taken data based on the availability. For some countries data was available from 1961 to 2014. For others data was not available for all the years, so we have taken maximum possible years data for those countries.

Methodology

In this part of the study, we are dealing with time series data. The methodology for this section has been adopted from the paper by Rahman, Mustafa (1997). At first, it is necessary to examine the stationarity/ non- stationarity property of time series data to determine the most appropriate econometric technique in order to avoid incorrect conclusions. Provided the time series data are found stationary, the most appropriate procedure is the simple Granger causality test. In the case of non- stationarity in the time series data, the most appropriate procedures are co- integration and error-correction models. To begin with this examination, the co-integration regression is specified as follows:

$$X_t = \propto_0 + \propto_1 Y_t + e_t$$

Where X_t = log of nominal GDP, Y_t = log of nominal trade coefficient, where trade coefficient is defined as (exports + imports) and e_t is the stochastic error term. The variables X_t and Y_t are integrated of order d (i.e., I(d)) if the time series data on X_t and Y_t have to be differenced d times to restore stationarity. For d = 0, X_t and Y_t are stationary in levels and no differencing is needed. Again, for d = 1, first differencing is needed to restore stationarity. For non- stationarity in each variable, unit root tests are to be conducted for which the following equations are considered:

$$X_t = \mu + \beta T + \alpha . X_{t-1} + \sum_{i=1}^{k} c_i \Delta X_{t-i}$$

$$Y_t = \theta + \pi T + \phi Y_{t-1} + \sum_{i=1}^{k} d_i \Delta Y_{t-i}$$

Each time series has non-zero mean and non-zero drift. That is why the estimation should include both a constant and a trend term in each specification. The relevant null hypothesis is that $|\alpha| = 1$ or $|\phi| = 1$ against the corresponding alternative hypothesis that $|\alpha| < 1$ or $|\phi| < 1$. A failure to reject the null hypothesis would imply that each variable is non- stationary.

Next, the following ADF regression is considered:

$$\Delta e_t = a\, e_{t-1} + \sum_{i=1}^{m} b_i \, \Delta e_{t-i} + q_t$$

The ADF test is applied on |â| to infer about the null hypothesis of no-cointegration. The null hypothesis is rejected if the calculated pseudo t-value associated with â is greater than its critical value, provided in Engle and Yoo (1987).

Along with the ADF tests, we have also performed Phillips Perron (PP) and Kwiatkouski – Phillips-Schmidt- Shin (KPSS) test to check the stationarity of the series under study.

The Engle-Granger (1987) cointegration procedures are not without drawbacks since they do not consider explicitly the error structure of the data processes. The cointegration procedure, as developed in Johansen (1988) and Johansen and Juselius (1990, 1992), avoid the above drawback by allowing interactions in the determination of the relevant economic variables and being independent of the choice of the endogenous

variable. Most importantly, it allows explicit hypotheses tests of parameter estimates and rank restrictions using likelihood ratio tests. The empirical exposition of Johansen and Juselius methodology is as follows:

$$\Delta V_t = \tau + \Omega V_{t-1} + \sum_{j=1}^{k-1} \Omega_j \Delta V_{t-j} + m_t$$

Where V_t denotes a vector of log of nominal GDP and log of nominal trade, and Ω= αβ`. Here, α is the speed of adjustment matrix and β is the cointegration matrix. The above equation is subject to the condition that is less than full rank matrix, i.e., r < n. This procedure applies the maximum eigenvalue test (max) and the trace test (trace) for null hypotheses on r. Of these two tests, max test is expected to offer a more reliable inference as compared to trace test (Johansen and Juselius (1990)). Again, the Johansen and Juselius test procedure suffers from its supersensitivity to the selection of the lag structures. As a result, this study pursues both the ADF and Johansen-Juselius procedures for cointegration. It is likely that these two procedures will provide contradictory evidence in some instances. If X_t and Y_t are found cointegrated by either ADF procedure or Johansen-Juselius procedure or both, there will exist an error correction representation (Engle and Granger (1987)). The error-correction model may take the following form:

$$\Delta X_t = \beta_1 e_{t-1} + \sum_{i=1}^{k} \varphi_i \Delta X_{t-i} + \sum_{j=1}^{k} \delta_j \Delta Y_{t-j} + u_{1t}$$

$$\Delta Y_t = \beta_2 e_{t-1} + \sum_{i=1}^{k} \pi_i \Delta X_{t-i} + \sum_{j=1}^{k} \gamma_j \Delta Y_{t-j} + u_{2t}$$

The reverse specification is considered due to plausible bidirectional causality. In these two equations, the series X_t and Y_t are cointegrated when at least one of the coefficients β1 or β2 is not zero. If β1≠0 and β2=0, they Y_t will lead X_t in the long run. Again, if β2≠0 and β1=0, then X_t will lead Y_t in the long run. If δ_j's are not all zero, movements in Y_t will lead those in X_t in the short run. If π_i's are not all zero, movements in X_t will lead movements in Y_t in the short run.

The error-correction model (ECM) was first introduced by Sargan (1964) and subsequently popularized by numerous papers (i.e., Davidson et al. (1978), Hendry et al. (1984)). It has enjoyed a revival in popularity due to the recent work of Granger (1986, 1988), and Engle and Granger (1987) on cointegration. Its importance lies in its ability to combine short-run dynamics and long-run relationship in a unified system. If two variables are cointegrated, the long-run Granger causality will stem at least from one direction. Sometimes, it is desirable to exclude the insignificant lags to improve the efficiency of OLS estimates of parameters (Baghestani and Mott (1997)). A lack of cointegration does not, however, preclude the short-run dynamics and Granger causality. In the absence of a long-run relationship, the above equations should not include the error-correction term for the detection of Granger causality between two variables (Bahmani and Payesteh (1993)).

V. Dynamic Of Trade Openness And Economic Growth In G20 Countries

In the current study, we are performing individual country- wise analysis. As we have mentioned previously that the countries in G20 are from different regions, continents with different geographical features. They have adopted and follow different trade policies. So, it is important to analyse the countries individually and see the causal relationship between trade and growth. Here we have performed unit root tests for stationarity checks, cointegration tests for checking whether there is a long run association between the variables under consideration. Here the variables used are LTRADE and LGDP. Where LTRADE is log value of sum of imports and exports and LGDP is the log value of log value of GDP. All the variables under study are nominal in nature.

Further, based on cointegration results, we run VECM or VAR followed by causality tests.

Performing the study we find out whether there causal relationship between trade and growth for the G20 countries. Here we have checked both way causality i.e. Trade→ Growth and Growth→ Trade. The final results are mentioned here and the analysis reports have been put up in the appendix for reference.

Unit Root Tests

In the study, we have performed three unit root tests ADF, PP and KPSS. We have taken into consideration these three unit root tests to verify and confirm the results.

ADF (Augmented Dickey- Fuller) Test

Without trend: 5%: -2.9188, 1%: -3.5627..... With trend: 5%: -3.4987, 1%: -4.1446

Table 1: ADF test results

Country	Variable	Without trend		With trend	
		At levels	First difference	At levels	First difference
Argentina (1962- 2014)	LGDP	-0.8659	-7.7821	-3.1310	-7.6984
	LTRADE	-0.3502	-8.8841	-4.1139	-8.7772
Australia (1961- 2014)	LGDP	-1.0195	-5.3950	-2.1968	-5.4184
	LTRADE	-0.9908	-5.4355	-2.4567	-5.4394
Brazil (1961- 2014)	LGDP	-1.5206	-5.7781	-2.0743	-5.7832
	LTRADE	-1.1536	-9.4318	-2.2027	-9.5790
Canada (1961- 2014)	LGDP	-2.3128	-4.7720	-1.6156	-5.1975
	LTRADE	-2.4917	-6.4897	-0.7969	-7.2950
China (1961- 2014)	LGDP	-2.7203	-5.9007	-0.3595	-6.3745
	LTRADE	0.8185	-5.8809	-3.3213	-5.8406
France (1961- 2014)	LGDP	-2.5059	-5.0341	-1.5471	-5.3720
	LTRADE	-2.7191	-4.7828	-1.4828	-5.2889
Germany (1970- 2014)	LGDP	-2.8693	-4.4709	-2.8348	-4.7309
	LTRADE	-2.5366	-4.7318	-3.5741	-5.0347
India (1961- 2014)	LGDP	0.4207	-6.7128	-1.6669	-6.7055
	LTRADE	0.3371	-4.3602	-2.4678	-4.3986
Indonesia (1967- 2014)	LGDP	-1.6612	-5.9918	-2.2435	-6.0226
	LTRADE	-2.8029	-4.7162	-2.4983	-4.9668
Italy (1961- 2014)	LGDP	-2.7542	-4.9906	-0.6352	-5.4664
	LTRADE	-2.9384	-5.2668	-0.8280	-5.8675
Japan (1961- 2013)	LGDP	-4.2504	-3.8459	-0.1434	-5.2012
	LTRADE	-3.3837	-5.5698	-0.9601	-6.7215
South Korea (1961- 2014)	LGDP	-2.4387	-5.6129	-0.5419	-6.0759
	LTRADE	-3.1397	-5.4744	-1.0178	-6.2079
Mexico (1961- 2014)	LGDP	-1.7389	-6.6676	-2.7414	-6.8920
	LTRADE	-1.0846	-5.6456	-2.1525	-5.6929
Russia (1989- 2014)	LGDP	0.0927	-3.2199	-1.5523	-3.3274
	LTRADE	-0.8776	-6.2362	-2.3166	-6.1659
Saudi Arabia (1968- 2014)	LGDP	-2.7748	-4.5165	-3.0134	-4.7775
	LTRADE	-2.6500	-3.4217	-3.2410	-3.5708
South Africa (1961- 2014)	LGDP	-1.7766	-5.5104	-2.2026	-5.7265
	LTRADE	-1.3798	-5.1463	-2.4782	-5.1814
Turkey (1961- 2014)	LGDP	-1.0004	-7.1939	-2.6468	-7.1697
	LTRADE	-0.7983	-6.5071	-1.9044	-6.4598
US (1961- 2013)	LGDP	-5.4069	-3.1866	-1.5890	-4.6811
	LTRADE	-2.2357	-6.0362	-0.6303	-6.5503
UK (1961- 2013)	LGDP	-1.2574	-4.5709	-2.1751	-4.6469
	LTRADE	-1.6166	-4.8983	-1.6247	-5.0816

From the above table, the ADF results suggests that for most of the countries LGDP (log of GDP) and LTRADE(log of imports+ exports) are non stationary both with and without trend at the levels. However, they become stationary after it is differenced once only.

But there are some cases where the series are stationary at levels also.

Under with trend case:

For Argentina, LTRADE is stationary at levels. For Germany, LTRADE is stationary at levels.

Under without trend case:

For Italy and South Korea; LTRADE stationary at levels. For Japan, both LGDP and LTRADE are stationary at levels. For US, LGDP is stationary at levels.

PP (Phillips- Perron) Test

Without trend: 5%: -2.9188, 1%: -3.5627..... With trend: 5%: -3.4987, 1%: -4.1446

Table 2: PP Test Results

Country	Variable	Without trend		With trend	
		At levels	First difference	At levels	First difference
Argentina (1962- 2014)	LGDP	-0.6761	-8.2716	-3.1310	-8.1699
	LTRADE	-0.2584	-8.9370	-4.1333	-8.8267
Australia (1961- 2014)	LGDP	-0.9771	-5.3462	-1.6282	-5.3601
	LTRADE	-0.7889	-4.8561	-1.8795	-4.8564
Brazil (1961- 2014)	LGDP	-3.7387	-2.9963	1.0095	-4.6811
	LTRADE	-2.4088	-6.0408	-0.5565	-6.5756
Canada (1961- 2014)	LGDP	-2.0255	-4.7760	-1.2295	-5.2004
	LTRADE	-4.5425	-6.4569	-0.1081	-14.7012
China (1961- 2014)	LGDP	2.9629	-5.9007	-0.4267	-6.3557
	LTRADE	1.1958	-6.1070	-3.3511	-6.1686

France (1961- 2014)	LGDP	-2.5059	-5.0317	-1.0873	-5.2915
	LTRADE	-2.4595	-4.7828	-1.0488	-5.2191
Germany (1970- 2014)	LGDP	-2.6458	-4.3798	-2.3948	-4.5914
	LTRADE	-2.4112	-4.6318	-2.7787	-4.9448
India (1961- 2014)	LGDP	0.3997	-6.7129	1.7583	-6.7030
	LTRADE	0.7852	-4.3919	-2.0245	-4.4407
Indonesia (1967- 2014)	LGDP	-1.6333	-5.9934	-2.2923	-6.0252
	LTRADE	-2.5335	-4.6975	-2.3948	-4.9825
Italy (1961- 2014)	LGDP	-2.5384	-4.9182	-0.8068	-5.2781
	LTRADE	-2.7601	-5.2668	-0.9375	-5.7671
Japan (1961- 2013)	LGDP	-3.7387	-2.9963	1.0095	-4.6811
	LTRADE	-3.5284	-5.5603	-0.9253	-6.7162
South Korea (1961- 2014)	LGDP	-2.3032	-5.6285	-0.6557	-5.9900
	LTRADE	-3.3186	-5.4928	-0.9763	-6.1443
Mexico (1961- 2014)	LGDP	-2.1055	-5.9666	-2.0260	-7.4057
	LTRADE	-1.1998	-5.4878	-1.6491	-6.1425
Russia (1989- 2014)	LGDP	-0.2016	-3.1765	-1.5523	-3.2798
	LTRADE	-0.7317	-6.4361	-2.2506	-6.4994
Saudi Arabia (1968- 2014)	LGDP	-3.7387	-2.9963	1.0095	-4.6811
	LTRADE	-2.4088	-6.0408	-0.5565	-6.7556
South Africa (1961- 2014)	LGDP	-3.7387	-2.9963	1.0095	-4.6811
	LTRADE	-2.4088	-6.0408	-0.5565	-6.5756
Turkey (1961- 2014)	LGDP	-1.0029	-7.1940	-2.8460	-7.1697
	LTRADE	-0.7870	-6.5071	-2.0776	-6.4697
US (1961- 2013)	LGDP	-3.7387	-2.9963	1.0095	-4.6811
	LTRADE	-2.4088	-6.0408	-0.5565	-6.5756
UK (1961- 2013	LGDP	-1.3283	-4.1614	-1.3398	-4.2083
	LTRADE	-1.4475	-4.7089	-1.0630	-4.7985

Further, the PP results also suggests that for most of the countries LGDP (log of GDP) and LTRADE(log of imports+ exports) are non stationary both with and without trend at the levels. However, they become stationary after it is differences once only.

But there are some cases where the series are stationary at levels also.

Under with trend case:

For Argentina, LTRADE is stationary at levels. For Russia, LGDP is stationary at levels.

Under without trend case:

For Brazil, China, Saudi Arabia and US; LGDP stationary at levels. For Canada and South Korea; LTRADE is stationary at levels. For Japan, LGDP and LTRADE both are stationary at levels.

KPSS (Kwiatkouski – Phillips- Schmidt- Shin) Test

Null hypothesis: The series is stationary.

Without trend: 5%: 0.4630, 1%: 0.7390; with trend: 5%: 0.1460, 1%: 0.2160

Table 3: KPSS test results

Country	Variable	LM stat.		LM Stat.	
		Without trend		With trend	
		At levels	First difference	At levels	First difference
Argentina (1962- 2014)	LGDP	0.9505	0.0649	0.0875	0.0651
	LTRADE	0.9737	0.0543	0.0482	0.0488
Australia (1961- 2014)	LGDP	0.8612	0.1249	0.1666	0.0689
	LTRADE	0.8678	0.0972	0.1623	0.0589
Brazil (1961- 2014)	LGDP	0.8516	0.6777	0.2482	0.1468
	LTRADE	0.8475	0.5574	0.2356	0.0766
Canada (1961- 2014)	LGDP	0.8565	0.3496	0.2096	0.0742
	LTRADE	0.8614	0.6067	0.2437	0.1768
China (1961- 2014)	LGDP	0.8625	0.6154	0.2349	0.0745
	LTRADE	0.8706	0.2520	0.1831	0.1375
France (1961- 2014)	LGDP	0.8437	0.3808	0.2290	0.0401
	LTRADE	0.8414	0.4359	0.2274	0.0555
Germany (1970- 2014)	LGDP	0.8269	0.3373	0.1742	0.0584
	LTRADE	0.8518	0.3213	0.1534	0.0687
India (1961- 2014)	LGDP	0.8647	0.1182	0.0975	0.0712
	LTRADE	0.8557	0.1748	0.1439	0.0572
Indonesia (1967- 2014)	LGDP	0.8530	0.1975	0.1248	0.1068
	LTRADE	0.8490	0.3274	0.1448	0.1078
Italy (1961- 2014)	LGDP	0.8416	0.5424	0.2437	0.0457
	LTRADE	0.8452	0.5664	0.2402	0.0409
Japan (1961- 2013)	LGDP	0.9056	0.8073	0.2491	0.0622

	LTRADE	0.9222	0.7326	0.2404	0.0771
South Korea (1961- 2014)	LGDP	0.8475	0.5216	0.2439	0.0603
	LTRADE	0.8468	0.6961	0.2402	0.0683
Mexico (1961- 2014)	LGDP	0.8631	0.2788	0.1851	0.1061
	LTRADE	0.8688	0.1769	0.1768	0.0866
Russia (1989- 2014)	LGDP	0.8516	0.6777	0.2482	0.1468
	LTRADE	0.8475	0.5574	0.2356	0.0766
Saudi Arabia (1968- 2014)	LGDP	0.7471	0.2551	0.1189	0.1356
	LTRADE	0.7086	0.2114	0.1064	0.1399
South Africa (1961- 2014)	LGDP	0.8429	0.2298	0.2047	0.0654
	LTRADE	0.9519	0.1451	0.1549	0.0684
Turkey (1961- 2014)	LGDP	0.8679	0.0718	0.0861	0.0386
	LTRADE	0.8688	0.0899	0.1747	0.0494
US (1961- 2013)	LGDP	0.8516	0.6777	0.2482	0.1468
	LTRADE	0.8475	0.5574	0.2356	0.0766
UK (1961- 2013	LGDP	0.8586	0.1890	0.2197	0.0487
	LTRADE	0.8573	0.3330	0.2167	0.0544

Considering KPSS results, we see that for most of the countries LGDP (log of GDP) and LTRADE (log of imports+ exports) are non stationary both with and without trend at the levels. However, they become stationary after it is differences once only.

But there are some cases where the series are stationary at levels also.

Under with trend case:

For India, Indonesia, Turkey; LGDP is stationary at levels. For Argentina and Saudi Arabia; both LGDP is stationary at levels.

Under without trend case:

For China; LGDP stationary at levels. For Canada; LTRADE is stationary at levels. For Brazil, Canada, Italy, Japan, South Korea, Russia, US; both LGDP and LTRADE both are stationary at levels.

Evidently, each time series on the log of nominal GDP and log of sum of nominal imports and nominal exports are non- stationary both with and without trend at 5% and higher level of significance. After each series is differenced once, each series becomes stationary.

Since each time series is non- stationary, the next step is to determine if both the series are cointegrated.

Cointegration Tests

To check the cointegration between the two series LGDP and LTRADE, we run the Johansen cointegration test.

Table 4: Cointegration test results

Country	Dependent (X_t)	Independent (Y_t)	Cointegration result	VAR/ VECM
Argentina (1962- 2014)	LGDP	LTRADE	No cointegration	VAR
Australia (1961- 2014)	LGDP	LTRADE	No cointegration	VAR
Brazil (1961- 2014)	LGDP	LTRADE	No cointegration	VAR
Canada (1961- 2014)	LGDP	LTRADE	Cointegrated	VECM
China (1961- 2014)	LGDP	LTRADE	No cointegration	VAR
France (1961- 2014)	LGDP	LTRADE	No cointegration	VAR
Germany (1970- 2014)	LGDP	LTRADE	No cointegration	VAR
India (1961- 2014)	LGDP	LTRADE	No cointegration	VAR
Indonesia (1967- 2014)	LGDP	LTRADE	No cointegration	VAR
Italy (1961- 2014)	LGDP	LTRADE	No cointegration	VAR
Japan (1961- 2013)	LGDP	LTRADE	No cointegration	VAR
South Korea (1961- 2014)	LGDP	LTRADE	No cointegration	VAR
Mexico (1961- 2014)	LGDP	LTRADE	Cointegrated	VECM
Russia (1989- 2014)	LGDP	LTRADE	Cointegrated	VECM
Saudi Arabia (1968- 2014)	LGDP	LTRADE	Cointegrated	VECM
South Africa (1961- 2014)	LGDP	LTRADE	No cointegration	VAR
Turkey (1961- 2014)	LGDP	LTRADE	No cointegration	VAR
US (1961- 2013)	LGDP	LTRADE	Cointegrated	VECM
UK (1961- 2013)	LGDP	LTRADE	No cointegration	VAR

In the above table we have only mentioned the final results i.e. whether the series are cointegrated or not and based on that whether we will further run VAR (Vector auto- regressive model) or VECM (Vector error correction model). In our analysis, we have considered both trace test as well as maximum eigenvalue test.

In the above table, we see that for Canada, Mexico, Russia, Saudi Arabia and United States the log of GDP (LGDP) and log of sum of imports and exports (LTRADE) are found cointegrated. The existence of cointegration implies a long- run equilibrium relation between LGDP and LTRADE.

In the Johansen cointegration test, the null hypothesis is that of no cointegration. Here, we are considering both Trace as well as Maximum Eigenvalue tests. The results have been put up in the appendices for reference.

After running the cointegration, we realise for which all countries the series LGDP and LTRADE are cointegrated and for which of them they are not cointegrated.

Further, depending on whether the series are cointegrated or not we run VAR or VECM. If the series are not cointegrated, we run VAR; but if they are cointegrated, we run VECM.

Results:

Further, after checking for cointegration; if the series are cointegrated we run VECM and if they are not we run VAR models. We also made an attempt to check causality using VAR and VEC Granger causality tests (Wald tests).

Causality Check

To check the causality, here we have used the Wald test.

Wladtets: C(3)= C(4)=0

chi square, p- value>0.05- can't reject null. No causality.

Table 5: Individual Country- Wise Causality Results

Country	Causality	
	LTRADE-> LGDP	LGDP-> LTRADE
Argentina	Yes	No
Australia	No	No
Brazil	No	Yes
Canada	Yes	No
China	No	No
France	No	No
Germany	No	No
India	No	No
Indonesia	No	No
Italy	No	No
Japan	No	Yes
South Korea	No	No
Mexico	No	No
Russia	No	No
Saudi Arabia	Yes	No
South Africa	No	No
Turkey	Yes	No
US	No	NA
UK	Yes	No

In the above table the results have been mentioned of the individual country wise analysis of the causality between trade openness and economic growth.

The above table shows that for Argentina, Canada, Saudi Arabia, Turkey and UK; there is a causal linkage running from LTRADE to LGDP. This signifies that adoption of trade openness policies in these countries has helped these countries gain economic growth during the study span. Whereas, for other countries trade openness does not help the economies gain economic growth.

Seeing the results of causality running from economic growth to trade openness, we observe that this LGDP- LTRADE linkage holds only for Brazil and Japan. For all the other countries, there is no causal linkage between economic growth and trade openness.

VI. Conclusion And Discussion

From this study, we see that there are some countries for which there is causal linkage from trade openness to economic growth, which means trade openness policies have led to economic growth. But, there are very less number of countries in G20 for which there is causal linkage between economic growth and trade openness, which means there has been less examples where economic growth of a country has led to trade openness.

G20 countries are from different continents and have different geographical regions. They also have different economic policies. These all factors also play great role in trade growth relationship. General policy implication of the above empirical study are as follows: Countries for which trade openness has caused economic growth should focus more on trade policies which focus on export promotion. The countries for which economic growth has led to trade openness should promote high economic growth policies to spur exports or

trade overall. For other countries, in which no causality was observed should focus on policies to support both trade openness as well as economic growth simultaneously.

This study can further be expanded to study specific country wise analysis. We can also incorporate trade policies and geographical conditions of the nations and try to establish the reasoning behind the established results.

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