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Causal Relationship between Trade Openness and Economic Growth: A Panel Data Analysis of Asian Countries

Khandaker Jahangir Alam[1]*, Khairul Kabir Sumon[2]

[1]Department of Economics, Begum Rokeya University, Rangpur 5400, Bangladesh, [2]Department of Finance and Banking, Begum Rokeya University, Rangpur 5400, Bangladesh. *Email: nirob@brur.ac.bd

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ABSTRACT

This paper examines the causal relationship between economic growth and trade openness for 15 Asian countries over period 1990-2017. We have applied panel cointegration and causality approaches to examine the long-run and causal relationship between variables. Empirical results confirm the presence of cointegration between variables. The impact of trade openness on economic growth is found to be positive. The panel vector error correction model Granger causality analysis reveals the bidirectional causality between economic growth and trade openness.

Keywords: Trade Openness, Economic Growth, Panel Cointegration, Causality
JEL Classifications: F11, F14, F43, C23

1. INTRODUCTION

From the last two decades international trade is accepted as one of the important positive factors of economic growth, which was for the 1st time raised by Adam Smith and David Ricardo. According to them trade openness increases income growth as countries are producing that goods, in which they are specialized or got comparative labour-productivity advantage. Trade openness is believed to channel foreign direct investment (FDI), capital inputs, goods and services flow to host countries.

Now a days it is widely accepted that open economics grow faster compared with closed ones. Fischer (2003) defined globalization as an ongoing process of greater economic interdependence among the countries reflected in the increasing amount of cross border trade in goods and services increasing volume of fund and flow of labour. It is also reported that the importance of trade in long-run. Many macro econometric evidence found that open economics enjoy faster economic growth in long-run while micro econometric evidence support that if a firm enter in export market can ensure faster growth in comparatively short-run. That's why Ben-David and Loewy (1998) suggested trade barriers should be decreased for an economy to grow. On the other hand, Adhikary (2011) found that free trade could lead to an exchange rate depreciation which reduces the aggregate supply of inputs by increasing the price of the imputed inputs used in the production. As a result, domestic output tends to be reduced and domestic market becomes less competitive.

The effect of open trade on economic growth is sometimes believed to be conditional, that is it depends on improvement of infrastructure such as human capital, physical infrastructure, social capability and absorption capacity of state to successfully implement the advanced technology use by developed economy. These facts are supported by Rodirk (1997), Abramoviz (1986) and Howitt (2000). World Bank (2002) tried to find the benefits of trade openness for developing countries in the context of globalization. It classified the developing countries into the more globalized and the less globalized and then summarised their relative economic performance as follows: Among the all countries 24 countries- with 3 billion people- have increased their trade ratio twofold to income over the past two decades. The remaining developing countries are trading less than it did 20 year earlier. The more globalized developing countries have increased per capita growth rate from 1% to 3%, to 2%, to 5% respectively in 1960s, 1970s, 1980s and 1990s. Whereas, for the less globalized with- 2 billion people increased growth in marginal rate, in fact the growth rate was negative. (World Bank, 2002, p. 4-5).

Although open trade can easily transmit the knowledge, technology and allocation of resources but there are many studies where it is found that the relationship between trade openness and economic growth is negative. According to De Matte is (2004) trade liberalization sets exogenous constraints to economic growth. It creates problems to the young economy as it makes them bound to depend on international markets and become highly vulnerability to the variation of international markets. In addition to this, Rodrik (1992) said that trade openness may cause macroeconomic instability by increasing inflation, devaluating exchange rate and finally directing to a balance of payment crisis. While Levine and Renelt (1992) mentioned that an increasing degree of openness adversely affect the domestic investment. Finally, Battra and Slottje (1993) and Leamer (1998) found that due to liberalization the developing country have to lower tariffs to make import more attractive and which might lead domestic economy to suffer and ultimately it is acting as a cause of economic downturn.

Despite of having the enormous literature or empirical work, still there is a gap in definition of "trade liberalization" or "openness." Though these two concepts are very close to each other but not alike. Trade liberalization means policy measure to increase trade while trade openness means increased size of country's trade in relation to its output. According to the Pritchett (1996) openness is determined by trade intensity. On the other hand, Kyrre (2006) defined openness in relation to the barriers to foreign trade.

2. LITERATURE REVIEW

Theories related to trade openness to long-run growth are typically based on models of endogenous technological change (Winters, 2004). Trade can increase the rate of technological progress, productivity growth, either by expansion of market for output or through expansion of market of inputs. The benefits form trade may be dynamic rather than static if specialization stimulates productivity growth through learning by doing (Lucas, 1988).

Romer (1990) found that trade openness explore opportunity to the domestic produces a wider variety of capital goods, and enlarging the base of productive knowledge. By access to more knowledge and a greater variety of intermediate goods and a wider market to faster productivity growth. This product-variety model and the quality-ladder model (Aghion and Howitt, 1992) are supportive, confirmed by Coe and Helpman (1995). On the other hand, the impact of trade policy on growth rate, volume of trade, methodologies used and robustness of results have been challenged by Rodriguez and Rodrik (2001), Ozturk and Acaravci (2010), Aljebrin (2018), Obeid and Awad (2018), Khobai et al. (2018), and Rodríguez (2007).

Dollar (1992) found a significant negative correlation between real exchange rate distortions and growth, which means a positive relation between trade and growth. Rodriguez and Rodrik (2001) argued that the law of one price may not hold due to many of factors. In particular, the monetary policy and nominal exchange rate policy may influence the real exchange rate irrespective of trade policy. On the top of that by applying the Dollar's method with updated data set they found an opposite regression result. This finding was confirmed by the Baldwin (2003) that Dollar failed to demonstrate a significant relationship between foreign orientation and growth.

Frankel and Romer (1999) studied various level of development of 150 countries, by measuring the real gross domestic product (GDP) per person in 1985, to control the potential endogeneity of trade they used geographical variables as exogenous variable. They found that 10% increase in trade integration increases level of income per person by 20%. Dollar and Kraay (2003) used the Frankel-Romer measure openness to find the decadal growth of per-capita GDP and found that a doubling of trade integration increases the annual growth rate by 2.5%.

Sachs et al. (1995) give a compact evidence of positive trade and growth relationship and find that developing countries with open economy grows at 4.49% per year while at the same tine developed open economy had grown at 2.29% per year. On the other hand, closed developing and developed economies have grown at 0.69% and 0.74% per year respectively. Edwards (1998) tries to capture different channels through which policy makers can protect their economies from foreign competition. He shows that total factor productivity growth is higher for open economies. In his study, he claims that the findings are robust to functional form, measures of trade openness, method of estimation and time period.

Krueger and Berg (2003) analysed the trade-growth relationship by cross country and panel regressions at both industry and firm level and found trade influences economic growth. This finding was supported by the Winters (2004) and concluded that trade openness enhances economic growth at least over the medium term. Mendoza (2010) found that the empirical record of trade and economic growth is not clear and the relationship between trade relationship between trade and economic growth is conditional. This view is supported by the Stone and Strutt (2010) that trade is an important driver of growth and infrastructure is pre-condition for growth. Again, same finding is supported by Chang et al. (2009) that the impact of increased openness is higher on growth provided that there is higher investment in human capital, deeper markets and needed infrastructure.

During the 1990-2000 it got a consensus that there is positive relationship between trade and economic growth but after the critical work done by Rodriguez and Rodrik (2001) things got a momentum. The study criticized the measures of openness used by Dollar (1992) and Sachs et al. (1995) on different issues. Methodology used by Edwards (1998) and Frankel and Romer (1999) was also criticized by them. That means they doubted the results of positive relationship between trade and growth due to these defects.

3. ECONOMETRIC MODEL AND DATA SOURCE

The relationship between economic growth (Y), trade openness (T), capital formation (K) and FDI (F) is modelled as follows:

$$Y_{it} = f(T_{it}, K_{it}, F_{it}) \quad (1)$$

$$Y_{it} = \beta_{1i}T_{it} + \beta_{2i}K_{it} + \beta_{3i}F_{it} + u_{it} \quad (2)$$

In Eq. (2), cross-sections are denoted by subscript i ($i = 1, 2,\ldots N$) and time period by subscript t ($t = 1, 2\ldots T$), and u is the stochastic random term.

Real GDP per capita in constant 2010 (US$) is used to measure economic growth, exports (constant 2010 US$) plus imports (constant 2010 US$) divided by total population is used to measure trade openness, gross capital formation (constant 2010 US$) divided by total population is used to measure per capita domestic investment, FDI divided by total population is used to measure per capita FDI inflows in constant 2010 (US$).

For estimating the econometric model, 15 Asian countries are selected on the basis of data availability. Asian countries included in the balanced panel are: Bangladesh, China, India, Indonesia, Iran, Japan, Malaysia, Pakistan, Philippines, Saudi Arabia, Singapore, Sri Lanka, Thailand, Turkey and Korea. The study covers the period of 1990-2017. Data on GDP per capita, trade openness, gross capital formation, FDI and total population are obtained from World Development Indicators of the World Bank.

4. METHODOLOGY

4.1. Panel Unit Root Test

Adding the cross-sectional dimension to the usual time dimension is very important in the context of nonstationary series. The main difference between unit root tests in time series data and panel data concerns the issue of heterogeneity. In the time series case, heterogeneity is not a problem since the unit root hypothesis is tested in a given model for a given individual. But, if individuals are characterized by different dynamics, the panel is heterogeneous and the panel unit root tests must take into account this heterogeneity, even if tests based on pooled estimates of the autoregressive parameters could be consistent against a heterogeneous alternative (Moon and Perron, 2008). This notion of heterogeneity constitutes a central point in the econometrics of panel data (Hsiao, 1986, Pesaran and Smith, 1995 for the dynamic models).

In this study, we used Levin-Lin-Chu (LLC) (Levin and Lin 1992, 1993 and Levin et al., 2002), Im, Pesaran and Shin (IPS) (Im et al., 1997; 2003), MW-augmented Dickey-Fuller (ADF) (Maddala and Wu, 1999), and MW-PP (Maddala and Wu, 1999) panel unit root tests to check the stationarity properties of the variables.

4.1.1. LLC unit root test

Levin et al. (1993) observed the stochastic process y_{it} for a panel of individuals $I = 1,\ldots N$ and each individual contains $t = 1,\ldots T$ time series observations. They wish to determine whether y_{it} is integrated for each individual in the panel. LLC test suggest the following hypotheses:

H_0 = Each time series contains a unit root

H_1 = Each time series is stationary.

The testing method follows the subsequent steps:

First, implement a separate ADF for each country

$$\Delta y_{it} = \rho_i y_{i,t-1} + \sum_{L=1}^{p_i} \eta_{iL}\Delta y_{it-L} + \alpha_{mi}d_{mt} + \varepsilon_{it} \quad (3)$$

The lag order p_i is permitted to vary across individuals. For selecting appropriate lag order, choose a maximum lag order and use the *t*-statistics of η_{iL} to determine if a smaller lag order is preferred.

Second, run two auxiliary regressions to generate orthogalized residuals:

1. Regress Δy_{it} on Δy_{it-L} ($L = 1,\ldots,p_i$) and d_{mt} to obtain the residual $\hat{e}_{it}$

$$\hat{e}_{it} = \Delta y_{it} - \sum_{L=1}^{p_i} \hat{\theta}_{iL}\Delta y_{it-L} - \hat{\alpha}_{mi}d_{mt} \quad (4)$$

2. Regress $y_{i,t-1}$ on $\Delta y_{i,t-1}$ ($L = 1,\ldots,p_i$) and d_{mt} to obtain the residual $\hat{v}_{it-1}$

$$\hat{v}_{it-1} = y_{it-1} - \sum_{L=1}^{p_i} \tilde{\theta}_{iL}\Delta y_{it-L} - \tilde{\alpha}_{mi}d_{mt} \quad (5)$$

Save the residuals $\hat{e}_{it}$ and $\hat{v}_{it-1}$ from these regressions.

Third, standardization of the residuals by performing

$$\tilde{e}_{it} = \frac{\hat{e}_{it}}{\hat{\sigma}_{\varepsilon i}}, \quad \tilde{v}_{it-1} = \frac{\hat{v}_{it-1}}{\hat{\sigma}_{\varepsilon i}} \quad (6)$$

Where $\hat{\sigma}_{\varepsilon i}$ denotes the standard error from each ADF Eq. (3).

Finally, run the pooled ordinary least squares (OLS) regression to compute the panel test statistics:

$$\tilde{e}_{it} = \rho\tilde{v}_{it-1} + \tilde{\varepsilon}_{it} \quad (7)$$

The null hypothesis is H_0: $\rho = 0$ and alternate hypothesis is H_1: $\rho < 0$. The conventional regression *t*-statistic for testing $\rho = 0$ is given by

$$t_\rho = \frac{\hat{\rho}}{se(\hat{\rho})} \quad (8)$$

4.1.2. IPS test

The IPS (Im et al., 1997) test allows for heterogeneous coefficients. This test basically applies the ADF test Eq. (3) to individual series thus allowing each series to have its own short-run dynamics. But the overall t-test statistics is based on the arithmetical mean of all individual countries' ADF statistics. The null hypothesis is defined as H_0: $\rho_i = 1$ for all *i,* whereas the alternative hypothesis is given as H_1: $\rho_i < 1$ for at least one *i*. The estimable equation of IPS unit root test is modelled as follows:

$$\bar{t}_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{i,t}(P_i) \tag{9}$$

Where, $t_{i,t}$ is the ADF t-statistics for the unit root tests of each country and P_i is the lag order in the ADF regression and test statistics can be calculated as follows:

$$t_{IPS} = \frac{\sqrt{N(T)}\left[\bar{t}_T - E(t_T)\right]}{\sqrt{\mathrm{var}(t_T)}} \tag{10}$$

Values for $E\left[t_{iT}(P_{i,}0)\right]$ can be obtained from the results of Monte Carlo simulation carried out by IPS, they have calculated and tabulated them for various time periods and lags.

4.1.3. MW unit root test

MW (Maddala and Wu, 1999) panel unit root test is a Fisher type test that combines probability values from unit root tests for each cross-section i. The test statistics are given by

$$t_{MW} = -2\sum_{i=1}^{n} \ln(p_i) \tag{11}$$

Where, p_i is the probability value from ADF unit root tests for unit i. The test is asymptotically Chi-square distributed with 2N degrees of freedom as $T_i \to T_i \to \infty$ for all N. The MW unit root test is superior to the IPS unit root test because it does not require a balanced panel and the MW test is sensitive to lag length selection in individual ADF regressions.

4.2. Panel Cointegration Test

A method for testing the null of no cointegration in dynamic panels with multiple regressors are developed by Pedroni (1999; 2004). The tests allow for considerable heterogeneity among individual members of the panel, including heterogeneity in both the long-run cointegrating vectors as well as heterogeneity in the dynamics associated with short-run deviations from these cointegrating vectors (Pedroni, 1999). To compute the regression residuals from the hypothesized cointegrating regression, Pedroni (1999) used the following equation:

$$y_{i,t} = \alpha_i + \delta_i t + \beta_{1i,}x_{1i,t} + \beta_{2i}x_{2i,t} + \ldots + \beta_{mi}x_{mi,t} + \varepsilon_{i,t} \tag{12}$$

For $t = 1,\ldots,T$; $i = 1,\ldots,N$; $m = 1,\ldots,M$

Where T refers to the number of observations over time, N refers to the number of individual members in the panel, and M refers to the number of regression variables. The member-specific intercept, or fixed-effects parameter α_i and slope coefficients $\beta_{1i}, \beta_{2i}, \ldots \beta_{mi}$ vary across individual members of the panel. Pedroni (1999; 2004) suggested seven different statistics to test for cointegration relationship in a heterogeneous panel. Of these seven statistics, four are referred to as the within-dimension (panel cointegration statistics) and three are referred to as the between-dimension (group mean panel cointegration statistics). For the within-dimension statistics, the null hypothesis of no cointegration as H_0: δ_i=1 for all $i = 1, 2,\ldots, N$ and the alternative hypothesis H_1: $\delta_i < 1$ where presumes a common value for $\delta_i = \delta$. On the other hand, for between-dimension statistics the null of no cointegration as H_0: δ_i=1 for all $i = 1, 2,\ldots, N$ and the alternative hypothesis H_1: $\delta_i < 1$ where it does not presumes a common value for $\delta_i = \delta$. After computing the regression residuals from the hypothesized cointegration Eq. (12), Pedroni's seven test statistics are as follows:

1. Panel v-Statistic : $$Z_{\hat{v}_{N,T}} = T^2 N^{3/2}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{i,t-1}^2\right)^{-1}$$
2. Panel ρ-statistic : $$Z_{\hat{\rho}_{N,T^{-1}}} = T\sqrt{N}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{i,t-1}^2\right)^{-1} \sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}(\hat{\varepsilon}_{i,t-1}\Delta\hat{\varepsilon}_{i,t} - \hat{\lambda}_i)$$
3. Panel t-statistic (non-parametric) : $$Z_{t_{NT}} = \left(\tilde{\sigma}_{N,T}^2\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{i,t-1}^2\right)^{-1/2} \sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}(\hat{\varepsilon}_{i,t-1}\Delta\hat{\varepsilon}_{i,t} - \hat{\lambda}_i)$$
4. Panel t-statistic: (Parmetric) : $$Z_{t_{NT}}^{*} = \left(\tilde{s}_{N,T}^{*2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\varepsilon_{i,t-1}^{*2}\right)^{-1/2} \sum_{i=1}^{N}\sum_{i=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{i,t-1}^{*}\Delta\hat{\varepsilon}_{i,t}^{*}$$
5. Group ρ-statistic : $$\tilde{Z}_{\hat{\rho}_{N,T^{-1}}} = TN^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{\varepsilon}_{i,t-1}^2\right)^{-1}\sum_{t=1}^{T}(\hat{\varepsilon}_{i,t-1}\Delta\hat{\varepsilon}_{i,t} - \hat{\lambda}_i)$$
6. Group t-statistic (non-parametric) : $$\tilde{Z}_{t_{N,T}} = N^{-1/2}\sum_{i=1}^{N}\left(\hat{\sigma}_i^2\sum_{t=1}^{T}\hat{\varepsilon}_{i,t-1}^2\right)^{-1/2}\sum_{t=1}^{T}(\hat{\varepsilon}_{i,t-1}\Delta\hat{\varepsilon}_{i,t} - \hat{\lambda}_i)$$
7. Group t-statistic (parametric) : $$\tilde{Z}_{t_{N,T}}^{*} = N^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{s}_i^{*2}\hat{\varepsilon}_{i,t-1}^{*2}\right)^{-1/2}\sum_{t=1}^{T}\hat{\varepsilon}_{i,t-1}^{*}\Delta\hat{\varepsilon}_{i,t}^{*}$$

In his paper Pedroni (1999) describes the seven test statistics. "The first of the simple panel cointegration statistics is a type of non-parametric variance ratio statistics. The second is a panel version of a nonparametric statistics that is analogous to the familiar Phillips–Perron rho-statistics. The third statistics is also non-parametric and is analogous to the Philips and Perron t-statistics. The fourth statistics is the simple panel cointegration statistics which is corresponding to the ADF-statistics" (Pedroni 1999, p. 658). The rest of the statistics are based on a group mean approach. "The first of these is analogous to the Philips and perron rho-statistics, and the last two analogous to the Phillips and perron statistics and the ADF statistics, respectively" (Pedroni, 1999, p. 658). Pedroni (2004) examined the small sample power properties of his seven test statistics. He found that the size distortion is small and the power is high for T > 100. For smaller T, he shows that the group ADF test has the best power properties followed by the panel ADF test; the panel variance test and group rho test perform poorly.

4.3. Panel Cointegration Regression Estimation

If all the variables are cointegrated, the next step is to estimate the associated long-run relationship among the variables. In the presence of cointegration, the OLS estimator is known to yield biased and inconsistent results (Johansen, 1988;1995). For this reason, several estimators for cointegrated panel data have been proposed. The most commonly used estimators have been dynamic OLS (DOLS) proposed by Kao and Chiang (2001) and the fully-modified OLS (FMOLS) proposed by Phillips and Moon (1999) and Pedroni (2000).

4.3.1. Panel DOLS estimator

Kao and Chiang (2001) argue that their parametric panel DOLS estimator (that pools the data along the within dimension of the panel) is promising in small samples and performs well in general in cointegrated panels. However, the panel DOLS of Kao and Chiang (2001) does not consider the importance of cross-sectional heterogeneity in the alternative hypothesis. The DOLS estimator is obtained from the following equation:

$$y_{it} = \alpha_i + \beta_i x_{it} + \sum_{j=-q_1}^{j=q_2} \gamma_{ij} \Delta x_{i,t+j} + u_{it} \quad (13)$$

Where y_{ij} is the coefficient of a lead or lag of first differenced explanatory variables. The estimated coefficient of DOLS is given by:

$$\hat{\beta}_D = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} z_{it} z'_{it} \right)^{-1} \left(\sum_{t=1}^{T} z_{it} \hat{y}_{it} \right) \quad (14)$$

Where, $z_{it} = \left[x_{it} - \bar{x}_i, \Delta x_{i,t-q,...,} \Delta x_{i,t+q} \right]$ is $2(q+1)\times 1$ vector of regressors.

4.3.2. FMOLS estimator

Pedroni's (2001) FMOLS estimator for conintegrated panels allows for cross-sectional heterogeneity in the alternative hypothesis, endogeneity and serial correlation problems to obtain consistent and asymptotically unbiased estimates of the cointegrating vectors. Following Pedroni (2001), the FMOLS technique generates consistent estimates in small samples and does not suffer from large size distortions in the presence of endogeneity and heterogeneous dynamics. Pedroni (2001) used the following regression equation:

$$y_{it} = \alpha_i + \beta_i x_{it} + u_{it} \quad (15)$$

Where, y_{it} and x_{it} are cointegrated with slopes β_i, which may or may not be homogeneous across *i*. The estimated coefficient of group mean panel FMOLS is given by:

$$\hat{\beta}_{GFM} = N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} (x_{it} - \bar{x}_i)^2 \right)^{-1} \left(\sum_{t=1}^{T} (x_{it} - \bar{x}_i) y^*_{it} - T\hat{\psi}_i \right) \quad (16)$$

Where,

$y^*_{it} = (y_{it} - \hat{y}_i) - \frac{\hat{\Omega}_{21i}}{\hat{\Omega}_{22i}} \Delta x_{it}$ (transformed variable to achieve the endogeneity correction)

$\hat{\psi}_i = \hat{\Gamma}_{21i} + \hat{\Omega}^o_{21i} - \frac{\hat{\Omega}_{21i}}{\hat{\Omega}_{22i}} (\hat{\Gamma}_{22i} + \hat{\Omega}^o_{22i})$ (serial correlation correction term)

The group mean panel FMOLS estimator can be constructed simply as $\hat{\beta}_{GFM} = N^{-1} \sum_{i=1}^{N} \hat{\beta}_{FM,i}$ where $\hat{\beta}_{FM,i}$ is the conventional FMOLS estimator, applied to the i^{th} member of the panel and the associated *t*-statistic can be constructed as

$$t_{\hat{\beta}_{GFM}} = N^{-1/2} \sum_{i=1}^{N} t_{\hat{\beta}_{FM,i}} \quad \text{where,}$$

$$t_{\hat{\beta}_{FM,i}} = \left(\hat{\beta}_{FM,i} - \beta_0 \right) \left(\hat{\Omega}^{-1}_{11i} \sum_{t=1}^{T} (x_{it} - \bar{x}_i)^2 \right)^{1/2}$$

4.4. Panel Vector Error Correction Model (VECM) Granger Causality Test

If the model contains cointegration relationship between the variables, a panel VECM developed by Pesaran et al. (1999) can be estimated to perform Granger causality tests, which could test both short run and long run causality. Evidence of cointegration between variables implies that there exists causality in at least one direction (Granger, 1969). The following VECM models are used to test the causality relation between the variables.

$$\Delta Y_{it} = \alpha_{1j} + \sum_{k=1}^{p} \beta_{ik} \Delta Y_{it-k} + \sum_{k=1}^{p} \gamma_{ik} \Delta T_{it-k} + \sum_{k=1}^{p} \lambda_{ik} \Delta K_{it-k} + \sum_{k=1}^{p} \theta_{ik} \Delta F_{it-k} + \psi_1 ECT_{t-1} + \varepsilon_{1t} \quad (17)$$

$$\Delta T_{it} = \alpha_{2j} + \sum_{k=1}^{p} \beta_{ik} \Delta T_{it-k} + \sum_{k=1}^{p} \gamma_{ik} \Delta Y_{it-k} + \sum_{k=1}^{p} \lambda_{ik} \Delta K_{it-k} + \sum_{k=1}^{p} \theta_{ik} \Delta F_{it-k} + \psi_2 ECT_{t-1} + \varepsilon_{2t} \quad (18)$$

$$\Delta K_{it} = \alpha_{3j} + \sum_{k=1}^{p} \beta_{ik} \Delta K_{it-k} + \sum_{k=1}^{p} \gamma_{ik} \Delta Y_{it-k} + \sum_{k=1}^{p} \lambda_{ik} \Delta T_{it-k} + \sum_{k=1}^{p} \theta_{ik} \Delta F_{it-k} + \psi_3 ECT_{t-1} + \varepsilon_{3t} \quad (19)$$

$$\Delta F_{it} = \alpha_{5j} + \sum_{k=1}^{p} \beta_{ik} \Delta F_{it-k} + \sum_{k=1}^{p} \gamma_{ik} \Delta Y_{it-k} + \sum_{k=1}^{p} \lambda_{ik} \Delta T_{it-k} + \sum_{k=1}^{p} \theta_{ik} \Delta K_{it-k} + \psi_5 ECT_{t-1} + \varepsilon_{5t} \quad (20)$$

Where, Δ denotes the first difference of the variable, *p* is the lag length, β_{ik}, γ_{ik}, λ_{ik}, δ_{ik}, θ_{ik} are short-run dynamic coefficients of the model's convergence to equilibrium, ECT_{t-1} is the lagged error-correction term from the cointegration relationship and the coefficient (ψ) of the ECT_{t-1} is the speed of adjustment. The dependent variable is regressed against past values of itself and other variables. The *t*-statistic on the coefficient of the lagged error-correction terms in each set of equations indicates the significance of the long-run causal effect. Short-run causality is estimated by testing various hypotheses. For example, short-run causality from *T* to *Y* is calculated by testing hypothesis: H_0: $\gamma_{ik} = 0$ for all *i* and *k*. The rejection of this hypothesis implies that *T* is causing *Y* in the short run. A similar procedure will be employed to test various hypotheses.

5. EMPIRICAL RESULTS AND DISCUSSION

5.1. Panel Unit Root Test Results

The estimated results of unit root tests at level and first difference are present in Table 1. In this study we use three panel unit root

Table 1: Panel unit root test results

Variables	At level				At first difference			
	Without trend	P-value	With trend	P-value	Without trend	P-value	With trend	P-value
LLC test								
Y_{it}	7.09	1.00	1.90	0.97	−2.16	0.00	−5.95	0.00
T_{it}	0.75	0.77	−0.07	0.49	−9.23	0.00	−7.64	0.00
K_{it}	6.71	1.00	3.02	0.99	−3.53	0.00	−3.52	0.00
F_{it}	−0.35	0.36	−0.57	0.28	−9.26	0.00	−6.84	0.00
IPS test								
Y_{it}	10.06	1.00	3.53	0.99	−5.56	0.00	−6.41	0.00
T_{it}	3.74	0.99	−0.58	0.27	−9.59	0.00	−7.23	0.00
K_{it}	6.02	1.00	3.28	0.99	−6.04	0.00	−4.81	0.00
F_{it}	3.69	0.99	−0.86	0.33	−9.31	0.00	−7.97	0.00
MW (augmented Dickey-Fuller) test								
Y_{it}	1.68	1.00	20.48	0.90	105.20	0.00	96.86	0.00
T_{it}	14.16	0.99	32.79	0.33	146.68	0.00	105.51	0.00
K_{it}	14.71	0.99	19.92	0.91	103.31	0.00	75.85	0.00
F_{it}	15.91	0.99	35.54	0.27	152.30	0.00	116.94	0.00
MW (PP) test								
Y_{it}	2.59	1.00	17.63	0.96	174.87	0.00	319.12	0.00
T_{it}	12.25	0.99	27.18	0.61	214.70	0.00	171.07	0.00
K_{it}	12.77	0.99	17.57	0.96	192.38	0.00	167.62	0.00
F_{it}	14.81	0.64	26.35	0.58	219.16	0.00	250.71	0.00

tests: LLC, IPS and MW on each selected variable without trend and with trend. The empirical test results suggest that all variables are non-stationary in their level form but the series are stationary at first difference. Thus, we reject the null hypothesis of non-stationary at 1% level of significance and conclude that all series are integrated of order one I(1) in the panel of 15 Asian countries.

5.2. Panel Cointegration Test Results

Since the variables are found to be integrated in the same order I(1), it helps us to apply the panel cointegration tests approach proposed by Pedroni (1999; 2004) to examine long-run relationship between the variables for the selected panel. Pedroni uses four within dimension (panel) test statistics and three between dimension (group) statistics to check whether the selected panel data are cointegrated. The results of Pedroni (1999; 2004) panel cointegration tests are stated in Table 2.

The cointegration test results reveal that, with intercept there are three out of seven statistics reject the null hypothesis of no cointegration at the 1% (Group ADF-statistics) and 5% (panel PP-statistics and group PP-statistics) significance level. Whereas, with intercept and trend there are five out of seven statistics reject the null hypothesis on no cointegration at the 1% (panel *v*-statistics, panel PP-statistics and group ADF-statistics) and 5% (panel ADF-statistics, group PP-statistics) significance level. Therefore, GDP, trade openness, capital formation, and FDI are cointegrated in our selected panels of 15 Asian countries for the period 1990-2017.

In the Tables 3 and 4 it has been displayed the result of FMOLS and DOLS for individual country. As it is well known that difference between these two approaches is not very significant from each other in terms of sign, magnitude and statistical significance. That's why the results are analysed in combined. In case of trade openness, sign of coefficient is positive and significance for all

Table 2: Pedroni panel cointegration test results

Test	With intercept	P-value	With intercept and trend	P-value
Panel				
v-statistic	1.2080	0.1135	7.5883*	0.0000
Rho-statistic	–0.2477	0.4022	0.3693	0.6441
PP-statistic	–1.7781**	0.0183	–2.1571*	0.0082
ADF-statistic	–0.4213	0.3368	–1.9053**	0.0284
Group				
Rho-statistic	2.1847	0.9855	2.2554	0.9879
PP-statistic	–2.0940**	0.0181	–2.0858**	0.0185
ADF-statistic	–2.1817*	0.0080	–2.4732*	0.0067

*, **Indicates rejection of the null hypothesis of no-co-integration at 1% and 5%, levels of significance respectively, ADF: Augmented Dickey-Fuller

14 selected Asian countries except India. However, the negative coefficient for India is statistically insignificant. Increase in capital formulation leads to growth in almost all countries except Pakistan, where sign is negative but statistically insignificant. Finally, in case of FDI the sign of the coefficient is positive and significant for Singapore and Korea. The results of FMOLS and DOLS at group level are reported in Table 5. Results shows that sing of all coefficient are according to economic theory but trade openness and capital formulation are significant.

Table 6 portrays the results of short-run and long-run Granger causality tests. With respect to the 17th equation the sign of error-correction term's coefficient is negative and significant at 1% level with 7% speed of adjustment to long-run equilibrium. The negative sign of error-correction term confirms the existence of long-run Granger causality running form trade openness, capital formation and FDI to income. With respect to short term casualty tests there is evidence of Granger causality running form trade openness to income, capital formation to income and FDI to income. From the 18th equation, the sign of error-correction term is negative and significant at 1% level with 3% speed of adjustment to long-run equilibrium. The negative sign of the

Table 3: Fully-modified ordinary least squares country-specific results (Y_{it}: Dependent variable)

Country	Variables			
	T_{it}	K_{it}	F_{it}	Constant
Bangladesh				
Coefficient	0.02	2.45	0.67	255.90
P-value	0.478	0.000	0.404	0.000
China				
Coefficient	0.38	1.73	−3.52	664.68
P-value	0.001	0.000	0.001	0.000
India				
Coefficient	−0.46	3.14	−3.51	221.78
P-value	0.421	0.001	0.445	0.007
Indonesia				
Coefficient	1.91	0.59	−4.34	35.03
P-value	0.000	0.036	0.139	0.909
Iran				
Coefficient	1.86	0.25	−2.91	339.64
P-value	0.001	0.599	0.627	0.602
Japan				
Coefficient	0.97	0.34	1.34	28817.06
P-value	0.000	0.013	0.424	0.000
Malaysia				
Coefficient	0.48	1.11	1.15	−199.71
P-value	0.000	0.007	0.437	0.785
Pakistan				
Coefficient	3.11	−3.31	−0.46	565.35
P-value	0.010	0.200	0.934	0.215
Philippines				
Coefficient	0.83	0.67	−0.75	566.92
P-value	0.000	0.314	0.831	0.004
Saudi Arabia				
Coefficient	0.22	0.69	−1.57	13696.23
P-value	0.025	0.000	0.000	0.000
Singapore				
Coefficient	0.14	0.50	0.41	11682.37
P-value	0.000	0.001	0.001	0.000
Sri Lanka				
Coefficient	1.07	0.82	4.59	404.60
P-value	0.001	0.013	0.406	0.013
Thailand				
Coefficient	0.54	0.21	−1.75	1593.57
P-value	0.000	0.151	0.072	0.000
Turkey				
Coefficient	0.48	2.39	−6.46	2696.46
P-value	0.013	0.000	0.000	0.000
Korea				
Coefficient	0.42	1.05	7.56	4059.18
P-value	0.000	0.004	0.003	0.003

Table 4: Dynamic ordinary least squares country-specific results (Y_{it}: Dependent variable)

Country	Variables			
	T_{it}	K_{it}	F_{it}	Constant
Bangladesh				
Coefficient	0.12	2.18	1.17	269.64
P-value	0.003	0.000	0.249	0.000
China				
Coefficient	0.69	1.28	−0.25	662.73
P-value	0.008	0.002	0.927	0.000
India				
Coefficient	−0.27	3.71	−16.22	159.14
P-value	0.638	0.001	0.000	0.015
Indonesia				
Coefficient	1.86	0.25	−2.91	339.64
P-value	0.001	0.599	0.627	0.602
Iran				
Coefficient	−0.38	1.78	−0.86	3278.52
P-value	0.117	0.000	0.907	0.000
Japan				
Coefficient	0.80	0.06	5.65	33339.50
P-value	0.000	0.770	0.151	0.000
Malaysia				
Coefficient	0.47	1.01	1.41	−21.38
P-value	0.000	0.075	0.597	0.981
Pakistan				
Coefficient	2.31	−7.54	5.78	1438.18
P-value	0.017	0.001	0.187	0.000
Philippines				
Coefficient	1.04	−0.09	−0.92	552.37
P-value	0.000	0.941	0.871	0.079
Saudi Arabia				
Coefficient	−0.11	1.14	−1.47	16465.90
P-value	0.630	0.003	0.036	0.000
Singapore				
Coefficient	0.14	0.60	0.44	10928.25
P-value	0.000	0.005	0.018	0.000
Sri Lanka				
Coefficient	0.77	1.19	8.94	468.36
P-value	0.000	0.000	0.088	0.000
Thailand				
Coefficient	0.60	0.14	−5.48	1735.17
P-value	0.000	0.047	0.000	0.000
Turkey				
Coefficient	0.46	2.77	−9.13	2242.02
P-value	0.002	0.000	0.000	0.000
Korea				
Coefficient	0.41	0.93	12.77	4636.78
P-value	0.000	0.031	0.000	0.006

error-correction term again confirms that long run causality running from all three variables to trade openness. With respect to short run causality of this equation and previous one it can be said that there is bidirectional causality between trade openness and income growth. From the 19th equation, the sign of error-correction term is negative and significant at 1% level with 2% speed of adjustment to long-run equilibrium which further confirm the existence of long run causality. And with respect to the short-run casualty test there is casualty running from income growth, trade openness and FDI to capital formulation. Finally, from the 20th equation again the sign is negative and significant at 1% level. Which again confirm the long-run relationship among all the variables. And with respect to the short-run causality test there is casualty running from trade openness to FDI. The last outcome suggests a bidirectional casualty between trade openness and FDI.

Table 5: FMOLS and DOLS panel results (Y_{it}: Dependent variable)

Variables	FMOLS		DOLS	
	Coefficient	P-value	Coefficient	P-value
T_{it}	0.650	0.000	0.593	0.000
K_{it}	0.903	0.000	0.627	0.000
F_{it}	0.661	0.389	−0.071	0.939

FMOLS: Fully-modified ordinary least squares, DOLS: Dynamic ordinary least squares

Table 6: Vector error correction model based Granger causality results

Dependent variables	Independent variables					Direction of causality
	ΔY_{it}	ΔT_{it}	ΔK_{it}	ΔF_{it}	ECT_{t-1}	
ΔY_{it} Eq. (17)		25.91* (0.00)	34.90* (0.00)	48.91* (0.00)	−0.07* (0.00)	T→Y, K→Y, F→Y
ΔT_{it} Eq. (18)	42.24* (0.00)		39.21* (0.00)	76.20* (0.00)	−0.03* (0.00)	Y→T, K→T, F→T
ΔK_{it} Eq. (19)	16.30* (0.00)	17.81* (0.00)		20.17* (0.00)	−0.02* (0.00)	Y→K, T→K, F→K
ΔF_{it} Eq. (20)	1.45 (0.22)	26.36* (0.00)	1.82 (0.17)		−0.08* (0.00)	T→F

Wald F-statistics reported with respect to short-run changes in the independent variables. ECT represents the coefficient of the error correction term. Values in ( ) are P-values. *Indicate the significance at 1% level

6. CONCLUSION AND POLICY IMPLICATIONS

The objective of the study is to find the direction of casual relationship between trade openness and economic growth using data of 15 Asian countries over a period of 1990 to 2017. In order to do this, we have applied panel unit root test to examine the integrating properties of the variables. For findings the cointegration between the variables, we have applied pedroni cointegration approaches. The VECM based Granger causality are applied to examine the direction of causality between variable in the Asian countries. We have also used FMOLS and DOLS to find the long-run responsiveness of the relationship. The empirical results say that all variables are integrated at I(1) confirmed by panel unit root. In the same way conclusion can be about the cointegration between economic growth and trade openness. The FMLOS and DOLS estimation analysis depict a positive and significant relationship between trade openness and economic growth for all 14 countries except India, whose coefficient is not statistically significant. From the result of short run and long run Granger causality test it is found that the sign of the coefficient of error-correction term is negative and significant. The negative sign of the error-correction term confirms the existence of long-run Granger causality of trade openness and economic growth. From the short run causality test there is evidence that causality running from trade to growth and growth to trade. So, it can be concluded that there is a bidirectional causality between trade and economic growth. To use this long run causal relationship the Asian counties should take pragmatic steps to increase export, which will help in earnings of foreign exchange and that will lead to economic growth rapidly. Also, they have to concentred to export semi manufacturing goods than to just raw materials. They have to be open enough to import advanced technology and capital-intensive technology, which could help their market to be competitive and more efficient. On the same side they should invest on human capital formation, so that they can adapt to the modern economical change.

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