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The Nexus between Openness and Economic Growth : Evidence from a Multivariate Panel VAR Model

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Abstract

The paper explores the long run equilibrium relationship between openness and economic growth in a multivariate panel VAR model for Australia, Canada and Israel over the period 1960-2008. Cointegration and causality tests, at individual and group level, are used to know whether trade openness stimulate economic growth (or vice versa) with the inclusion of foreign direct investment. The results confirm the bidirectional causality from openness to economic growth and openness to FDI in Australia and Canada. It also confirms the presence of unidirectional causality from economic growth to FDI in Australia, Canada and Israel. However, there is no evidence for short run Granger causality from openness to foreign direct investment in Israel. The dynamic panel data model further confirms the unidirectional causality from economic growth to foreign direct investment and bidirectional causality between economic growth and openness.

I. Introduction

A CLASSIC AND important topic in both trade and development literature has been the potential impact of a country's openness on its economic growth. The question of concern is whether openness can have a propulsive role on economic development of a country. The literature, in fact, provides divergent views on the issue of openness to economic growth. However, it is widely accepted that openness constitutes a potentially important mechanism for long run economic growth. We have numerous studies that support the relationship between openness and economic growth, both theoretically and empirically. The theoretical underpinning of this relationship can be traced back to the work of Solow (1956) and more recently, to Bhagwati (1978), Krueger (1978), Lucas (1988) and their disciples like Romer (1986), Grossman and Helpman (1991), Yougn (1991), Levine and Renelt (1992), Edwrads

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(1993), Sachs and Warner (1995) and Slaughter (1995). The overall finding is that openness contributes economic growth through efficient allocation of resources, competition in national and international markets and diffuses knowledge and technology across the countries. The relationship between the two is considered as a positive sum game. Therefore, an open economy can grow much faster than a closed economy.

Methodologically, there are two approaches on the issue of the relationship between "openness and economic growth": production based regression model approach (Michaely, 1977; Balassa, 1978; Tyler, 1981; Kavoussi, 1984; Feder, 1982; Moschos, 1989; Salvatore and Hatch, 1991; Edwards, 1998; Yanikkaya, 2003) and causality approach (Jung and Marshall, 1985; Chow, 1987; Kunst and Mavin, 1989; Krueger, 1990; Dadoro, 1991; Gartley, 1993; Frankel and Romer, 1999; Bahmani-Oskooee and Niroomand, 1999; Awokuse, 2007). The present study, however, deals with the causality approach. The objective of this approach is to know the direction of causality between openness and economic growth in a bivariate and multivariate framework. We have lots of empirical investigation on the issue of the direction of causality between openness and economic growth. However, most of the studies have primarily focused on the role of exports towards economic growth and merely ignored the contribution of imports. But in reality, the linkage between exports and economic growth, without involvement of imports, may be spurious and misleading (Riezman et al., 1996). These studies have also ignored the impact of capital flows, measured by Foreign Direct Investment (FDI), on economic growth and openness. Hence, our main task in this paper is to integrate economic growth with openness and FDI in a multivariate panel Vector Auto Regressive (VAR) model.

The remaining of the paper is organized into four sections including earlier introduction. Section II describes the analytical framework and methodological issues. Section III discusses the multivariate VAR model. Section IV presents the empirical results and its discussion thereof. Section V presents conclusion with policy implications.

II Analytical Framework and Methodological Issues

The earlier empirical formulations tried to capture the causal link between exports and economic growth by incorporating exports into the aggregate production function (see Balassa, 1978; Sheehey, 1992). This article, however, expands the growth equation by including other potentially relevant variables such as exports, imports and foreign direct investment (FDI). Accordingly, the generalized aggregate production function that used in this paper is as follows:

$$Y = \{(K, L); EX, IM; FDI\} \tag{1}$$

where, Y represents real GDP growth, K is real gross capital, L represents labour, EX represents export, IM represents imports, and FDI represents inflows of foreign direct investment.

III. Econometric Methods

The paper seeks to explore the long run behavioural relationship between openness, FDI and economic growth in a VAR multivariate system. This requires an estimation technique appropriate for long-run equilibrium. We deploy cointegration and error correction model to explore the same. However, the prime requirement of these two techniques is to check the stationarity (order of integration) of these time series variables. This section provides a brief discussion about these techniques.

3.1 *Test for Order of Integration*

We applied Augmented Dickey Fuller (ADF) and Phillips and Perron (PP) unit root test to check the order of integration. The estimation procedure of these two tests is described as follows:

$$\Delta Y_t = \alpha_1 + \alpha_2 Y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (2)$$

where Y is the variable of choice; "Δ is the first- difference operator; α_i (for i = 1 & 2) and β_i (for i = 1, 2... p) are constant parameters; and ε_t is a stationary stochastic process. To determine the order of integration of a particular time series variable, the equation has to be modified by including second differences on lagged first and p lags of second differences. This is as follows:

$$\Delta^2 Y_t = \eta_1 \Delta Y_{t-1} + \sum_{i=1}^{p} \mu_i \Delta^2 Y_{t-i} + \xi_t \quad (3)$$

where Δ^2 is the second- difference operator; η_1 and μ_i (for i = 1, 2... p) are constant parameters; and ξ_t is a stationary stochastic process. The p lagged difference terms are included so that the error terms (ε_t and ξ_t) in the respective equations are serially independent. For stationarity, the ADF test (Dickey and Fuller, 1981) and PP test (Phillips and Perron, 1988) are applied to equations 2 and 3 respectively. The null hypothesis are H_0: $\alpha_2 = 0$ against H_0: $\alpha_2 \neq 0$ for equation 2 and H_0: $\eta_1 = 0$ against H_0: $\eta_1 \neq 0$ for equation 3 respectively.

We also deploy Im, Pesaran and Shin (2003) panel unit root test to discern the stationarity properties of the respective variables before proceeding to cointegration and causality. The panel unit root test allows for the heterogeneous autoregressive coefficients. The test averages the augmented Dickey- Fuller (ADF) unit root tests while allowing for different orders of serial correlation. This is presented as follows:

$$\Delta Y_{it} = \gamma_i Y_{it-1} + \sum_{j=1}^{p_i} \beta_j \Delta Y_{it-j} + u_{it} \quad (4)$$

where, $\varepsilon_{it} = \sum_{j=1}^{p_1} \rho_{ij} \varepsilon_{it-j} + u_{it}$; i = 1, 2,..N for each country in the panel; t = 1, 2, ...T refers to the time period; Y_{it} represents the exogenous variable in the model (i.e fixed effects or individual time trend); γ_i are the autoregressive coefficients; p_i represents the number of lags in the ADF regression; and ε_{it}

are the stationary terms. If $\gamma_i < 1$, Y_{it} is considered weakly trend stationery whereas if $\gamma_i = 1$, then Y_{it} contains a unit root. The null hypothesis is that each series in the panel contains a unit root. The alternative hypothesis is that at least one of the individual series in the panel is stationary. Im Pesaran and Shin (2003) specify a *t*-bar statistic as the average of the individual ADF statistics, and is normally distributed under the null hypothesis.

Let'*d*' denotes the number of times that a variable needs to be differenced in order to reach the stationarity. In this case, such a variable is said to be integrated of order'*d*' and denoted by I (d). For instance, if the variable is stationary at the level data then it is said to be integrated of order zero [i.e. I (0)]. Similarly, if the variable is stationary at the first difference then it is said to be integrated of order one [i.e. I (I)] and if the variable is stationary at the second difference then it is said to be integrated of order two [i.e. I (2)] and so on.

3.2 *Cointegration Test*

It is to be noted that the long run equilibrium relationship between two variables could be detected by the cointegration test. Cointegrated variables, if disturbed, will not drift apart from each other and hence, possess a long run equilibrium relationship. Testing for the existence of cointegration among economic variables has been widely used in the empirical literature to study economic interrelationships. Its existence would imply that the two series would never drift too far apart. A non-stationary variable, by definition, tends to wonder extensively over time, but a pair of non-stationary variables may have the property that a particular linear combination would keep them together, i.e., they do not drift too far apart. Under this scenario, two variables are said to be cointegrated, or possess a long run (equilibrium) relationship. The Johansen (1991) maximum likelihood test is used here to test the cointegration among the variables. The test procedure is as follows:

Consider a Vector Auto Regressive (VAR) model of order k:

$$\Delta Y_t = \mu + \Gamma_1 Y_{t-1} + \Gamma_2 X_{t-2} + ... + \Gamma_{k-1} X_{t-k+1} + \prod Y_{t-k} + \zeta_t \quad (5)$$

where, Y_t is an 3 X 1 vector of the first order integrated [i.e., I (1)] variables; Γ_i are 3 X 3 coefficient matrices; ζ_t is a vector of normally and independently distributed error terms. The existence of cointegrating vectors (r) implies Π is rank-deficient. The maximal eigenvalue and trace statistic tests derived by Johansen (1991) for identifying the number of distinct cointegrating vectors in the VAR are well known. If Π is of rank r (0 < r < 3), then it can be decomposed as: $\Pi = \alpha\beta'$, where α(3Xr) and β(3Xr); and the equation (3) can be rewritten as:

$$\Delta Y_t = \mu + \Gamma_1 Y_{t-1} + \Gamma_2 X_{t-2} + ... + \Gamma_{k-1} X_{t-k+1} + \alpha(\beta' Y_{t-k}) + \zeta_t \quad (6)$$

The rows of β are interpreted as the distinct cointegrating vectors whereby $\beta' Y_{t-k}$ from linear stationary processes. The α's are the error correction coefficients (loading factors) that indicates the speed of adjustment towards the long run equilibrium. In equation (4), β vector is unrestricted. Unless there is a unique cointegrating vector (i.e. r =1), the matrix of cointegrating vectors, as it stands, cannot be identified as typical long run economic relationships. This is because any linear combination of cointegrating vectors forms another linear stationary relationship. Hence, the VAR can also be rewritten as

$$\Delta Y_t = \mu + \Pi Y_{t-p} + \sum_{i=1}^{k-1} A_i \Delta Y_{t-i} + \varepsilon_t \qquad (7)$$

From the residual vectors, we construct two likelihood ratio test statistics. The first test statistics is trace test, which is represented as follows:

$$\lambda_{Tra} = -T \sum_{i=r+1}^{n} Log(1-\hat{\lambda}_i) \qquad (8)$$

where $\hat{\lambda}_{r+1}$, ... $\hat{\lambda}_n$ are (n-r) smallest estimated eigen values. The null hypothesis is to test that there are at most r unique cointegration vectors. The second test statistics is the maximal eigenvalue test, which is represented by:

$$\lambda_{Max} = -TLog(1-\hat{\lambda}_{r+1}) \qquad (9)$$

The null hypothesis for this test is that there are r cointegrating vectors in Y_t. For both tests, the alternative hypothesis is that there are g > r cointegration vectors in Y_t. Johansen and Juselius (1990) suggested that the trace test may lack power relative to the maximal eigenvalue test. However, the trace test is more robust to the non-normality of errors.

We also deploy the Pedroni (1999, 2004) heterogeneous panel cointegration test, which allows for cross section interdependence with different individual effects and that is specified as follows:

$$GDP_{it} = \alpha_{it} + \delta_i t + \beta_{1i} FDI_{it} + \beta_{2i} OPEN_{it} + \varepsilon_{it} \qquad (10)$$

where, i = 1, 2,..N for each country in the panel; t = 1, 2, ...T refers to the time period. The equation α_{it} and δ_i allow for the possibility of country specific fixed effects and deterministic trends, respectively. ε_{it} are the estimated residuals representing deviations from the long run relationship. To test the null hypothesis of no cointegration, $\rho_i = 1$, the following unit root test is conducted on the residuals as follows:

$$\varepsilon_{it} = \rho_i \varepsilon_{i(t-1)} + w_{it} \qquad (11)$$

The Pedroni (1999, 2004) proposes two sets of tests for cointegration. The panel cointegration tests are based on the within dimension approach which includes four statistics: panel v- statistics, panel ρ- statistic, panel pp- statistic and panel ADF- statistic. These statistics pool the autoregressive coefficient across different countries for the unit root tests on the estimated residuals taking into account common time factors and heterogeneity across countries. The group mean panel cointegration tests are based on the between dimension approach which includes three statistics: group ρ - statistic, group pp-statistic and group ADF- statistic. These tests are based on averages of the individual autoregressive coefficients associated with the unit root tests of the residuals for each country. All the seven tests are distributed asymptotically as standard normal. Of the seven tests, the panel v- statistic is a one sided test where large positive values reject the null hypothesis of no cointegration, while large negative values for the remaining test statistics reject the null hypothesis.

3.3 *Multivariate Panel VAR Model*

The Granger representation theorem (Granger, 1988; Engle and Granger, 1987) states that if two variables (say Y_{1t} and Y_{2t}) are cointegrated and each is individually I (1), then either Y_{1t} Granger causes Y_{2t} or Y_{2t} Granger causes Y_{1t}. In this paper, the causality of cointegrated variables is captured in Vector Error Correction Model (VECM). The model is expressed as follows:

$$\Delta Y_{1t} = \phi_1 + \sum_{k=1}^{p-1} \alpha_{11,k} \Delta Y_{1,t-k} + \sum_{k=1}^{p-1} \alpha_{12,k} \Delta Y_{2,t-k} + \sum_{k=1}^{p-1} \alpha_{13,k} \Delta Y_{3,t-k} + \sum_{h=1}^{r} \alpha_{1,h} EC_{h,t-1} + \xi_t \quad (12)$$

$$\Delta Y_{2t} = \phi_2 + \sum_{k=1}^{p-1} \alpha_{21,k} \Delta Y_{1,t-k} + \sum_{k=1}^{p-1} \alpha_{22,k} \Delta Y_{2,t-k} + \sum_{k=1}^{p-1} \alpha_{23,k} \Delta Y_{3,t-k} + \sum_{h=1}^{r} \alpha_{21,h} EC_{h,t-1} + \xi_t \quad (13)$$

$$\Delta Y_{3t} = \phi_3 + \sum_{k=1}^{p-1} \alpha_{31,k} \Delta Y_{1,t-k} + \sum_{k=1}^{p-1} \alpha_{32,k} \Delta Y_{2,t-k} + \sum_{k=1}^{p-1} \alpha_{33,k} \Delta Y_{3,t-k} + \sum_{h=1}^{r} \alpha_{3,h} EC_{h,t-1} + \xi_t \quad (14)$$

where, $EC_{h,t-1}$ is the hth error correction term, the residuals from the hth cointegration equation, lagged one period, and $\alpha_{ij,k}$ describes the effect of the kth lagged value of variable j on the current value of variable of i. In addition to indicating the direction of the causality among the variables, the VECM approach allows us to distinguish between the two types of Granger causality: short- and long- run causality. In the above setting (Equations 9-11), long run Granger causality from variable Y_i to variable Y_j in the presence of cointegration is evaluated by testing the null hypothesis that $\alpha_{j,h} = 0$ for h = 1,... r, whereas the short run Granger causality from variable Y_i to variable Y_j is evaluated by testing the null hypothesis that $\alpha_{ij,1} = \ldots = \alpha_{ij,p-1} = 0$, using the standard F test. By rejecting either one or both of the two null hypotheses, we conclude that variable Y_i Granger-causes variable Y_j.

The study also deploys panel vector error correction model in order to infer the Granger-causal relations among the variables at the panel level (Pesaran, Shin and Smith, 1999). The dynamic error correction model can be represented as follows

$$\Delta Y_{1it} = \phi_{1i} + \sum_{k=1}^{p-1} \alpha_{11ik} \Delta Y_{1it-k} + \sum_{k=1}^{p-1} \alpha_{12ik} \Delta Y_{2it-k} + \sum_{k=1}^{p-1} \alpha_{13ik} \Delta Y_{3it-k} + \lambda_{1i} EC_{it-1} + \xi_{1it} \quad (15)$$

$$\Delta Y_{2it} = \phi_{2i} + \sum_{k=1}^{p-1} \alpha_{21ik} \Delta Y_{1it-k} + \sum_{k=1}^{p-1} \alpha_{22ik} \Delta Y_{2it-k} + \sum_{k=1}^{p-1} \alpha_{23ik} \Delta Y_{3it-k} + \lambda_{2i} EC_{it-1} + \xi_{2it} \quad (16)$$

$$\Delta Y_{3it} = \phi_{3i} + \sum_{k=1}^{p-1} \alpha_{31ik} \Delta Y_{1,t-k} + \sum_{k=1}^{p-1} \alpha_{32ik} \Delta Y_{2it-k} + \sum_{k=1}^{p-1} \alpha_{33ik} \Delta Y_{3it-k} + \lambda_{3i} EC_{it-1} + \xi_{3it} \quad (17)$$

The panel error correction model also allows for two sources of causation: short run causality (the lagged difference terms) and the long run causality (the error correction terms). The causality runs from ΔY_2 to ΔY_1 in eq. (15), if the null hypothesis, α_{12ik} =0 for all ik is rejected, whereas the causality runs from ΔY_3 to ΔY_1, if α_{13ik} is rejected. This could be similarly generalized for other two equation (16) and equation (17). With respect to long run causality in equation (15), ΔY_1 responds to deviation from the long run equilibrium, if the null hypothesis, λ_{1i} = 0 for all i, is rejected. This could be also generalized for other two equations.

The annual data from 1960 to 2008 from the International Financial Statistics is used in the empirical analysis for three countries (namely Australia, Canada and Israel, both at the individual level and panel level. The Table I displays the summary statistics associated with economic growth (GDP is used a proxy), openness (the sum of exports and imports as a percentage of GDP), and Foreign Direct Investment (FDI) for each country over the period 1960-2008. The Table I also reflects that the univariate statistics are fairly persistent with cross correlation between FDI, OEN and GDP. Hence, it provides the possibility of long run equilibrium relationship among these three times variables.

Table I
Summary Statistics

	Australia			Canada			Israel		
	Panel A: Univariate Statistics								
Statistics	**GDP**	**OPEN**	**FDI**	**GDP**	**OPEN**	**FDI**	**GDP**	**OPEN**	**FDI**
Mean	9.377	11.178	1.443	9.614	11.458	1.669	8.2145	10.413	9.377
Median	9.373	11.25	1.435	9.573	11.541	1.656	8.058	10.416	9.373
Maximum	10.230	11.65	1.553	10.82	11.937	1.8569	9.7100	11.082	10.230
Minimum	8.1681	10.38	1.352	7.954	10.732	1.5012	6.602	9.564	8.168
Std. Dev.	0.5045	0.396	0.052	0.511	0.3631	0.0981	0.804	0.503	0.505
Skewness	-0.319	-0.634	0.431	-0.388	-0.602	0.384	0.139	-0.238	-0.319
Kurtosis	2.212	2.130	2.233	4.746	2.064	2.203	2.334	1.808	2.212
Jarque-Bera	1.672	3.845	2.163	5.935	3.779	1.989	0.847	2.679	1.672
Probability	0.433	0.146	0.339	0.051	0.151	0.369	0.654	0.261	0.433
	Panel B: Cross- Correlation								
GDP	1.0000								
OPEN	0.8391	1.0000							
FDI	0.7054	0.7047	1.0000						
GDP				1.0000					
OPEN				0.6157	1.0000				
FDI				0.7609	0.8497	1.0000			
GDP							1.0000		
OPEN							0.8840	1.00000	
FDI							0.1013	0.22574	1.0000

Note : GDP: Gross Domestic Product; OPEN: Trade Openness; FDI: FDI Inflows.

IV. Empirical Results and Discussion

This section presents the estimated results on the data set described above. A necessary condition of the multivariate VAR model is that each of the variables should be stationary and integrated of same order. Therefore, the first step of our empirical work is to know the degree of integration of each variable by using unit root test (ADF and PP) for the level data and first difference and second difference of each variable. The estimated result of this part is reported in Table II. We find that all the variables are non stationary in their levels and found stationary in their first differences and second differences. Hence, they are integrated of order one [I (1)]. This is true for all the three countries namely Australia, Canada and Israel. The panel unit root test is also further confirm that each variable is integrated of order one (see Table III). The next step is to know the cointegration relationship among these variables. The Johansen Maximum Likelihood test (λ_{Tra} & λ_{Max}) is used to ascertain whether or not the variables are cointegrated. This provides a unified framework for estimation and testing of cointegrating relations in context of a VAR error correction model. The cointegration rank 'r' of the time series was tested using two test statistics. Denoting the number of cointegrating vectors by 'r_o', the maximum eigen value (λ_{Max}) test is calculated under the null hypothesis $r_o = r$ against an alternative hypothesis $r_o > r$. The trace test (λ_{Tra}) is calculated under the null hypothesis that $r_0 \geq r$ against $r_0 < r$. The results of both the statistics are reported in Table IV. We test the cointegration for no deterministic trend in the individual series for Australia and Canada and quadratic deterministic trend for Israel. The Pedroni's panel cointegration test also rejects the null hypothesis of no-cointegration at the 1% significance level (see Table V). Above all, the results support the existence of a long run equilibrium relationship between economic growth, openness and FDI during the period 1960-2008.

Table II
Unit Root Test Results

	ADF Statistics				PP Statistics			
	LD	FD	SD	Conclusion	LD	FD	SD	Conclusion
					Australia			
FDI	-1.28	-10.8*	-8.59*	I [1]	-1.97	-26.8*	-51.3*	I [1]
GDP	-2.61	-3.96*	-7.50*	I [1]	-2.65	-3.99*	-9.87*	I [1]
OPEN	1.00	-5.09*	-5.29*	I [1]	-0.82	-7.75*	-24.0*	I [1]
					Canada			
FDI	-2.49	-6.79*	-9.19*	I [1]	-2.39	-9.55*	-20.3*	I [1]
GDP	-3.26	-3.48*	-7.13*	I [1]	-3.26	-3.48*	-8.59*	I [1]
OPEN	-1.54	-3.89*	-7.14*	I [1]	-1.44	-3.35*	-11.8*	I [1]
					Israel			
FDI	-0.87	-7.45*	-6.10*	I [1]	-1.62	-11.6*	-37.8*	I [1]
GDP	-1.44	-4.69*	-6.51*	I [1]	-1.51	-4.56*	-17.6*	I [1]
OPEN	-2.94	-7.13*	-9.35*	I [1]	-2.98	-7.12*	-22.1*	I [1]

Note : ADF Augmented Dickey Fuller Test;
PP Phillips- Perron Test;
LD Level Data;
FD First Difference Data;
SD Second Difference Data;
I (1) Integrated of order one;
* Indicates Statistical Significance and other notations are defined earlier. MacKinnon's (1991) tabulated value has been used to test the level of significance.

Table III
Results of Panel Unit Root Test

	FDI		GDP		OPEN	
Statistics	LD	FD	LD	FD	LD	FD
LLC	-0.02	-2.09*	-2.130	-5.14*	-1.310	-2.621*
IPS	-1.14	-7.16*	0.282	-4.25*	-0.936	-6.267*
ADF	17.70	63.79*	3.235	29.91*	9.782	-47.09*
PP	56.70	102.70*	5.097	36.09*	7.237	-79.65*

Note: C Constant;
CT Constant with trend;
LD level data; FD: First difference
LLC LLC statistics; IPS: IPS statistics;
ADF Fisher Chi- Square statistics;
PP Fisher Chi- Square statistics;
FDI Foreign Direct Investment;
GDP economic growth;
OPEN Trade Openness.

Table IV
Johansen's Cointegration Likelihood Ratio Test for Multiple Cointegrating Vectors

Hypothesized Number of Cointegrating Relationships		Test Statistics					
H_o	H_A	λ- Tra	CV	Probability	λ-Max	CV	Probability
				Australia			
r = 0	r > 0	49.72*	35.19	0.000	28.45*	22.3	0.000
r ≤ 1	r > 1	21.28*	20.26	0.036	12.02	15.9	0.185
r ≤ 2	r > 2	9.260	9.164	0.048	9.260	9.16	0.048
				Canada			
r = 0	r > 0	42.33*	35.19	0.007	23.26*	22.3	0.037
r ≤ 1	r > 1	19.07*	20.26	0.072	10.48	15.9	0.293
r ≤ 2	r > 2	8.594	9.164	0.064	8.595	9.16	0.064
				Israel			
r = 0	r > 0	30.92	35.01	0.128	15.71	24.25	0.437
r ≤ 1	r > 1	15.21	18.39	0.132	10.17	17.15	0.382
r ≤ 2	r > 2	05.04	3.841	0.025	5.036	3.841	0.025

Note: r indicates the number of cointegrating relationships;
CV Critical values, which are taken from MacKinnon- Haug- Michelis, 1999.
* Indicates Statistical Significance.

Table V
Results of Panel Cointegration Test

Test Statistics	Calculated Value
Panel v- statistic	-1.404
Panel ρ- statistic	-8.039*
Panel PP- statistic	-8.635*
Panel ADF- statistic	-2.865*
Group ρ- statistic	-5.656*
Group PP- statistic	-7.418*
Group ADF- statistic	-1.276

Note: * Indicates the test statistic is statistically significant

The Granger representation theorem states that a system of cointegrated variables has an error correction and that combines the short run dynamics of the variables with their long run properties as implied by the cointegrating relationships. Hence, the Vector Error Correction Model (VECM) has been formed and estimated, both at the individual and panel level, to determine the direction of causality between economic growth openness and FDI. Tables VI and VII present the estimated results of VECM, while the summary of the direction of causality is represented in Table VIII.

The findings of causality are summarized as follows:

- For Australia, there is bidirectional causality from economic growth (Y_1) to openness (Y_2) [Y_1 <=> Y_2] and foreign direct investment (Y_3) to openness (Y_2) [Y_3 <=> Y_2] and a unidirectional causality from economic growth to (Y_1) foreign direct investment (Y_3) [Y_1=> Y_3].
- For Canada, there is bidirectional causality from economic growth (Y_1) to openness (Y_2) [Y_1 <=> Y_2] and foreign direct investment (Y_3) to openness (Y_2) [Y_3 <=> Y_2] and a unidirectional causality from economic growth to (Y_1) foreign direct investment (Y_3) [Y_1=> Y_3].
- For Israel, there is unidirectional causality from openness (Y_2) to economic growth (Y_1) [Y_1 <=> Y_2] and economic growth (Y_1) to foreign direct investment (Y_3) [Y_1 => Y_3] and no causality from foreign direct investment (Y_3) to trade openness (Y_2) [Y_3< ≠ > Y_2].
- The panel error correction model finally confirms the presence of unidirectional causality from economic growth (Y_1) to foreign direct investment (Y_3) [Y_1 => Y_3] and bidirectional causality between economic growth (Y_1) and trade openness (Y_2) [Y_1 < = > Y_2].

Table IV
Results of Error Correction Model

	Australia			Canada			Israel		
	ΔFDI	ΔOPEN	ΔGDP	ΔFDI	ΔOPEN	ΔGDP	ΔFDI	ΔOPEN	ΔGDP
C	-0.02	0.012	0.014	0.200	0.026	0.246	0.226	0.024	0.024
	(0.08)	(0.01)	(0.01)	(0.15)	(0.01)	(0.01)	(0.07)	(0.01)	(0.01)
FDI (-1)	-0.36	-0.006	0.029	-0.135	0.014	0.012	-0.347	-0.027	0.003
	(0.30)	(0.03)	(0.03)	(0.20)	(0.01)	(0.01)	(0.14)	(0.02)	(0.02)
FDI (-2)	0.067	0.004	0.030	-0.462	-0.003	-0.013	-0.333	0.006	0.003
	(0.21)	(0.02)	(0.02)	(0.19)	(0.01)	(0.01)	(0.13)	(0.02)	(0.02)
OPEN (-1)	5.316	0.906	-0.44	-0.909	-0.42	0.243	-1.008	0.561	-0.312
	(2.27)	(0.24)	(0.20)	(3.47)	(0.22)	(0.19)	(1.04)	(0.17)	(0.16)
OPEN (-2)	2.502	0.304	-0.32	1.154	0.368	-0.029	-0.762	-0.05	-0.19
	(2.53)	(0.27)	(0.22)	(3.05)	(0.19)	(0.18)	(1.17)	(0.19)	(0.18)
GDP (-1)	0.397	0.276	-0.13	-1.74	0.381	-0.385	0.482	0.676	-0.11
	(1.57)	(0.16)	(0.14)	(3.06)	(0.19)	(0.18)	(1.36)	(0.22)	(0.21)
GDP (-2)	0.609	0.299	-0.23	-3.51	-0.209	-0.248	-2.626	-0.31	-0.25
	(1.53)	(0.16)	(0.13)	(3.40)	(0.21)	(0.19)	(1.32)	(0.21)	(0.21)
EC (-1)	-0.34	0.09	-0.03	0.056	0.008	0.011	0.008	-0.001	0.003
	(0.23)	(0.02)	(0.02)	(0.07)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
R^2	55%	60%	37%	28%	40%	46%	45%	36%	50%
F	4.826	6.018*	2.381	1.529	2.631	3.427	3.335	2.258	3.953
SBC	0.800	-3.708	-4.065	1.392	-4.15	-4.32	0.627	-3.041	-3.083

Note: SBC Schwarz Bayesian Criterion;
D Difference Operator;
EC Error Correction Term;
* Indicates Statistical Significance at 5%.

Table VII
Results of Panel Causality Test

	Independent Variables				
DV	**FDI**	**GDP**	**OPEN**	**EC**	**Interferences**
ΔFDI	–	7.252*	3.178	-2.899*	GDP => FDI
ΔGDP	1.626	–	11.77*	-1.519	OPEN => GDP
ΔOPEN	5.989*	15.036*	–	-2.998*	FDI => OPEN
					GDP => OPEN
Two ways links					GDP < = > OPEN
					GDP => FDI

Note: Notations are defined earlier.

Table VIII
Pair wise Granger Causality Test

Australia			
DV	**GDP**	**OPEN**	**FDI**
GDP		←┘↑	─┘↑
OPEN	←┘↑		←┘↑
FDI	←┘	←┘↑	
Canada			
DV	**GDP**	**OPEN**	**FDI**
GDP		←┘↑	─┘↑
OPEN	←┘↑		←┘↑
FDI	─┘↑	←┘↑	
Israel			
DV	**GDP**	**OPEN**	**FDI**
GDP		←┘	─┘↑
OPEN	─┘↑		—
FDI	←┘	—	
Panel Data Model			
DV	**GDP**	**OPEN**	**FDI**
GDP		←┘	—
OPEN	←┘		←┘
FDI	←┘	—	

Note: → Unidirectional causality;
↔ Bidirectional Causality;
— No causality; and other notations are defined earlier.

The estimated results represent that VECM specification forces the long run behaviour of time series variables to converge to their cointegrating relationships, while accommodating short run dynamics. Thus, the notions of short run and long run causality between economic growth, openness and foreign direct investment have interesting economic interpretation. For instance, the change of economic growth leads to change of foreign direct investment and that is true for all the three countries; change of economic growth also leads to change of openness and that is true for Australia and Canada only. Similarly, change of openness leads to change of foreign direct investment and that is true for Australia and Canada only. In the case of Israel, we found no causality between foreign direct investment and openness. The above results also verified through generalized impulse response functions (GIRFs). The GIRFs trace the effect of a one-time shock to one of the innovations on current and future values of endogenous variables. The generalized impulse responses provided more insight into how shocks to openness and foreign direct investment affect economic growth and vice versa.

The results of generalized impulse responses for the individual country and panel level are represented in Figure 1 to Figure 4 respectively. The GIRFs are provided the support of causality status between these three time variables in the multivariate VAR system. The emphasis is, however, given more importance to the relationship between openness and economic growth. In each figure, the first panel presents the response of foreign direct investment to openness and economic growth, the second panel presents the response of economic growth to openness and foreign direct investment and the third panel presents the response of openness to foreign direct investment and economic growth. In all the cases, the GIRFs are very responsive to the results of VECM. Hence, the overall finding is that openness has significant impact on economic growth in Australia, Canada and Israel.

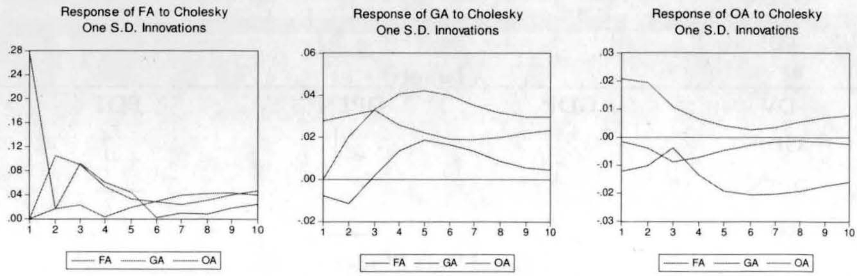

Figure 1
Impulse Response Function for Israel

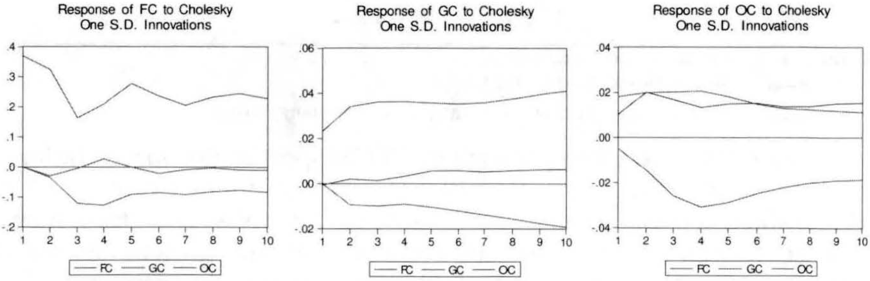

Figure 2
Impulse Response Function for Canada

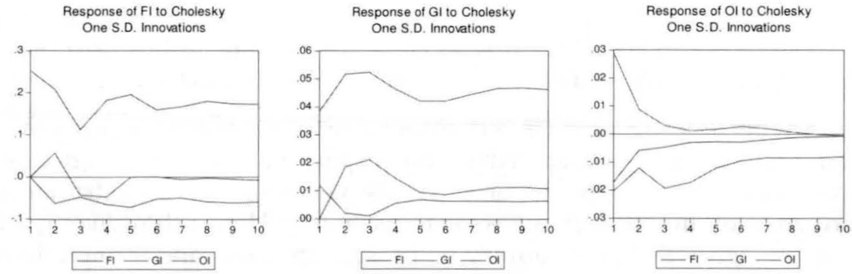

Figure 3
Impulse Response Function for Australia

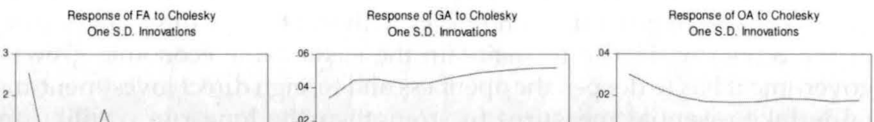

Figure 4
Impuluse Response Function in General

V. Conclusion and Policy Implications

The central goal of this paper is to investigate the nexus between economic growth and openness in a multivariate VAR framework in Australia, Canada and Israel over the period from 1960-2008. The estimation process starts with examining the stationarity of the time series variables such as economic growth, openness and foreign direct investment. The unit root tests (both at the individual and panel level) have been applied for investing the same. The estimated results declared that these three time series variables are non-stationary at the level data but found stationary at the first differences. Hence, they are integrated of order one. We next examined the existence of cointegration among the stationary variables. The cointegration test (Johansen and Pedroni) has been applied to inspect the same. The estimated results affirmed that there is cointegration among these three time series variables and hence, an existence of long run equilibrium relationship between them.

The Granger- causality test, both at the individual and panel level, finally confirmed the presence/ absence of causality between economic growth, openness and foreign direct investment. There exists bidirectional causality from economic growth to openness and from foreign direct investment to openness in Australia and Canada. A unidirectional causality has been found from economic growth to foreign direct investment in all these three countries. The findings also found no causality between openness and foreign direct investment in Israel. The panel error correction model is, however, confirms the unidirectional causality from economic growth to foreign direct investment and bidirectional causality between economic growth and trade openness.

To conclude, openness is very responsive to enhance economic growth and enhanced economic growth is very responsive to attract foreign direct investment in the country. Openness is also very responsive to attract more foreign direct investment inflows in the economy. Hence, the dynamism of economic growth in the country will foster openness and foreign direct investment and dynamism of openness will also faster economic growth and foreign direct investment in the economy. The policy implication of this result is that economic growth is considered as the policy variable to accelerate openness and foreign direct investment and openness could be used as the policy variable to generate economic growth and foreign direct investment in the economy. Hence to maintain the sustainable economic growth, government has to deepen the openness and foreign direct investment and undertake essential measures to strengthen the long run equilibrium relationship between openness, foreign direct investment and economic growth in the country. These include more economic integration and more foreign direct investment inflows in the economy. They are very crucial and useful for strengthening the relationship between economic growth and openness. The lack of same not only affects the growth-open nexus but also affect the overall socio-economic development in the country. Hence, government has to take the initiative with greater attention.

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