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# The Impact of Trade Openness on Economic Growth in China: An Empirical Analysis

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## Abstract

This study uses an endogenous economic growth model to determine the long run relationship between trade openness and economic growth in China by using the data 1975-2009. It contributes to the literature by developing trade openness index. An autoregressive distributed lag approach to cointegration and rolling regression method are employed. This study tests the link between trade openness and economic growth in the case of China by using the framework of endogenous economic growth model. This study also employs the rolling window regression method in order to examine the stability of coefficients throughout the sample span. The autoregressive distributed lag (ARDL) cointegration technique and rolling regression method are used. The empirical findings indicate that trade openness (i.e. Both individual trade indicator and composite trade openness index) are positively related to economic growth in the long run and short run. Our results indicate that trade openness as measured by individual trade indicator and composite trade openness index are positively related to economic growth in the long run and short run. However, results from the rolling window suggest that trade openness is negatively linked to economic growth only for a number of years.

**Keywords:** Trade Openness, Economic Growth.

**JEL Classification Codes:** F43, O11, O16

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## 1. Introduction

In examining the relationship between trade openness and economic growth in China, it is pertinent to trace the development of its economy. China began its economic reforms in the late 1978 by making effort to integrate itself into the international trading system. From a centrally planned to a market based economy, China has experienced fast economic growth and social development. The turning point came after China joined the Asia-Pacific Economic Cooperation (APEC) group in November 1991. China further served as the APEC chair in 2001 when the annual APEC leaders meeting was held in Shanghai.<sup>2</sup>

After 16 years of negotiations under the General Agreement on Tariffs and Trade, China finally concluded the multi lateral negotiations which paved the way for its accession into World Trade Organization (WTO) on 11 December 2001. The WTO membership has enabled China to become the top destination of foreign direct investment (FDI) and successfully integrated its economy to the global production chain. Throughout the last few years, China's GDP has grown at an average of nine percent per year. Thus, Chinese economy has been growing faster as compared to other economies (a standard example of an endogenous growth model) for the past decade.

From the trade point of view, China was ranked thirtieth largest trading country in the world in 1977. However, China rose to the rank of seventh largest trading nation in 2000 and the fourth position in 2002 after surpassing Canada, the United Kingdom and France. It became the third largest trading nation in 2008 and to the second, in both exports and imports, and surpassing the GDP of Japan as the world

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<sup>2</sup> [http://www.chinaapec.org/en/about\\_apec/content\\_6.shtml](http://www.chinaapec.org/en/about_apec/content_6.shtml), accessed on 15 October 2015

second largest GDP in 2010.<sup>3</sup> The rapid economic growth over the last few years has elevated over and above 500 million people out of poverty.

With this background in mind, this study aims to investigate the link between trade openness and economic growth in China empirically by using the endogenous growth model. The remaining paper is arranged as follows. Section 2 and 3 briefly review the literature and discuss the trade openness policies. Section 4 touches on the methodology and empirical results, and the last section concludes the study.

## 2. Literature Review

Both theoretical and empirical literature shows different explanation about the relationship between trade openness and economic growth. According to theoretical literature, trade openness stimulates economic growth through the increase in spillover effect (see Romer, 1990). The developed countries innovate and developing countries imitate the technology (Grossman & Helpman, 1991). Young (1991) describes that trade openness between developed and developing countries contribute to human capital accumulation in the developing countries.

In terms of size, Feenstra (1996) illustrates that smaller countries also have a lesser pool of skilled labor in research and development. So in the absence of trade openness (or spillover effect), these small countries cannot achieve desired level of economic growth. In addition, Bruno (1997) states trade openness will decrease cost per unit, increase competition among local producers; improve the efficiency of allocation of resources and thus increase economic growth in the long run.

Edward (1992) suggests on the basis of empirical results that more trade liberalized countries grow faster as compared to close economies. The liberal economies grow unusually faster compared to closed economies. In addition, Dollar (1992) states that the real exchange rate distortion index and real exchange rate variability are indicators of trade liberalization. Villanueva (1994) employs regression analysis by using the data of 36 countries from 1975-1990. He finds that openness policies and investment in human capital positively impact on economic growth. Further, Sachs and Warner (1995) provide comprehensive study about the positive link between trade and economic growth and empirically confirm that liberal developing economies have been growing per year at the rate of 4.49 per cent,

although together liberal developed economies have been growing at the rate of 2.29 per cent annually.

Conversely, closed developed and developing economies have grown at the rate of 0.74 per cent and 0.69 per cent annually. Subsequently, Edward (1998) utilizes the data of 93 countries to examine the link between trade openness and economic growth. He employs nine indexes to capture the impact of trade openness on economic growth.<sup>4</sup> His empirical findings indicate that trade openness indexes positively and trade distortion indexes are negatively associated with economic growth. The endogeneity issue relates to the trade-volume measure of openness has been discussed by Frankel and Romer (1999). They conclude a positive association between actual trade openness, instrumented trade openness and economic growth.

In another study, Söderbom and Teal (2001) find trade openness positively impacts on the growth rate of productivity. They use the data of 54 countries, and employ the generalized method of moments (GMM) for empirical evidence. Isaksson (2002) uses the data of 73 developed and developing countries. His regression analysis shows that human capital is an important element in the trade-growth link. Ynikkaya (2003) examines the association between trade openness and per capita income growth by employing the data of 120 countries.<sup>5</sup> He finds both trade volume and trade restriction has positively associated with per capita income growth.

Furthermore, Warner (2003) finds a positive link between trade openness and economic growth. Another study of Wacziarg and Welch (2003) support the trade liberalization policies and conclude that over the period 1950-1998, after trade liberalization, the annual rate of economic growth have 1.5 percentage points higher for countries with liberalized trade strategies. Karras (2003) uses the data in 161 countries. He finds trade openness (exports plus imports divided by GDP) positively effect on economic growth: a 10 percent increase in trade openness measure increases GDP by 0.25 to 0.3 percent. The trade openness has a positive effect on economic growth in the case of developed countries but in contrast, it has a negative effect on economic growth in developing countries (Kim, 2008).

Furthermore, Islam et al. (2012) examine the relationship between import and economic growth in 62 countries. They find a long-run relationship when economic growth is a

<sup>3</sup> <http://www.worldbank.org/en/country/china/overview>, and <http://www.theguardian.com/business/2011/feb/14/china-second-largest-economy> accessed on 15 October 2015,

<sup>4</sup> In which three were associated to trade openness, and other six were related to trade distortions.

<sup>5</sup> In this study he uses two trade openness measures i.e. trade volumes (exports, imports, exports plus imports) as percentage of GDP and trade restrictiveness on foreign exchange on bilateral payments and current transactions.

dependent variable in majority of the sample.<sup>6</sup> These results confirm the importance of import in the process of sustainable economic growth of these countries. In an alternative model when import is a dependent variable, the long-run relationship is also found.<sup>7</sup> These results confirm the importance of sources of economic growth for import. The results of the Granger causality test indicate mixed results, for higher income countries, there is unidirectional long-run causality found from import to economic growth (except the USA, Iceland and Italy), and bidirectional long-run causal relationship exists between import and economic growth in low income countries except Madagascar and Mauritania.

In case of 46 countries,<sup>8</sup> Huang and Chang (2014) examine the association between financial development, trade openness and economic growth. They conclude that higher stock market development and more trade openness will increase the economic growth, whereas the reverse in countries there is less stock market development. Zarra-Nezhad, Hosseinpour and Arman (2014) conclude that foreign trade indicators have positive effect on economic growth irrespective of level of development by using the data of 94 countries<sup>9</sup> and 103 variables.

In contrast, Fenira (2015) is found in the case of 82 developing countries that trade openness policies are weak contributed to economic growth, and the deterioration of external balance caused by the 'preferences erosion' phenomenon. Brueckner and Lederman (2015) examine the link between trade openness and economic growth in Sub-Saharan Africa by using the instrumental variables approach. They observe that the estimated result by instrumental variables indicate that economic growth has a significant

negative and contemporaneous impact on trade openness, however trade openness is positively related to economic growth. In the case of developing countries,<sup>10</sup> Tahir and Azid (2015) find a positive relationship between trade openness and economic growth.

From another perspective, Ghatak and Milner (1995) find a long run association between trade openness, human capital, physical capital and real GDP in the case of Turkey as proposed by the endogenous growth theories. Véganzonès et al. (1998) shows that the impact of trade openness and foreign technology on economic growth is not stable in the case of Argentina. In contrast, the impact of education on economic growth is positive and stable. Lin et al. (2002) empirically examines the role of foreign trade in the economic growth of China. He concludes that 10 percent increase in exports will lead to 1 percent economic growth. Ahmad (2003) investigates the cointegration between trade openness and industrial sector growth. He finds a long run relationship between industrial production, investment, trade openness and human capital in the case of Bangladesh.

Carmen and Pilar (2004) examine the impact of manufacturing sector imports on real GDP and employment by using quarterly data set over the period of 1979-2002. They conclude a positive and long run relationship between economic growth and trade openness in the case of China. The long run association between the trade openness and industrial growth was found by the Dutta (2004) in the case of Pakistan. Furthermore, Khan and Qayyum (2007) find trade openness is positively associated with economic growth and suggest further liberalization for sustainable growth. Guisan (2007) uses the data of several industrial and non-industrial countries in order to test the relationship between foreign trade and economic development.<sup>11</sup> He finds the positive impact of foreign trade on the economic development of industrial and nonindustrial countries.

In the case of China, Tsen (2010) has found a long run relationship between the trade openness (exports), domestic demand and economic growth, and granger causality results show bidirectional causality among trade openness, domestic demand, and economic growth. He suggests both trade openness and domestic demand are

<sup>6</sup> In the case of USA, the UK, Japan, Iceland, Canada, Italy, Algeria, Brazil, Chile, Colombia, Cuba, Gabon, Malaysia, Mexico, Peru, South Africa, Uruguay, Bolivia, Cameroon, Cote d'Ivoire, Ecuador, Egypt, El Salvador, Guatemala, Honduras, India, Lesotho, Nicaragua, Papua New Guinea, Thailand, Bangladesh, Benin, Chad, Congo, Gambia, Kenya, Madagascar, Togo, Zambia, and Zimbabwe.

<sup>7</sup> In the case of USA, the UK, Japan, Finland, Iceland, Canada, Italy, Brazil, Cuba, Dominican Republic, Iran, Malaysia, Mexico, Peru, South Africa, Bolivia, Cameroon, Guatemala, Honduras, India, Indonesia, Lesotho, Morocco, Nicaragua, Pakistan, Philippines, Senegal, Sudan, Swaziland, Thailand, Tunisia, Bangladesh, Benin, Burkina Faso, Chad, Congo, Gambia, Kenya, Madagascar, Malawi, Mali, Mauritania, Togo and Zambia

<sup>8</sup> India, Israel, Italy, Kenya, Korea, Malaysia, Mexico, Netherlands, New Zealand, Nigeria, Norway, Peru, Singapore, South Africa, Spain, Switzerland, Turkey, United Kingdom, United States, Venezuela, Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, Colombia, Denmark, Ecuador, Egypt, Finland, France, Germany, Greece, Indonesia, Japan, Jordan, Pakistan, Philippines, Portugal, Sri Lanka, Sweden, Thailand, Uruguay, Zimbabwe.

<sup>9</sup> 74 developing countries and 20 developed countries.

<sup>10</sup> Albania, Algeria, Angola, Bangladesh, Brazil, Bulgaria, Chile, China, Colombia, Cote d'Ivoire, Dominican Republic, Egypt, El Salvador, Ethiopia, Fiji, Gabon, Guatemala, Guyana, Honduras, Indonesia, India, Kenya, Lesotho, Malawi, Malaysia, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Namibia, Pakistan, Panama, Paraguay, Peru, Philippines, Romania, Russia, Senegal, South Africa, Sri Lanka, Sudan, Tanzania, Thailand, Tunisia, Turkey, Uganda, Uruguay, Uzbekistan, Zambia.

<sup>11</sup> Latin America; East Asia; China; Other East Asia; European Monetary Union; India; Middle East and Northern Africa; Russian Fed.; Sub-Sahara and USA.

vital for sustainable economic growth. Shahbaz et al. (2011) examine the exports-led growth hypothesis using quarterly data from 1990 up to 2008 for Pakistan by using ARDL bounds testing approach, Error Correction Method (ECM) and Ng-Perron test for integration. They find that exports are positively correlated with economic growth in the short run and long run.

On the other hand, Hye (2012) finds a negative and significant association between trade openness and economic growth in case of Pakistan. Shahbaz et al. (2012) investigate the effect of financial development, imports (trade openness) and foreign direct investment (FDI) on output in case of Pakistan over the period of 1990-2008 using quarterly data set. They find cointegration between financial development, imports, FDI and real GDP. In addition, it is found that financial development, imports and FDI have a positive and significant effect on the output of Pakistan. The causality analysis reveals bidirectional relation among the variables, but strong causality is also running from financial development, economic growth and FDI to real imports. Shahbaz (2012) investigates trade openness led economic growth hypothesis by using the framework of Mankiw (1992) in the case of Pakistan. The findings indicate that trade openness promotes economic growth. The causality test indicates that growth-led-trade hypothesis is valid.

Hye and Lau (2015) investigate the relationship between trade openness and economic growth in the case of India by using a new endogenous growth model for theoretical support, auto-regressive distributive lag model and rolling window regression method in order to determine long run and short run association between trade openness and economic growth. They conclude that trade openness index is negatively related to economic growth in the long run and the rolling window regression results indicate that the impact of trade openness index of economic growth is not stable throughout the sample. Further, the short run results show that trade openness index is positively related to economic growth. The Granger's causality test result shows trade openness-led growth and human capital-led growth exist both in the short and long run.

### 3. Trade Openness Indicators

In China, economic reforms started in 1978. For the period of 1979-1987, the central government had reduced its direct involvement in trade policies. The economic reform has seen a number of policies being implemented. To enhance exports, China followed the tax rebate system in the early 1980s. However, trade contract responsibility system was used in the late 1980s. Other reforms include

the eradication of foreign exchange preservation system in 1994.<sup>12</sup>

In order to encourage more trade with other countries, it was observed that in 1991, the average tariff rate was 47.2%.<sup>13</sup> However, the import tariff was reduced from 35.9 % to 23% on more than 4900 commodities in 1996. Subsequently, the import tariff was further reduced from 23% to 17% in 1997.

<Table 1> Share of Foreign Trade in GDP and TOI.

Year	Exports of goods and services (% of GDP)	Imports of goods and services (% of GDP)	Trade (% of GDP)	Trade Openness Index (2000=100)
1980	10.647	11.013	21.661	50.281
1990	16.073	13.085	29.159	67.685
2000	23.326	20.917	44.243	100
2005	37.081	31.551	68.632	159.312
2006	39.133	31.433	70.567	163.802
2007	38.413	29.613	68.027	157.908
2008	34.979	27.264	62.243	144.482
2009	26.743	22.328	49.072	113.908

Source: World Development Indicators (online data, 2011) and trade openness index is developed by this study.

Table 1 shows the trade indicators in the case of China. The shares of exports of goods and services and imports of goods and services in China's GDP were 10.647% and 11.013 % respectively in the 1980. Hence, the share of total foreign trade in GDP was 21.661%. The total foreign trade increased reach to 29.159% in 1990. The trade percentage of GDP reached at 44.243% in 2000 and 70.567% in 2006. It reached 62.243% in 2008 and 49.072% in 2009. The share of foreign trade in GDP is less in 2009 (i.e., 49.072%) as compared to previous five years; this is due to the global financial crisis.

The empirical literature shows that economists have employed different proxies of trade openness (i.e. export divided by GDP, imports divided by GDP and exports plus imports divided by GDP) in order to find a relationship with economic growth. It is difficult to decide which proxy represented the trade openness. If we select any one and drop the other, it would be a loss of information. By definition all three proxy indicators of trade openness are positively

<sup>12</sup> An overvalued exchange rate reduces the exports incentives. After reforms was started in 1978, the real exchange rate depreciated rapidly. The real exchange rate depreciated more than 400 percent from 1978 to 1992. The depreciation of exchange rate has enhanced the exports competitiveness and also contributed as the main factor in phenomenal growth of exports.

<sup>13</sup> Refer to World Bank, 1997

correlated to each other (see Table 2 Ordinary correlations). Hence we cannot use all three trade openness indicators in a single model. Finally, this study investigates the impact of trade openness on economic growth by using the trade openness proxies separately and combining the effect through developing a composite trade openness index (TOI).

The TOI is developed by calculating the weight of each indicator by using Principal Component Analysis (PCA). Principal component method (PCM) is used to capture the importance of each variable. The PCM was first coined by Pearson (1901) and then developed by Hotelling (1933). The PCM uses a multivariate technique to examine the relationships among several quantitative variables. The method has been widely applied to many areas including computation of environmental index (Kang 2002).

More recently, Agenor (2003) computes simple globalization index using PCM and applies it to trade and financial openness. In terms of methodology, for any given data set with  $p$  variables, at most  $p$  principal components can be computed, each being a linear combination of the original variables, where the coefficients equal the eigenvectors of the correlation of the covariance matrix.

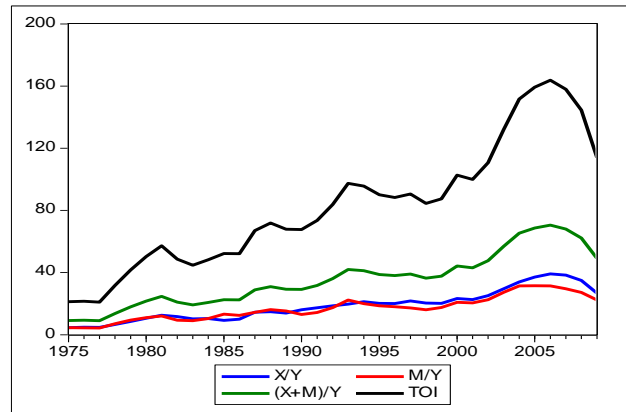
The principal component is then sorted by the descending order of the eigenvalues, which are equal to the variance of the components. It is noted that the eigenvectors are taken at unit length. The first component has the largest variance of any unit length linear combination of the determinant variables, and likewise for the last component. The PCM can be expressed as:

$$Z_j = a_{j1}F_1 + a_{j2}F_2 + \dots + a_{jn}F_n + d_jU_j$$

where, each of the 1 to  $n$  observed variables  $Z_i$  is described linearly in terms of  $n$  new uncorrelated components  $F_1, F_2, \dots, F_n$ , each of which in turn is a linear combination of the  $n$  original variables. The coefficient  $a_{ij}$  is the regression weight on the  $i^{\text{th}}$  factor and  $U_i$  denotes a unique factor, influenced by idiosyncratic determinants. The critical issue here is to obtain the best linear combination.

The eigenvalues show that the first principal component demonstrates about 99.1 % cumulative proportion of variation (See Table 2). The second explains another 0.9% and last principal component demonstrates 0.0% standardized variables. It is a clear first principal component is superior to other combination of variables because it shows the high level of variability. Hence, this study uses the first eigenvector values as a weight to construct a composite measure of trade openness and denoted as TOI. The separate contribution of (X+M)/Y; (X)/Y and (M)/Y in standardized variance of the first principal component is 57.9, 57.6 and 57.5% respectively.

<Figure 1> shows the graph of trade openness indicators. The graph indicates that exports of goods and services as a percentage of GDP and imports of goods and services as a percentage of GDP are moving closer. The trade openness index is above all other trade openness indicators.



<Figure 1> Trade Openness Indicators.

<Table 2> Principal Components Analysis.

Eigenvalues: (Sum = 3, Average = 1)					
Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	2.973	2.946	0.991	2.973	0.991
2	0.026	0.026	0.009	3.000	1.000
3	0.000	---	0.000	3.000	1.000
Eigenvectors (loadings):					
Variable	PC 1	PC 2	PC 3		
(X+M)/Y	0.579	-0.055	-0.812		
X/Y	0.576	-0.677	0.457		
M/Y	0.575	0.733	0.361		
Ordinary correlations:					
	(X+M)/Y	X/Y	M/Y		
(X+M)/Y	1.000				
X/Y	0.994	1.000			
M/Y	0.991	0.973	1.000		

## 4. Methodology

The present empirical study investigates the link between trade openness and economic growth by using the Lucas (1988) production function. In which the trade openness employs as a separate factor input with the other input

factors like physical capital and human capital.

$$Y = F(K, HC, TOI) \quad (1)$$

In an equation, we rewrite function-1 as follows:

$$\ln(Y_t) = \theta_0 + \theta_1 \ln(K_t) + \theta_2 \ln(HC_t) + \theta_3 \ln(TOI_t) + \varepsilon_i \quad (2)$$

Where  $Y_t, K_t, HC_t$  and  $TOI_t$  respectively confers the real GDP, physical capital, human capital and trade openness index. The  $\ln$  show natural logarithms, and  $\theta_s$  represents the slope coefficients of respective variables. The  $\varepsilon_i$  is the error correction terms. The real GDP is used as a proxy of economic growth (measured in US \$). The physical capital is represented by the real gross fixed capital formation (measure in US \$) and secondary school enrollment (% gross) is used as a proxy of skilled labour force/human capital. The trade openness index is constructed by using different proxies of trade openness. The data of all variables have been taken from World Development Indicators published by the World Bank.

#### 4.1. Estimation Technique

The long run relationship between trade openness and economic growth is tested by using Autoregressive Distributed Lag (ARDL) approach to cointegration (Pesaran et al. 2001).<sup>14</sup> The ARDL method of cointegration is concerned with estimating the following error correction model.

$$\begin{aligned} \Delta \ln(Y_t) = & \lambda_0 + \sum_{i=1}^p \lambda_i \Delta \ln(Y_{t-i}) + \sum_{i=0}^p \lambda_i \Delta \ln(HC_{t-i}) \\ & + \sum_{i=0}^p \lambda_i \Delta \ln(K_{t-i}) + \sum_{i=0}^p \lambda_i \Delta \ln(TOI_{t-i}) \\ & + \alpha_1 \ln(Y_{t-1}) + \alpha_2 \ln(HC_{t-1}) + \alpha_3 \ln(K_{t-1}) + \alpha_4 \ln(TOI_{t-1}) + \psi_t \end{aligned} \quad (3)$$

Where  $Y_t, K_t, HC_t$  and  $TOI_t$  respectively refer to the real GDP, human capital, physical capital and trade openness.  $\Delta$  is the difference operator,  $p$  indicates the optimum lag and  $\psi_t$  is the error term. The existence of a long - run relationship among the variables is tested by using overall F-test statistic. The no-cointegration null hypothesis for

equation 3 is that  $\langle H_0 = \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0 \rangle$ , the alternative hypothesis of cointegration is  $\langle H_1 = \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 \neq 0 \rangle$ . The decision of long run relationship is taken in this way: if the computed F- test has exceeded the upper critical bound value, then the  $H_0$  (null hypothesis) is rejected and if the F- test statistic falls into the bounds, then the test becomes inconclusive. Lastly, if the F- test statistic is below the lower critical bounds value, it implies no co-integration. When a long - run relationship exists, in the next step we will estimate the long run coefficients.

#### 4.2. Empirical Results

This study employs the Augmented Dickey Fuller (ADF) in order to examine the level of integration. The results of ADF test indicate that all variables are integrated order one.

After examining the level of integration in next step this study explores the long run relationship by using the autoregressive distributed lag model. The long run relationship is investigated by using the three different scenarios (Pesaran et al. 2001, 295-296) i.e. with unrestricted intercept and no trend ( $F_{III}$ ); with unrestricted intercept and restricted trend ( $F_{IV}$ ) and with unrestricted intercept and trend ( $F_{IV}$ ).

Table 5 indicates the result of the long run relationship. The results indicate that the long run relationship exists in all the four models (if we use all the proxies separately or in the shape of a composite trade openness index). This study employs the Schwarz information criterion to select the optimum lags. After determining the long run relationship in the next step we estimate the log run coefficients.

The Table 6 shows the result of long run coefficients. The results demonstrate that trade openness positively impact on the economic growth in the case of China, a one percent increase in  $\ln(X/Y)$  increases real GDP by 1.054%, a one percent increase in  $\ln(M/Y)$  increases real GDP by 0.887%, a one percent increase in  $\ln(X+M/Y)$  increases real GDP by 0.875% and a one percent increase in trade openness index increases real GDP by 0.885%. These findings are in the same direction as suggested by Lin et al (2002), Guisan (2007) and Tsen (2010) in the case of China, and Khan and Qayyum (2007) in case of Pakistan. Some other cross-country studies are included in Edward (1992) and Karras (2003). The other variables in this study: human capital and physical capital are positively related to economic growth or real GDP in all four models.

The short run coefficients are shown in Table 7. The trade openness is positively associated with economic growth in all four cases. The human capital is statistically insignificant, and physical capital is positively related to economic growth in the short run. The error correction terms are represented by the speed of adjustment from short run disequilibrium to

<sup>14</sup> The main advantage of this method is that it is applicable whether regressors are purely I(0), I(1) or mutually cointegrated.

long run equilibrium. Where the error correction term is in all four cases. This confirms the long run relationship. negative (according expectation) and statistically significant

<Table 3> Results of Unit root Test.

Variable	ADF					
	None		Constant & Trend		Constant	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
Y	-0.106	-4.194***	-3.101	-4.279***	0.802	-3.473**
HC	-0.617	-3.486***	-2.245	-3.791**	-1.175	-2.751*
K	-1.098	-4.093***	-1.025	-3.061**	-1.043	-3.526**
X/Y	-2.299	-3.171**	-1.386	-4.882***	-1.445	-4.722***
M/Y	-1.329	-3.932***	-2.213	-4.042**	-2.232	-3.795***
X+M/Y	-2.391	-3.328**	-1.645	-4.201**	-1.584	-3.934***
TOI	-2.391	-3.327**	-1.635	-4.301**	-1.784	-4.067***

Note: None means no intercept and trend. \*\*\* and\*\* respectively show the 1% and 5% level of significance

<Table 4> Critical Values for ARDL Modeling Approach.

K = 3	0.10		0.05		0.01	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
$F_{III}$	2.933	4.020	3.548	4.803	5.018	6.610
$F_{IV}$	3.264	4.094	3.850	4.782	5.258	6.526
$F_V$	3.760	4.795	4.510	5.643	6.238	7.740
$t_V$	-2.57	-3.46	-2.86	-3.78	-3.43	-4.37
$t_{III}$	-3.13	-3.84	-3.41	-4.16	-3.96	-4.73

Source : Narayan (2005) for F-statistic and Pesaran et al. (2001) for t-statistics

Note : k is the number of regressors,  $F_{III}$  represents the F-statistic of the model with unrestricted intercept and no trend;  $F_{IV}$  represents the F-statistic of the model with unrestricted intercept and restricted trend,  $F_V$  represents the F-statistic of the model with unrestricted intercept and trend,  $t_V$  and  $t_{III}$  are the t ratios for testing  $\alpha_1$  in equation (3) is respectively with and without deterministic linear trend

<Table 5> Bound Testing Analysis.

Variables	Without Deterministic Trends			With Deterministic Trends			Conclusion $H_0$
	Lags	$F_{III}$	$t_{III}$	$F_{IV}$	$F_V$	$t_V$	
$Y = F[ K, HC, (X/Y)]$	1	2.686 <sup>c</sup>	-1.984 <sup>c</sup>	-	-	-	Rejected
	2	0.181 <sup>c</sup>	-0.511 <sup>c</sup>	2.702 <sup>c</sup>	3.321 <sup>c</sup>	-3.578 <sup>a</sup>	
	3	2.589 <sup>c</sup>	-2.34 <sup>c</sup>	2.594 <sup>c</sup>	3.088 <sup>c</sup>	-1.751 <sup>c</sup>	
	4	14.117 <sup>a</sup>	-5.902 <sup>a</sup>	14.232 <sup>a</sup>	17.025 <sup>a</sup>	-2.961 <sup>b</sup>	
$Y = F[ K, HC, (M/Y)]$	1	4.301 <sup>a</sup>	-2.255 <sup>c</sup>	5.689 <sup>a</sup>	4.572 <sup>b</sup>	-3.063 <sup>b</sup>	Rejected
	2	0.351 <sup>c</sup>	-0.797 <sup>c</sup>	1.821 <sup>c</sup>	2.176 <sup>c</sup>	-2.818 <sup>b</sup>	
	3	1.773 <sup>c</sup>	-2.082 <sup>c</sup>	2.499 <sup>c</sup>	2.905 <sup>c</sup>	-2.382 <sup>c</sup>	
	4	2.139 <sup>c</sup>	-2.452 <sup>c</sup>	5.549 <sup>a</sup>	6.231 <sup>a</sup>	-3.905 <sup>a</sup>	
$Y = F[K, HC((X + M)/Y)]$	1	3.905 <sup>b</sup>	-2.276 <sup>c</sup>	2.169 <sup>c</sup>	2.628 <sup>c</sup>	-3.119 <sup>b</sup>	Rejected
	2	0.322 <sup>c</sup>	-0.761 <sup>c</sup>	2.734 <sup>c</sup>	3.241 <sup>c</sup>	-1.831 <sup>c</sup>	
	3	2.729 <sup>c</sup>	-2.527 <sup>c</sup>	9.534 <sup>a</sup>	11.041 <sup>a</sup>	-3.683 <sup>a</sup>	
	4	6.703 <sup>a</sup>	-4.351 <sup>a</sup>	6.008 <sup>a</sup>	4.788 <sup>b</sup>	-1.889 <sup>c</sup>	
$Y = F[ K, HC, TOI]$	1	3.905 <sup>b</sup>	-2.276 <sup>c</sup>	2.169 <sup>c</sup>	2.628 <sup>c</sup>	-3.119 <sup>b</sup>	Rejected
	2	0.322 <sup>c</sup>	-0.761 <sup>c</sup>	2.734 <sup>c</sup>	3.241 <sup>c</sup>	-1.831 <sup>c</sup>	
	3	2.729 <sup>c</sup>	-2.527 <sup>c</sup>	9.534 <sup>a</sup>	11.041 <sup>a</sup>	-3.682 <sup>a</sup>	
	4	6.703 <sup>a</sup>	-4.351 <sup>a</sup>	6.008 <sup>a</sup>	4.788 <sup>b</sup>	-1.888 <sup>c</sup>	

Note:  $H_0$  indicates no cointegration. 'a' indicates that the statistic lies above the 0.10 upper bound; 'b' that it falls within the 0.10 bounds and 'c' that it lies below the 0.10 lower bound.

**<Table 6>** Long Run Coefficients.

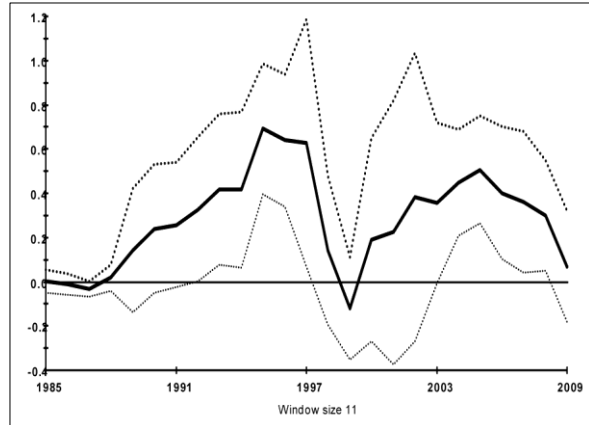
	Model – 1	Model – 2	Model – 3	Model – 4
Ln(HC)	0.605 <sup>c</sup>	1.071 <sup>b</sup>	0.974 <sup>c</sup>	0.904 <sup>c</sup>
Ln(K)	0.654 <sup>b</sup>	0.832 <sup>a</sup>	0.805 <sup>b</sup>	0.805 <sup>b</sup>
Ln(X/Y)	1.054 <sup>b</sup>	–	–	–
Ln(M/Y)	–	0.887 <sup>b</sup>	–	–
Ln((X + M)/Y)	–	–	0.875 <sup>b</sup>	–
Ln(TOI)	–	–	–	0.885 <sup>b</sup>
Constant	5.8251	-0.217	0.156	-0.581

Note: a: b: c respectively represents the 1%, 5% and 10% level of significance.

**<Table 7>** Short Run Coefficients.

	Model – 1	Model – 2	Model – 3	Model – 4
$\Delta(\text{Ln}(\text{HC}))$	-0.081	-0.023	-0.059	-0.059
$\Delta(\text{Ln}(\text{K}))$	0.037 <sup>c</sup>	0.045 <sup>b</sup>	0.048 <sup>b</sup>	0.047 <sup>b</sup>
$\Delta(\text{Ln}(\text{X}/\text{Y}))$	0.059 <sup>b</sup>	–	–	–
$\Delta(\text{Ln}(\text{M}/\text{Y}))$	–	0.112 <sup>b</sup>	–	–
$\Delta(\text{Ln}((\text{X} + \text{M})/\text{Y}))$	–	–	0.119 <sup>b</sup>	–
$\Delta(\text{Ln}(\text{TOI}))$	–	–	–	0.129 <sup>b</sup>
$\text{ecm}_{t-1}$	-0.056 <sup>b</sup>	-0.055 <sup>b</sup>	-0.059 <sup>b</sup>	-0.058 <sup>b</sup>

Note: a: b: c respectively represents the 1%, 5% and 10% level of significance.



**<Figure 2>** Coefficient of Ln(X/Y) and its two\*S.E. bands based on rolling OLS (Dependent Variable: Ln(Y) ; Total no. of Regressors: 4)

#### 4.3. Rolling Window Results

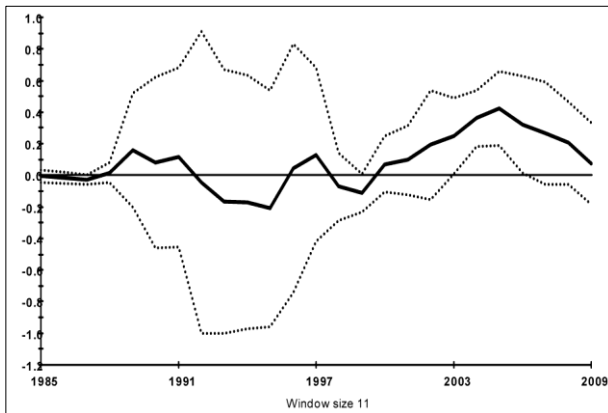
This study also employs the rolling window regression method in order to examine the stability of coefficients throughout the sample span. The main advantage of this method is that it can estimate the coefficient of each observation over the sample by fixing window size. In contrast to the other available cointegration approaches, it supposes that the parameters of the coefficients remain

the same throughout the sample. But in reality, the coefficients cannot remain the same due to the fluctuation in economic conditions.<sup>15</sup> Figures 2 to 5 show the results of the rolling window regression method. The solid line graphs in the figures represent the estimated coefficients. These graphs show the two standard deviation bands (upper and lower bands of dotted lines) that confirm the coefficients' statistical significance.

Figure 2 shows the graph of export coefficients. This coefficient graph indicates that exports are related to negative economic growth in the years from 1987 to 1988 and 2000. Figure 3 shows that in these years (1986 to 1988, 1993 to 1996, and 1999 to 2000), Ln(M/Y) has a negative impact on economic growth. Ln((X + M)/Y) and the composite trade openness index are negatively associated with economic growth in the years 1986 to 1988 and 1999 to 2000. For the remaining years, all the trade openness indicators are positively associated with economic growth.

<sup>15</sup> If the economic variables change over time, this technique also captures the instability.

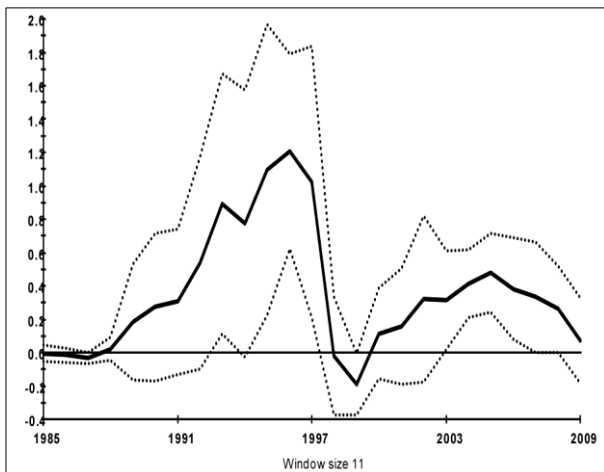




**<Figure 3>** Coefficient of  $\ln(M/Y)$  and its two\*S.E. bands based on rolling OLS (Dependent Variable:  $\ln(Y)$  ; Total no. of Regressors: 4)



**<Figure 4>** Coefficient of  $\ln(X+ M/Y)$  and its two\*S.E. bands based on rolling OLS (Dependent Variable:  $\ln(Y)$  ; Total no. of Regressors: 4)



**<Figure 5>** Coefficient of  $\ln(TOI)$  and its two\*S.E. bands based on rolling OLS (Dependent Variable:  $\ln(Y)$  ; Total no. of Regressors: 4)

## 5. Conclusion

This study tests the link between trade openness and economic growth in the case of China by using the framework of endogenous economic growth model. The autoregressive distributed lag (ARDL) cointegration technique and rolling regression method are used. The empirical findings indicate that trade openness (i.e., Both individual trade indicator and composite trade openness index) are positively related to economic growth in the long run and short run.

The findings of this study are similar to earlier findings of Lin et al. (2002), Guisan (2007) and Tsen (2010) in the case of China. The other variables under this investigation are human capital and physical capital. They both are positively related to economic growth in the long run. In the short run, physical capital is positively associated with economic growth. The rolling window results suggest that trade openness is negatively linked to economic growth in years 1986 to 1988, 1993 to 1996 ( only  $\ln(M/Y)$  and 1999 to 2000.

On the basis of empirical results the following policy implication is suggested. The positive coefficient of trade openness (except for a few years) suggests that comprehensive trade openness is vital for sustainable economic growth. The positive and significant coefficient of human capital in the long run suggests that more expenditure in education will enhance the economic growth. The positive physical capital coefficient infers the importance of increasing level of investment in China.

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