

Article

Trade Openness and Economic Growth in Malaysia: Some Time-series Analysis

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Abstract

This study is an attempt to examine the effects of trade openness along with two other conditioning variables on economic growth in Malaysia by applying time-series econometric technique. LSE-Henry's general to specific approach results show significant positive effect of trade openness on growth. Human capital and good economic policies tested with an interaction term increases the growth effects of trade openness. The addition of these variables and findings are significant statistically and robust to different specifications. On the basis of the findings, it is concluded that while trade openness enhance growth, decision makers should also focus on human capital development. In addition, decision makers should ensure good economic policies to take full benefit of trade openness.

JEL: C32, F11, F43

Keywords

Trade openness, growth, time series approach

Introduction

Trade openness has become one of the recent trends particularly in developing and emerging market economies that are motivated to enhance their own economic progress. The appropriateness of trade openness for economic growth has been discussed time and again in the literature. The outcome of trade openness is

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scrutinized in a number of available empirical studies. Some studies suggest significant positive effect of trade openness on economic growth (Dollar, 1992; Edwards, 1998; Sachs & Warner, 1995). Others suggest small but positive result of trade openness on economic growth (Lee, Ricci, & Rogobon, 2004). The success story of the East Asian economies provide additional support to the view that trade openness is useful for economic growth even though there are other determinants of economic growth mentioned for these economies (World Bank, 1993, 2003). Further, the recent huge changes in the volume of trade in favour of China shows economies that are open for trade are more productive than those who only produce for domestic consumption without economies of scale. According to Arrow (1962) international trade can bring about more research and development (R&D) and learning by doing that is crucial for enhancing productivity and hence economic growth. Beside trade openness, technological progress and human capital are also considered as key determinants of economic growth (Borensztein, De Gregorio, & Lee, 1998; Solow, 1956). This study begins with the remark that even though trade openness is considered as one of the determinants of economic growth, its impact differ substantially across economies and it depends on absorptive capacity of the economy and sound economic policies.

In the beginning of the twentieth century, many developing economies such as Malaysia have been largely regulated and protected economy with industrial regulation and highly regulated imports. However, as world trade policy changed from import substitution to export promotion strategies in the 1980s, barriers to trade and investment in Malaysia have declined relative to other economies in the region except for Singapore and Hong Kong. This policy shift enabled Malaysia to respond positively to increasing opportunities from worldwide trade expansion. However, this generalized view does not suggest that all is good with trade in Malaysia. The current account balance, which stood at around 16.8 per cent of gross domestic product (GDP) highest in 2008, is on the decline and stood at 3.4 per cent of GDP in 2013. The growth engine changed remarkably from export-oriented manufacturing to domestic services since global financial crisis in 2008. However, Malaysia continues with its liberalization policies to raise production, investment and diffusion of technology for more export-based industries. The removal of restrictions on foreign equity participation in service sector, relaxation of foreign exchange policies, reduction in FDI caps particularly in export industries and streamlining customs tariffs are evidence to be key aspect of export growth during this period. Several studies have been undertaken to examine the outcome of trade openness or liberalization on growth in Malaysia (see Sarkar, 2008; Yanikkaya, 2003); however, the last two decades are deemed very crucial to get technical and structural changes. Trade policies have also been re-examined and were revised. These changes in Malaysia's openness and domestic economic structure make her a suitable time series case study to examine trade openness and economic growth nexus. There are two further grounds for undertaking the current study. First, apart from some studies (Eaton & Kortum, 1996; Edwards, 1998; Rodriguez & Rodrik, 2000) on trade and economic growth, a number of studies are debatable on choice of the variable for they only choose trade openness while trade openness alone may not enhance economic growth (Rodriguez & Rodrik, 2000).

The need to introduce important conditioning factors of growth is also emphasized in Bosworth and Collins (2003). This study takes this concern seriously and seeks to overcome this by appropriately introducing additional variables namely human capital and tests for sound economic policy with interactive term beside trade openness in our specification. Human capital stock limits the absorptive capacity of the developing economies (Nelson & Phelps, 1966). Thus, the gains arising from trade openness in terms of technical know-how, research and development and learning new ideas require sufficient level of human capital so that the beneficial effect of trade openness is fully exploited. Similarly, sound economic policies are important when economy opens up for international trade and intend to realize the potential expansion of income from trade (Bolaky & Freund, 2004). Second, although research on trade and economic growth have proliferated (Ahmed & Anoruo, 2000; Barlow, 2006; Chatterji, Mohan, & Dastidar, 2013; Hye, 2012; Jawaid, 2014; Wacziarg & Welch, 2010), the focus has been on groups and regions of economies. While this idea may be due to unavailability of adequate yearly data, no such issue is present for Malaysia. Further, in cross-sectional studies, it is difficult to gauge from across economies at specific point in time as to what is happening in individual economy over time. A time series analysis overcomes this issue with different econometric technique, providing confidence and strong basis for acquainted economic policy decision. Motivated by these premises and policy implications, this study aims to explore the effect of trade openness on growth of output in Malaysia. Using LSE-Hendry general to specific (GETS) technique and updated data over the period 1980–2013, this study presents long-run estimates of trade openness and two other additional variables on growth of output.

The remainder of the study is structured as follows. Following introduction, the second section provides review of literature focusing on growth implications of trade openness. The third section outlines the empirical modelling of the study. The fourth section provides empirical results and discussion, and the final section concludes the study with policy implications.

Review of Literature

Trade openness and economic growth nexus has been empirically tested for different countries using panel, cross-section and time series methods, and findings differ substantially with some encouraging and some conflicting evidence.

Tyler (1981), Heitger (1987) and Lussier (1993) in a neoclassical framework investigate the relation among export of goods and services, and economic growth using ordinary least square method of estimation. The results indicate that export is essential determinant of economic growth. Kraay (1999), using number of industrial firms from China for the period 1988–1992, shows that their export has lead to considerable development in firm's productivity. Similarly, Park, Yang, Shi and Jiang (2008) using Chinese manufacturing firms show that manufacturing export increases their total factor productivity (TFP), overall sales and asset return.

Gonclaves and Jurgen (1986) using sample of 70 developing economies analyze the relation of export growth rate and ratio of export to output with economic growth over the period 1960–1981. Findings suggest that both growth rate of export and ratio of export to output have positive impact on economic growth. Harrison (1996) using several variety of proxies of trade openness suggest that even though the correlation across the different proxies is not so strong, by and large there is positive connection amid trade openness and growth of output. In contrast, Colombatto (1990) utilizing ordinary least square method, examine export-led growth hypothesis for 70 under developed economies. His results do not support the export-led growth hypothesis. Gatti (2001) suggest that as a result of market distortions and corruption, there is inverse association among trade openness and growth which can have harmful impact on investment.

Rao and Singh (2010) estimate the effect of openness on steady state growth rate of chosen Asian economies. Augmented Solow (1956) model with endogenous growth framework has been employed. Estimates show that Singapore and Hong Kong has the highest steady state growth rate while India, Malaysia and Thailand should pay more emphasis on learning by doing to better their steady-state growth rates. Khan, Malik and Hassan (1995) employing Granger causality test, examine the path of causality among export and economic growth in Pakistan. The findings show bidirectional long-run stable relations among export and economic growth while primary export and economic growth exhibit unidirectional long-run relationship.

Chaudhary, Shirazi and Chaudhary (2007) empirically scrutinize the effect of trade policy on growth in Bangladesh using time series annual data over the period 1973–2002. Long-run cointegration test between export, import and economic growth was performed. The results provide evidence of long-run relationship, and export and import have positive impact on economic growth. Export and technology-oriented strategies have been outlined with the emphasis on necessary import of raw materials to boost economic growth in the country.

Melitz (2003) applying dynamic industry model examines the intra-industry impact of trade. The model demonstrates that trade encourage efficient and productive firms to export while some less efficient firms only produce for local market or exit the industry. It shows that increase in industry's experience to trade give raise to inter-firm reallocations to more efficient firms. The productivity gained through reallocation leads to welfare gain, hence underlining the benefit of trade openness. Feenstra (2010) in his study on assessing gains from trade openness under monopolistic competition indicates new product variety, increase productivity and efficiency, and lower markups introduced by firms can lead to gains from international trade.

Mohammad (2010) using time series analysis examined that impact of financial deepening and liberalization of trade on economic development in Pakistan. Results indicate that both financial sector development and liberalization of trade have substantial positive effect on development of the economy. Similarly, Sakyi (2011) examines the impact of aid and trade openness on economic output in Ghana. Findings indicate that trade openness and aid are positively related to economic development. Hye (2012) found negative relationship among total

volume of trade and economic output in Pakistan. In contrast, Jawaid (2014) taking various dimensions of trade openness reports positive relation among export and economic in addition to proficient use of capital goods to boost production in Pakistan.

Chang, Kaltani and Loayza (2009) in a sample of 82 developed and developing countries investigate how the effect of trade openness may subject to number of structural characteristics of these economies. Results indicate that positive impact of trade openness can be enhanced substantially if structural and complementary reforms are carried out.

Chandran and Munusamy (2009) applying bounds testing procedure within the autoregressive distributed-lag (ARDL) framework scrutinize the long-term relation among trade openness and manufacturing growth in Malaysia. The finding reports that trade openness has positive effect on manufacturing growth in Malaysia and that trade openness could be viewed as long-term policy strategy.

Empirical Modelling of the Study

To empirically examine the effect of trade openness on economic growth, the widely applied variant of Solow (1956) model developed by Rao and Singh (2010) is adopted. To begin with, the Cobb–Douglas production function with Hicks neutral technology and constant returns is utilized:

$$y_t = A_0 e^{g^t} k_t^\alpha \quad 0 < \alpha < 1 \quad (1)$$

where the level of output (y) is function of capital stock (k), technology (A) and exogenous growth rate of total factor productivity (g). In this study we use trade openness (TRA), human capital (H) and interactive term of sound economic policies and trade openness (TRA*GE) as growth enhancing variables. The extension of Equation 1 with respect to these growth enhancing variables is outlined step by step in Appendix I.

The empirical specification for our estimation, based on London school of economics (LSE) GETS approach,¹ is expressed as

$$\begin{aligned} \Delta \ln y_t = & -\lambda[\ln y_{t-1} - (\ln A_0 + (g_1 + g_2 \text{TRA}_{t-1} + g_3 H_{t-1} \\ & + g_4 \text{TRA} * \text{GE}_{t-1})t + \alpha_1 \ln k_{t-1})] + \beta_1 \sum_{i=1}^n \Delta \ln y_{t-i} \\ & + \beta_2 \sum_{i=0}^n \Delta \ln k_{t-i} + \beta_3 \sum_{i=0}^n \Delta \ln \text{TRA}_{t-i} + \beta_4 \sum_{i=0}^n \Delta \ln Z_{t-1} + \varepsilon_t \quad (2) \end{aligned}$$

Here, Δ is difference operator. Z is vector of other growth enhancing variables (human capital (H) and interactive term of economic policies and trade openness (TRA*GE)). α and β are coefficients to be estimated and are expected to be positive. Lambda (λ) measures the speed of adjustment to equilibrium and it is also interpreted as the indication of cointegration.

There are several time series methods of carrying out cointegration analysis. Some well-known approaches include LSE-Hendry's GETS, fully modified ordinary least square (FMOLS), Engle-Granger (EG), Johansen maximum likelihood and ARDL procedures. LSE-Hendry's GETS is popular single equation estimation procedure. It involves the formulation of unrestricted 'general' model which is congruent to data and application of testing down process. Testing down process is elimination of variables that have statistically insignificant coefficients, leading to a 'specific' simpler congruent model. Encompassing and congruency are essential elements in this method. Encompassing relates to preventing any loss of information during the reduction process, while congruency is concerned about harmonizing model with data in-line with the criteria like normality, weak exogeneity of right hand side variables, homoskedasticity, coefficient constancy and innovation errors (see Charemza & Deadman, 1997; Sargan, 1964).

Although Johansen cointegration and vector error correction model is extensively applied, sometimes it is hard to find significant result with small number of observations. On the other hand, EG and FMOLS are easier to put into use. However, it is common knowledge that FMOLS is non-parametric correction of OLS and EG, and it accounts for (a) problem of serial correlation and (b) potential endogeneity of the variables. LSE-Hendry's GETS technique is similar to FMOLS. In present form, LSE-Hendry's GETS approach is reliable and consistent with traditional Engle and Granger procedure. However, it is sometimes criticized for the reason that it estimates long-run coefficients and autoregressive distributed lag coefficients in single step. Thus, it presents an impression that regression is combination of $I(1)$ and $I(0)$ variables. Hendry himself has argued that this censure does not hold because if variables in levels, $I(1)$, are cointegrated, the linear combination of them is $I(0)$ (Hendry & Doornik, 1994; Hendry & Krolzig, 2000). Moreover, Banarjee, Dolado, Galbraith and Hendry (1993) and Patterson (2000) have demonstrated that, akin to FMOLS, Hendry's GETS approach is improvement on EG and asymptotically equal to FMOLS. Therefore, in this study we use LSE-Hendry's GETS approach to illustrate growth effects of trade openness.

Data from Malaysia are used for the period 1980–2013. All the data are sourced from World Development Indicators (2014). The level of output (y) is measured by real gross domestic product (GDP) in millions and local currency unit. Real gross fixed capital formation is used as proxy for stock of capital (k). Trade openness (TRA) is measured by share of export plus import to GDP while human capital (H) is captured by secondary school enrollment. For sound economic policies (GE), share of government spending in total output is used. The unit root test of all the series is conducted to check the stationary properties prior to the estimation procedure. All the variables are used in the logarithmic form. Thus, the interpretation of estimated coefficient is on basis of log-log regression.

Estimation and Results

As a first step to quantify the growth effect of trade openness, we conducted unit-root test in regard to time-series properties of the variables employed in the study. Testing the presence of unit root in each of the variables is essential to investigate

Table 1. Unit Root Test Results

Variables	In Levels	In First Difference
	ADF	ADF
<i>y</i>	-1.67	-5.47
TRA	-0.52	-5.06
TRA*GE	-1.89	-4.78
<i>H</i>	-2.00	-4.69
<i>k</i>	-1.72	-4.33

Source: Author's calculation using Micro-fit 4.1.

Notes: The ADF test includes the intercept and trend when testing for unit root test. The lag length 2 is selected based on Schwarz Bayesian criteria. The critical value for intercept with trend for ADF test is -4.26 at 1 per cent and -3.55 at 5 per cent significance level.

the properties of the series under study and to avoid spurious results (Yule, 1926). In Table 1 we report the results of Augmented Dickey–Fuller (ADF) unit root test which have the null hypothesis that the series under study has unit root. Based on the results, it is found that variables in levels are non-stationary, however; all the series are stationary when tested in first difference, indicating that series are integrated at $I(1)$.

Ascertaining the stationary properties of the underlying variables, we proceed to model the effect of trade openness on output for Malaysia. Estimates of Equation 2 with linear effects of trade openness and other conditioning variable are presented as Equations I, II and III in Table 2. Given the possibility that right hand side variables in the model are correlated, the problem of multicollinearity between regressors is examined by estimating a baseline model that only includes the key explanatory variables. Then additional variables such as human capital and interactive term are added in the model one at a time. The findings stand when multicollinearity is tested. The results for multicollinearity test in Appendix II indicate that calculated detection-tolerance and variance inflation factor are within the conventional range. Hence, there is no problem of multicollinearity between variables. However, high correlation among trade openness and interaction term is unavoidable.

The result of Equation I in Table 2 is estimates of the baseline model and appear impressive. All the estimated parameters are significant at 5 or 10 per cent levels. Trade openness appears to have small but positive effect on level of output—a 1 per cent rise in trade openness leads to 0.13 per cent increase in level of output. The significance of time trend indicates that trade openness is sturdily trended variable and inclusion of time trend could capture the impact of other time trended and omitted variables which could weaken its effect on output. Also, in this equation the trade openness has left a big residual since the estimated R^2 is low around 0.44. The chi-square test summary for serial-correlation, heteroscedasticity and normality of residual are not significant.

Equation 2 is re-estimated by adding additional variable namely human capital along with trade openness and is illustrated as Equation II in Table 2. Borensztein et al. (1998) show that human capital is closely related to long-term growth.

Table 2. Equations for Long-run Growth Effects of Trade Openness with LSE-Hendry's GETS

Dependent variable: $\Delta \ln y_t$			
Variables	I	II	III
Constant	6.33 (5.55)*	6.29 (4.85)*	5.29 (1.71)
λ	-0.16 (3.33)*	-0.15 (2.14)*	-0.09 (4.21)*
Time trend	0.02 (4.99)*	0.02 (4.60)*	0.02 (4.01)*
TRA_{t-1}	0.13 (1.94)**	0.14 (2.00)*	-0.17 (1.57)
H_{t-1}		0.02 (1.90)**	0.03 (1.74)**
$TRA_{t-1} * GE_{t-1}$			0.21 (2.53)*
$\ln k_{t-1}$	0.37 (2.46)*	0.38 (2.20)*	
$\Delta \ln k_t$	0.20 (7.47)*	0.20 (7.26)*	0.33 (7.56)*
$\Delta \ln k_{t-1}$	-0.05 (2.60)*	-0.05 (1.56)	-0.08 (2.13)*
$\Delta \ln y_{t-1}$	0.13 (1.63)**		
DUMFC			-0.01 (2.18)*
R^2	0.44	0.56	0.68
χ^2 (SC)	0.95	0.93	0.05
χ^2 (NM)	0.97	0.96	0.53
χ^2 (HT)	0.15	0.14	0.89
DW	1.99	1.93	2.60

Source: Author's calculation using Micro-fit 4.1

Notes: Absolute t-ratios below coefficients are reported in parenthesis. The χ^2 tests in the table are for Breusch-Godfrey LM test for serial correlation (SC), Jarque-Bera test for non-normality (NM) and White test for heteroscedasticity (HT), respectively, for which p-values are reported. DW is Durbin Watson statistics. Significance level at 5 per cent and 10 per cent are marked with * and **, respectively.

Time trend is also included. The results are robust to the addition of human capital as another determinant of economic growth. The summary statistics reflects improvement on Equation I with R^2 of 0.56. Human capital variable is positively related to output and is significant at 10 per cent level. Although there is no

substantial change in the size of coefficient of trade openness, its significance level has improved when modelled with human capital compared to Equation I. The result is consistent with the notion that human capital act as absorptive capacity of the economy. The beneficial effect arising from opening up for international trade in terms of flow of new technology, technically sophisticated know how and efficient use of capital goods can be enhanced if economy has sufficient level of human capital which in turn increases productivity and economic growth.

To further examine the role of trade openness in economic growth, we analyze its relationship with sound economic policies. The proxies for sound economic policies are ratio of government expenditure to GDP, proportion of budget deficit to GDP, etc. Dollar and Kraay (2004), for good institutional setting, have used share of cash and time deposits to GDP. However, these measures are not outside the debate. In our analysis we use share of government expenditure to output. Estimates for this specification with interactive term of trade openness and sound economic policies are illustrated in Equation III of Table 2. The proposition is that sound economic policies make trade openness more successful. The result shows significant positive balancing effect among trade openness and good economic policies on growth of output. It is in-line with the view that trade openness lead to increase in income or growth only in economies that are not heavily regulated or adopt sound economic policies in relation to international trade. However, it is puzzling to note that individual effect of trade openness has become negative although insignificant. This implies that trade openness has negative effect on growth in economies with less human capital and lack of sound economic policies. While one could accept that trade openness no longer contribute to economic growth, it is hard to conceive this in situations where economies have low human capital and continue to engage in international trade.

Further, the effect of financial crises is also tested through dummy variable which takes the value of 1 in the crisis year. The crisis year includes 1997—Asian financial crisis and 2008—global financial crisis. As expected impact of financial crisis has significant negative impact on output. This strong effect of both the crisis augurs well because Malaysia experienced substantial contraction in GDP. For example, the adverse effect of 2008 financial crisis hit Malaysian economy late in 2008. Export and investment declined and industrial output deteriorated. As a result, economic growth in the last quarter of 2008 was substantially declined to 0.1 per cent compared to first three quarters which on average stood at 5.9 per cent. The estimated coefficient of capital 0.33 is parallel to stylized value. Lambda (λ) which indicates cointegration between variables is negative and significant at 5 per cent level. It also determines the pace of correction towards equilibrium in dynamic model and shows that long-term equilibrium is obtainable. The R^2 of 0.68 imply that 68 per cent of the variations in growth rate of output is explained by capital input, trade openness, human capital and sound government policy while the remainder of the variation appears to be submerged in trended variables that may be explored further. On the basis of coefficient-of-determination and diagnostic statistics, we may come to a close that Equation III is the best equation in Table 2. The effect on economic growth derived from Equation III, implies that human capital and sound economic policies made positive effect of trade openness more effective and significant than that of Equation I in Table 2.

Conclusion and Policy Implications

This study examined the effect of trade openness along with two additional conditioning variables namely human capital and sound economic policies on output growth in Malaysia using time-series data from 1980 to 2013. LSE-Hendry's GETS modelling procedure has been applied.

The empirical results to capture effect of trade openness on output growth have been positive. Human capital is found to have positive effect and significantly improves the positive impact of trade openness on growth of output. Further, it is also found that the interaction term of trade openness and sound economic policies has relatively large positive effect on output growth. These interactions are also found to be significant statistically and robust to changes in specification. Although the findings indicate that around 68 per cent of variation in output growth is explained by trade openness, capital input, human capital and good economic policies, there is a need to improve by testing other additional growth enhancing variables. Edwards (1998) emphasizes the need for time-series country-specific studies to critically examine importance of openness to growth. Although he showed trade openness contributes significantly through its impact on total factor productivity, the standardized parameters indicate that human capital adds extra to productivity. In our study, trade openness found to be the main contributor; however, human capital and sound economic policies help enhance its effect on growth. Nonetheless, it is tough to make conclusions on the relative significance of different growth enhancing variables until more variables are recognized and examined. In one of their important survey Rodriguez and Rodrik (2000) claim that exact relationship between trade and growth is still not resolved. It is for these reasons, even though our findings indicate that a 1 per cent increase in trade openness leads to increase in output growth by 0.21 per cent, we do not exaggerate this findings until further developments are done using additional growth enhancing variables to appreciate country-specific growth effects of trade openness with time series approaches. However, on the basis of these findings, it is important that while the country continues to open up for international trade, it should also focus on human capital development to enhance economic growth in Malaysia. In addition, decision makers should ensure good economic policies to take full benefit of trade openness. This is an important argument on the debate about effect of trade openness in developing economies.

Appendix I. Derivation of Extended Solow Model

Starting with the Cobb–Douglas production function with Hicks-neutral technical progress and constant returns:

$$y_t = A_0 e^{g't} k_t^\alpha \quad 0 < \alpha < 1 \quad (1)$$

where y = level of output, A_0 = technology, g = autonomous rate of growth of total factor productivity, t = time, k = stock of capital. α is share of capital input. The derivation of Solow (1956) model's steady state is well known. The steady state level of output and growth rate is derived below respectively.

$$y^* = \left(\frac{s}{d+n+g} \right)^{\frac{\alpha}{1-\alpha}} A \quad (2)$$

$$\Delta \ln y^* = \text{Steady state growth rate} = \Delta \ln A = g \quad (3)$$

Here s = savings rate, d = depreciation rate, n = represents growth rate of labour force while A = steady state stock of knowledge. The implied assumption in this model about total TFP is that:

$$A_t = A_0 e^{gT} \quad (4)$$

Here it is assumed that the initial level of knowledge develops at an exogenous rate of growth of g , that is $g = g(T)$.

Hence, the effect of trade openness on TFP can be confined with an alternative specification. A simple linear practical specification of extended production function of Equation 1 is as follows:

$$y_t = A_0 e^{(g_1 + g_2 \text{TRA}_t)T} k_t^\alpha \quad (5)$$

In this case, we have used trade openness (TRA) as one of the growth enhancing variable. The expansion to other growth enhancing variables can follow similar process. For sound economic policies (GE) (measured by ratio of government expenditure to output), it is tested as an interactive term. The modified production function with this conditional variable (GE) can be specified as:

$$y_t = A_0 e^{(g_1 + g_2 \text{TRA}_t + g_3 \text{TRA}_t * \text{GE}_t)T} k_t^\alpha \quad (6)$$

Taking the log-linear relationship for Equation 6 with variable trade openness (TRA) and interactive term of trade openness and economic policies (TRA*GE) can be expressed as

$$\ln y_t = \ln A_0 + (g_1 + g_2 \text{TRA}_t + g_3 \text{TRA}_t * \text{GE}_t)T + \alpha \ln k_t + \varepsilon_t \quad (7)$$

The estimation technique employed is the LSE-Hendry's general-to-specific modelling approach, thus, expressing Equation 7 in their first difference of time would be:

$$\begin{aligned} \Delta \ln y_t = & -\lambda[\ln y_{t-1} - (\ln A_0 + (g_1 + g_2 \text{TRA}_{t-1} + g_3 \text{TRA}_{t-1} * \text{GE}_{t-1})t \\ & + \alpha_1 \ln k_{t-1})] + \beta_1 \sum_{i=1}^n \Delta \ln y_{t-i} + \beta_2 \sum_{i=0}^n \Delta \ln k_{t-i} \\ & + \beta_3 \sum_{i=0}^n \Delta \ln \text{TRA}_{t-i} + \beta_4 \sum_{i=0}^n \Delta \ln Z_{t-1} + \varepsilon_t \end{aligned} \quad (8)$$

where TRA is trade openness. Δ is difference operator. Z is vector of other growth enhancing variables (human capital and interactive term of economic policies and trade openness).

Appendix II. Test for Multicollinearity

We have used formal detection-tolerance and variance inflation factor (VIF) to test for multicollinearity.

Where

$$\text{Tolerance} = 1 - R^2, \text{ VIF} = \frac{1}{\text{tolerance}}$$

Here R^2 is coefficient of determination of regression. A tolerance of less than 0.2 or 0.1 and/or VIF of 5 or 10 and above indicates issue of multicollinearity.

In our case:

$$\begin{aligned} \text{Tolerance} &= 1 - 0.68 \\ &= 0.32 \end{aligned}$$

and

$$\begin{aligned} \text{VIF} &= 1/0.32 \\ &= 3.1 \end{aligned}$$

Thus, there is no problem of multicollinearity between the variables.

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Note

1. Professor Hendry of LSE is the chief and ardent exponent of GETS approach See Rao and Singh (2006) for its application.

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