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Effects of export and technology on economic growth: Selected emerging Asian economies

Md Reza Sultanuzzaman[a] (iD), Hongzhong Fan[a] (iD), Elyas Abdulahi Mohamued[b] (iD), Md Ismail Hossain[a] (iD) and Mollah Aminul Islam[a] (iD)

[a]School of Economics, Huazhong University of Science and Technology, Wuhan, Hubei, P. R. China; [b]Department of Social Science and Humanity, Jigjiga University, Jigjiga, Ethiopia

ABSTRACT

Recent studies regarding the impacts of technology spillover and international trade have gained momentum in the emerging economies. Empirical evidences show that some countries gain and other loss to grasp the opportunities of international trade and technological innovation to compete in the global market. This paper examines the effect of export and technology on the economic performance of emerging Asian countries, using the Generalized Method of Moments (GMM) model between the periods 2000–2016. Following the Solow economic growth model, the result identifies a positive and significant effect of export and technology on the economic growth of the emerging Asian economies. Similarly, the long-run estimation ascertains the significant and positive impacts of trade and technology on the economic growth of the countries. The results are robust using alternative dynamic panel models, representing the pivotal role of export and technology to the economic growth of the countries. Thus, we recommend policymakers to device attractive policies that can enhance the advancement of technology and trade to maintain sustained economic growth. This would also fasten the internationalisation process and enable to compete efficiently in the global markets in terms of quality of exports and standardisation.

1. Introduction

Since the 1980s, the Asian as well as other economy of the world have extensively changed by the involvement of international trade and advanced technology. From the perspective of international trade, exports are generators of foreign exchange, which is necessary for the import of goods and services. Theoretical and empirical arguments indicate a positive relationship between international trade and economic growth (Frankel & Romer, 1999). Similarly, they indicate the pivotal role of exports in facilitating investment and technology transfer that accelerate the globalisation process (Bhagwati & Srinivasan, 1975; Dervis, 1979; Keesing, 1967).

From the beginning of the twenty-first century, exports and advanced technology are playing a vital role in the economic growth of the emerging economies. The advancement in technology that is carried out in terms of policies significantly improved the productivity of many developing countries through the optimisation of exporting of goods and services. It also signifies the export potential of an economy and enlightens the competitiveness of the global world as a whole. According to Radelet, 'rapid export growth facilitates the acquisition of capital goods and technology transfer that drives rapid economic growth' (Radelet, 1999). The technological elevation also contributes to the productivity and the strategic development of economies. Advanced technology can produce goods with less input and less complexity. In addition to this, with better execution and trade, it can be transferred from one country to the other without too much cost, effort and difficulty (Elster, 1984). Thus, it is eternally acknowledged as a vital factor of the 'new international economics' (Antimiani & Costantini, 2013; Asiamah, Ofori, & Afful, 2019; Romer, 1990; Hulst, Mulder, & Soete, 1991).

In the industrial sector, technology is manifested through telecommunication technologies that have realised a higher degree of integration to enable the process of internationalisation process (Rosenbloom & Larsen, 2003). The development of this technology increases the labour productivity, enhances the process of human capital formation, facilitates increases in output, minimises wastages of resources in the production process, improves the quality of infrastructure, reduces costs of production and provides a better living standard (UKEssays, 2018). Recently, the internationalisation process has encouraged the researchers and policy-makers to do more study regarding exports, technological innovation, and GDP of the economy (UNCTAD, 2000). The international trade can promote by bilateral or unilateral ways into most categorised emerging Asian countries.

The classical, neo-classical and new economic growth theories suggest that exports and technology jointly collaborate to be the 'engine of economic growth' (Heitger, 1987; Lussier, 1993; Robertson, 1940). Similarly, several contemporary researches have pointed out the significant relationship between exports, technology and economic growth in developing and emerging countries (Dollar, 1992; Frankel & Romer, 1999; Hesse, 2008; Radelet, Sachs, & Lee, 1997; Sachs, Warner, Aslund, & Fischer, 1995; Schiff & Wang, 2006; World Bank, 1993), it can stimulate demand for the economic output and create new employment opportunities in an economy (Khawar, 2003). Thus, Baliamoune-Lutz (2011) suggests that exports as a vital factor in an economy's growth and development.

Hereafter, comprehensive theoretical arguments consider that export and technology are indispensable elements to economic development in developing countries. Adam Smith and Ricardo theorised that countries could benefit from trade by exporting of goods and services what they produce at a lower labour cost, and import what they produce goods at a higher price (Ricardo, 1821; Smith, 1776). Similarly, Solow's (1956) neoclassical growth model indicates how exports enhance GDP growth. Thus, the cross-country study is crucial to discuss the basic assumptions of exports to economic growth. However, the Solow growth model is the right path to facilitate these problems. The growth model argues that technology is associated with advanced

industrialisation, which reflects rapid economic development. However, in an open economy, economic growth is stimulated by technology and knowledge which are transferred through trade (Frankel, Romer, & Cyrus, 1996; Frankel & Romer, 1999; Grossman & Helpman, 1991; Hsiao & Hsiao, 2006). Vernon (1966) has formed a trade theory that the tendency for the new manufactured goods should focus on the developed countries by the early stage of the goods and later on, it should concentrate on other countries. Since countries are separated by the 'technology gap' at different stages of economic development, new markets are ready to receive new goods by means of exports. Therefore, the role of export is paramount to standardise and enhance the production process of an economy.

Regarding this, the theory of Marjit and Ray (2017) argues that exports are amplified with the rise in competition in the presence of advanced technology, thus cause economic development. Contrarily, the new growth theory identifies six major sources of growth, namely, (a) growth of capital goods, (b) productivity growth from low-tech- to high-tech sectors, (c) developments in the skilled labour force, (d) technological changes (Durlauf, Helliwell, & Raj, 1996), (e) Technology may increase export; resulting economic growth, and (f) export and technology might additionally generate the competitive advantages of an economy. Antimiani and Costantini (2013) discuss that the economic integration practices have reduced the technological gap for the economy. Their study also suggests that technological innovation has produced larger positive effects on export. Thus, higher technological innovation has statistically received the strongest impulse, demonstrating the technological innovation has fostered the crucial role of export competitiveness.

Hence, in this study, we attempt to examine the economic link between export and technology in emerging markets of Asia. After economic reform of 1990, the issues become more motivating and important for these countries due to tremendously increased exports and considerable adoption of technology. To assess this nexus, this study utilises the newly developed augmented endogenous growth model, using a dynamic system-GMM approach that sufficiently handles potential endogeneity problems with short-run and long-run effects estimations.

The rest of the paper is organised as follows: the following section presents theoretical reflections of export and technology. Section 2 presents a review of the existing empirical literature of the study. Section 3 is followed by the data, methodology and econometric estimation technique. While Section 4 discusses the empirical outcomes and also explains the relationship between export, technology and economic growth of emerging Asian countries. Finally, the paper is concluded with policy implications and recommendations for future study.

2. Literature review

In developed and developing countries, there are massive empirical studies that explore the causal link between international trade and economic growth (Baliamoune-Lutz, 2011; Bhagwati & Srinivasan, 1975; Dervis, 1979; Keesing, 1967; Marjit & Ray, 2017; Ncube & Cheteni, 2015; Hulst et al., 1991). Some studies examine the relationship through the neoclassical growth framework and reveal that the export

of goods and services is an essential determinant of economic growth (Heitger, 1987; Lussier, 1993). A recent study of Hagemejer and Mućk, (2019) reveals the GDP growth of the Central and Eastern European (CEEC) countries form 1995–2014. It suggests that exports have played a major role in determining economic growth in large part of transition and integration with the EU. It also confirms that exports have been the predominant factor driving the convergence of these countries with their advanced counterparts. Hsiao and Hsiao (2006) focus on the bidirectional evidence between exports and GDP of the East and Southeast Asian economies. However, Nguyen (2016) also econometrically investigates the impact of trade liberalisation policy on the exports sophistication of Vietnam by applying system GMM over the year 2001–2010. The findings imply that trade liberalisation has a positive effect on the export baskets of Vietnam.

Conversely, productivity associated with the export of non-manufacturing industries are larger than manufacturing export industries in terms of trade liberalisation in Vietnam. Baliamoune-Lutz (2011) investigates the effect of trade with China on the growth in African countries. His empirical evidence suggests that export concentration enhances the growth effects of exporting to China, and there is an inverted-U relationship between exports and growth in Africa and developed countries as well. Wierts, Van Kerkhoff, and De Haan (2014) investigate the export and its performance of Eurozone countries (top 20 trade partners) using GMM estimator over the period of 1988–2009. The results imply that a higher share of high technology exports is positively linked to total exports. Although, the share of high technology exports increases as a proportion of total exports, the effect of real exchange rate also diminishes. Constant (2010) reveals a bidirectional relationship between export and GDP growth. However, imports and exchange rate have negative effects, and the labour force has positive effects on the economic growth of Cote d'Ivoire.

According to Kumar, Stauvermann, and Shahzad (2017), 'technology is considered as a critical driver of various types of economic activities and has transformed from knowledge-based economies.' Regarding this, Trlaković, Despotović, and Ristić (2018) examines the effect between technology-intensive exports and economic growth of Western Balkan Countries (WBCs) over the period of 2005–2015. The findings suggest that manufacturing commodities have the most significant effect on increasing GDP per capita, which is run by medium-low and low technology industries. These economies should develop technology-intensive industries for avoiding high dependence on imports of high-value products. Therefore, the natural resources might be a vital factor to increase in terms of total exports and re-industrialisation for each country of WBCs. Greenaway, Morgan, and Wright (1999) evidence the causality using panel data for 69 countries from 1975 to 1993 that there is a strong and positive causality between exports, exports composition, and growth of these countries. Hesse (2008) also states that exports diversification is an important factor for developing countries to improve economic growth. Likewise, developed countries are also attaining the advantage through exports specialisation.

Lee (2011) examines the linkage between technological characteristics in exports on economic growth across 71 countries. He specifies that high-technological exporting goods rapidly effect on the economic growth of as compared to 'traditional' or

low technological exporting goods. In addition, he focuses that emerging economies like China are growing more rapidly due to the high-tech goods and more open to global trade and high technology is the matter of quality product and the rapid economic growth. Lacasa, Jindra, Radosevic, and Shubbak (2019) suggests that the generic trends have increased technology intensity reflected in the accumulation of innovation capability and increased the diversification of technological knowledge of BRICS. However, the BRICS economies have increased frontier technology activities and indicate the nature of modernisation of the individual BRICS economy.

Peneder (2003) reveals that both manufacturing and service exports of technology-driven high skilled industries are positively and correlated with the level of growth of per capita GDP. The study also indicates that this is not only an increase in exports but also in imports. Hence, the application of technologically advanced products contributes positively to the aggregate growth of OECD countries. Pan and Nguyen (2018) interestingly reviewed the literature of Todaro and Smith (2012) book and found that export and import is a twofold-edged sword. Trading with developed nations may interminably perpetuate developing nation's comparative advantages in unskilled labour-intensive or natural resource-intensive production, which inhibits the growth of needed capital, entrepreneurship, and technical skills and thus the long-term economic growth in developing nations. They also investigate that ASEAN countries are most advantageous for exporting to the Western industrial countries, such as: exporting to Japan, Korea, and China.

Solow suggests that exports, technology, and human capital contribute as the vital factors for the growth of an economy (Solow, 1956). Likewise, the human capital is also effective in generating, executing and adopting new technology and hereafter it stimulates economic growth (Benhabib & Spiegel, 1994). They also reveal that the linkage between trade and growth are not similar at different stages for the prospects of economic development, although the trade always speeds up the diffusion of knowledge, innovations, and technology. They also suggest once again that the adoption of the technology depends on the absorptive capacity of an economy, which also depends on human capital (Benhabib & Spiegel, 2005). It also focuses interestingly on the role of human capital and capital accumulation in the economy. Ncube and Cheteni (2015) also examine the effects of international trade on economic growth experiences BRICS on South Africa over the period of 1980–2012. The study reveals that international trade is not only the contributing factor but also the factor of human capital formation; real effective exchange rate appreciation and gross domestic capital formation. The study also discloses that South Africa's economic contribution is very limited due to the malpractices of trade amongst the members of the alliance. Ahmad and Khan (2019) estimated system GMM for finding a link between human capital and economic growth for 67 selected developing countries over the year 1960–2014. They reveal that human capital positively influences economic growth. Another study, Chuang (2000) finds that human capital accumulation sustains the growth of the Taiwan economy and stimulates exports, whereas exports promote long-run growth by accelerating the process of human capital accumulation.

According to Schiff and Wang (2006), external investment flows can lead to quicker accumulation of knowledge, which stimulates higher productivity growth. It's

also introduced importing the newest technology in the recipient country. Borensztein, De Gregorio, and Lee (1998) argue that FDI and human capital are important components for higher economic growth. FDI and human capital have positive and significant effects on the GDP per capita growth of the economy. Besides, Pacheco-López (2005), investigates the causality between FDI, export, and import in Mexico since the late 1980s. The study reveals the bi-directional causality between FDI, export, and import. The study also confirms that the FDI has promoted exports and imports, and it is responsible for the larger trade openness of Mexico.

Similarly, Liu, Burridge, and Sinclair (2002) find that there is a bidirectional long-run relationship between economic growth, exports, imports, and FDI of China. They advocate that economic development, exports, and FDI seem to be mutually reinforcing under the open-door policy. Yao (2006) reveals that exports and FDI have strong and positive evidence on economic growth, where technology is a matter for exports and growth. The study suggests that export promotion and adoption policies are most useful for China and other developing and transitional economies. Kaur, Yadav, and Gautam (2013) discuss for the Indian economy that there is a bidirectional causal association between FDI and economic growth. Moreover, they reveal FDI-led growth in pre-liberalisation and post-liberalisation of 1991.

From the viewpoint of the theoretical and empirical literature, this study assumes that export and technology are important determinants for the rapid growth of the economy. However, very few studies have been analyzed previously the relationship either export and economic growth or technology and economic growth. Thus, this study newly investigates the effects of export and technology on economic growth among emerging Asian economies.

3. Data and methodology

This section is divided into three Parts; the first part presents the source of data and variables; the second part contains empirical methodology while the third part covers estimation techniques used.

3.1. The source of data and variables

This paper designs to study the impact of exports and technology on the economic growth of sixteen emerging Asian countries. According to the emerging Asian market, Bangladesh, China, Hong Kong, India, Indonesia, Iran, Korea, Macao, Malaysia, Pakistan, Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka and Thailand are emerging, advanced, and developing economy (IMF, 2015). Thus, we form hypotheses, how exports and technology impact on the growth of these economies.

This study contends that they are either positive or negative effects between exports, technology and economic growth of emerging Asian economies. The growth model is generally extended to comprise technology for the cross-country analysis (Barro, 1991). However, this study has used total telephone subscription (Asiamah et al., 2019; Hardy, 1980; Kumar et al., 2017; Meijers, 2014) as a proxy of technology. This technology helps to 'communicate better, faster and at lower costs, reducing

Table 1. Declaration of the variables.

Variable		Definition
Dependent Variable	Y	Real Gross Domestic Product (current US$) as a proxy of Economic Growth (Chuang, 2000; Pan & Nguyen, 2018)
Independent Variables	X	Real Exports of Goods and Services (BoP, current US$) (Chuang, 2000; Pelinescu, 2015)
	T	Fixed Telephone Subscriptions (total) as a proxy of Technology (Asiamah et al., 2019; Meijers, 2014)
Control Variables	G	Gross Fixed Capital Formation (current US$) as a proxy of Capital Stock (Naik & Padhi, 2015; Rahman, Rana, & Barua, 2018)
	H	Total Number of Students Enrolled in Secondary Education as a proxy of Human Capital (Barro & Lee, 1994; Meijers, 2014; Pelinescu, 2015)
	F	FDI inflows (BoP, current US$) is the sum of reinvestment of earnings, equity capital, cross-border investment and other capital (Naik & Padhi, 2015)
Instrumental Variables (IV)	EXR	Official Exchange Rate (local currency per US$) (Naik & Padhi, 2015)
	CPI	Consumer Price Index (2010 = 100) (Kahouli, 2019)
	TO	Trade Openness is the total amount of Exports and Imports of Goods and Services measured as a Trade (% of GDP) (Rahman et al., 2018; Zahonogo, 2016)

internal and external transaction costs and thus lowering production costs and enhancing productivity and generating economic growth' (Meijers, 2014). However, we create a strongly balanced panel dataset, including nine macroeconomic variables on yearly data from 2000 to 2016. The dataset consists of 272 observations along with sixteen emerging Asian countries such as Bangladesh, China, Hong Kong, India, Indonesia, Iran, Korea, Macao, Malaysia, Pakistan, Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka and Thailand. All these data are extracted from World Development Indicators, published by World Bank (2018), except for the gross fixed capital formation of Qatar data, which is collected from World Data Atlas database (Knomea, 2018). The dataset has been converted into natural logarithm forms. Hence, Table 1 shows in details concerning the category and definition of the variables.

3.2. Empirical model

This study employs a System-GMM estimator by Arellano and Bond (1998) and Arellano and Bond (1991), to investigate the effects of export and technology on GDP growth in emerging Asian countries. The GMM works simply by adding moment conditions where the base model has the endogeneity problem; also, the majority of regressors are not truly exogenous. Therefore, the system-GMM is more consistent than difference GMM when endogenous variables and fixed-effects exist (Bond, 2002). Due to this, the study applies the two-step system GMM estimator (Arellano & Bond, 1991; Blundell & Bond, 1998; Soto, 2009).

For panel data analysis, the two-step system GMM estimator is exceptionally efficient in the empirical economic growth study, where the typical number of cross-units in economic growth samples is much smaller (Soto, 2009). However, the study uses some instrumental variables to remove endogeneity problems from the model. This model also uses a lagged dependent variable to estimate the dynamic panel GMM. According to Antimiani and Costantini (2013), a system-GMM is the most effective econometric determinant to mitigate both endogeneity of the regressor and

autocorrelation of residuals. Similarly, it is also important for an appropriate estimation technique of a theoretically based simultaneous equation, while retaining time-invariant covariates (Arellano & Bond, 1998; Manuel Arellano & Bond, 1991; Manuel Arellano & Bover, 1995; Blundell & Bond, 1998).

For structuring the empirical model, the study follows the Solow (1956) growth model, which is known as Cobb–Douglas production function (Hsieh & Klenow, 2010; Kalaitzi, 2018; Lee, Psaran, & Smith, 1995). The production function can be determined as a function of exports, technology, physical capital stock, human capital, and FDI. However, our empirical model can begin with a simple production function and express as:

$$Y_{it} = A_{it} G_{it}^{\gamma} H_{it}^{\theta}, \ 0 < \gamma + \theta < 1 \tag{1}$$

Where Y = output, G is the capital stock, and H is the human capital, i and t denote country and time respectively. Also, γ and θ is the share of physical capital stock, and human capital and A denotes a function of productivity parameter. Based on this, we deduce equation (2):

$$A_{it} = f(X_{it} T_{it} F_{it}) = X_{it}^{\alpha} T_{it}^{\beta} F_{it}^{\sigma} \tag{2}$$

Where X is exports, T is technology, and F is foreign direct investment. After combining Equations (1) and (2), the study is found:

$$Y_{it} = X_{it}^{\alpha} T_{it}^{\beta} G_{it}^{\gamma} H_{it}^{\theta} F_{it}^{\sigma} \tag{3}$$

Where $\alpha, \beta, \gamma, \theta$ & σ denote the elasticity of production function with respect to X, T, G, H & F. Following this, the equation (3) can be transformed into linear form and by taking natural logarithm both side of the equation:

$$\ln Y_{it} = c + \alpha \ln X_{it} + \beta \ln T_{it} + \gamma \ln G_{it} + \theta \ln H_{ti} + \sigma \ln F_{it} + \varepsilon_{it} \tag{4}$$

Where c is the intercept, $\alpha, \beta, \gamma, \delta, \theta$ and σ are elasticity, while ε is the error correction term.

The estimation technique contains taking lagged values of the dependent variable with the right side variables to control unobserved time-invariant effects in the model. Our empirical dynamic panel model will be followed by the equation (5) as specified by Mankiw, Romer, and Weil (1992):

$$\ln Y_{it} = c + \delta \ln Y_{it-1} + \alpha \ln X_{it} + \beta \ln T_{it} + \gamma \ln G_{it} + \theta \ln H_{it} + \sigma \ln F_{it} + \mu_i + \mu_t + v_t \tag{5}$$

Where c the intercept, $\ln Y$ is the dependent variable and $\ln Y_{t-1}$ is the lagged value of the dependent variable, which acts as the independent variable. Also, $\ln X$ & $\ln T$ are the core independent variables of the model and $\ln G, \ln H$ & $\ln F$ are comprised as the determinant of growth or control variables. From equation (4), the error correction term (ε_{it}) has been decomposed into three components in equation (5).

Table 2. Descriptive statistics.

Variables	Observations	Mean	Standard Deviation	Minimum Value	Maximum Value
ln$Y$	272	11.358	0.601	9.827	13.049
ln$X$	272	11.034	0.609	9.776	12.391
ln$T$	272	6.688	0.787	5.152	8.566
ln$G$	272	10.755	0.682	8.8	12.685
ln$H$	272	6.462	0.944	4.442	8.115
ln$F$	272	9.042	3.558	−9.658	11.464

Source: Authors Calculations.

The first component (μ_i) is measured by the unobserved country-specific effects, the second component (μ_i) is measured by the time-specific effect, and the third component (ν_{it}) is measured by the idiosyncratic error term.

3.3. Estimation techniques

When N is large relative to T and to avoid spurious estimations in the model, we conducted panel unit root test to all variables of the study (Pedroni, 1999; Pesaran, 2007). Due to the nature of the data, the study has established a second generation panel unit root tests as developed by Pesaran (2007). The descriptive statistics and correlation metrics are also carried out to specify the model. The descriptive statistics are summarised and shown in Table 2. Hereafter, it implies that comparatively low standard deviation recommends that the value of GDP, Export and Technology are fairly close to its mean value. It suggests that these countries are being heterogeneous in various aspects. The correlation matrix shows (see Table 3) the possibility of any significant multicollinearity bias and the level of relationships between variables.

The correlation matrix indicates that maximum variables exist a weak relationship between them (see Table 3). Only Capital stock has a strong relationship with other variables. Theoretically, the coefficient of the variable should be within 0.80–0.90 for avoiding multicollinearity from the series as guidelines of Kennedy (1998). However, the presence of multicollinearity in the series is not surprising for the GMM estimator; it can automatically remove multicollinearity from the series (Arellano & Bond, 1998).

Afterward, we check the core results using GMM estimator. This estimator can tackle the problems of time-invariant omitted variable bias (Ahmad & Khan, 2019). Furthermore, we take a lag of the dependent variable as an independent variable to make the model dynamic GMM and control the endogeneity effects. Finally, we check the validity of the instruments ranks by Sargan, Hansen test and robustness by AR(2) test for serial correlation.

4. Empirical outcomes and discussions

To have better and reliable estimations, testing the stationarity and the unit roots in the data has paramount importance in panel data (Naik & Padhi, 2015). Thus, prior running the main analysis, the study made the panel unit root tests using the first and second-generation panel unit root tests. Studies identify limitations in first generation unit root test in providing robust results, when there is cross-sectional

Table 3. Pairwise correlations.

Variables	lnY	lnX	lnT	lnG	lnH	lnF
lnY	1.000					
lnX	0.737	1.000				
lnT	0.862	0.509	1.000			
lnG	0.986	0.734	0.848	1.000		
lnH	0.658	0.098	0.799	0.638	1.000	
lnF	0.243	0.230	0.212	0.267	0.112	1.000

Source: Authors Calculations.

dependency (Levin, Lin, & Chu, 2002), making second-generation unit root test undisputable test to examine unit roots in series with the cross-sectional dependency. Hence, Table 4 shows the second generation panel unit root results (without trend and with trend) provided by Pesaran (2007); consequently, all the variables are stationary at first difference at 1% significant level, except lnF, which is stationary at level and first difference.

Following the stationarity test, the study considered pooled OLS and Driscoll-Kraay econometrics estimation techniques for baseline and robustness analysis. The pooled OLS is used as a baseline model of the study, and the result shows significant effects of the factors of the study, except lnFDI. Similarly, the study uses Driscoll-Karry matrix, which automatically removes heteroskedasticity & serial correlation problems and produces consistent standard errors from the series to provide robust to general forms of cross-sectional and temporal dependence (Driscoll & Kraay, 1998). Similarly, the Driscoll-Karry results also show significant effects of the variables, except the control variable FDI is insignificant (see Table 5).

Table 5 shows that export and technology have a positive and statistically significant effect on economic growth. If we compare between pooled OLS, Driscoll-Kraay and system GMM estimators, the pooled OLS and Driscoll-Kraay models strongly support the results of GMM estimator. However, the system GMM estimator has a lower bias and higher efficiency than the other estimators Soto (2009). In addition, the selection of instruments for the system GMM is determined by keeping $IV < N$ as corresponding to Roodman (2006), and the validity of these instruments is a mild condition on initial values (Blundell & Bond, 1998). The AR(2) probability value is insignificant (see Table 5), to suggest the validity of GMM estimator. It also implies that this model does not suffer from second-order serial correlation and the stationarity of the series. Hence, the post estimations provide evidence that the model is robust and a good fit for investigating the impact of exports and technology on the economic growth of the selected emerging Asian countries. Thus, the result is robust and support the empirical literature of Santos-Paulino (2011) and Meijers (2014).

Thus, from Table 5, if the export (lnX) increases by 1%, economic growth (lnY) will increase by 0.15%, proving the key role of export to the economic growth of emerging Asian countries that is also suggested by many researchers (Constant, 2010; Hagemejer & Mućk, 2019; Heitger, 1987; Lussier, 1993; Nguyen, 2016). Likewise, from Table 5, we identify the technology (lnT) increases by 1%, economic growth (lnY) will increase by 0.05%. It implies that technology is the subject to reinforce the spillover effects of the economy. This results also supported by the studies of (Donou-Adonsou, 2019; Kumar et al., 2017; Lee, 2011; Meijers, 2014)

Table 4. Second generation unit root tests.

Variables	At level	1st Difference	At level with trend	1st Difference with trend
lnY	−2.016	−3.374***	−2.305	−3.546***
lnX	−1.769	−3.573***	−1.769	−5.341***
lnT	−1.323	−2.839***	−1.771	−3.278***
lnG	−2.039	−2.959***	−2.109	−3.204***
lnH	−1.483	−3.27***	−2.257	−3.607***
lnF	−3.189***	−4.557***	−3.409***	−4.494***

Significance levels:
*at 1% level.
Source: Authors Calculations.

Table 5. Pooled OLS & Driscoll Kraay results and two-step system-GMM: Short-run results.

Variables	Pooled OLS	Driscoll Kraay	System GMM
L1.lnY			0.148***
			(2.99)
lnX	0.154***	0.165*	0.151***
	(5.99)	(1.97)	(3.39)
lnT	0.128***	0.136***	0.047*
	(6.06)	(2.98)	(1.78)
lnG	0.090**	0.066***	0.136***
	(1.99)	(4.74)	(5.20)
lnH	0.201**	0.171***	0.192*
	(2.16)	(4.07)	(1.69)
lnF	0.001	0.000	0.001**
	(0.89)	(1.56)	(2.49)
Constant	0.030***	0.027***	0.023***
	(11.23)	−4.27	(13.12)
AR(1)			0.043
AR(2)			0.485
Sargan			0.597
Hansen			0.267
Observations	256	256	240
No of Groups	16	16	16
R-squared	0.325	0.287	–
Adj. R- squared	0.309	–	–

GDP (lnY) is a dependent variable, t-statistics in parentheses for OLS & Driscoll Kraay and z-statistics in parentheses for GMM.
*$p < 0.01$.
**$p < 0.05$. ***$p < 0.1$.
GMM is estimated using xtabond2 of STATA (Roodman, 2006).

Regarding the results of the capital stock, the estimation shows that if the capital (lnC) increases 1%, the economic growth (lnY) increases by 0.14%. Subsequently, Table 5 also shows that if the human capital (lnH) increases by 1%, economic growth (lnY) increases by 0.19%, supported by Donou-Adonsou (2019) and Meijers (2014). Our findings also support the theory of Benhabib and Spiegel (2005) and Solow (1956) guidelines, where trade (exports), technology and human capital are the vital factors for the growth of an economy. The human capital (education) is effective in generating, executing and adopting new technology and stimulates economic growth (Benhabib & Spiegel, 1994). That is the catching up process for technological development of the countries which are strongly influenced by physical capital and human capital stock supported by Funke and Strulik (2000). Moreover, Table 5 (Column 1 &2), OLS and Driscoll Kraay results show insignificant effects of lnF on economic growth in emerging Asian countries; however, the result is positive and significant with system GMM estimation, signalling an increases by 1%,

Table 6. Two-step system-GMM: Long-run results.

Variables	Coefficient	Standard Error	Z-statistics
ln$X$	0.178***	0.136	1.66
ln$T$	0.055**	0.030	1.83
ln$G$	0.159***	0.024	6.55
ln$H$	0.226*	0.136	1.66
ln$F$	0.001***	0.000	2.60

GDP (ln$Y$) is a dependent variable.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

increasing economic growth (ln$Y$) slightly by 0.001% of the emerging Asian countries (Table 5, Column 3).

The empirical results also suggest that the lag value of the dependent variable GDP (lnY_{t-1}) is positive and significant at 1% level (see Table 5), signifying strong association between the current economic growth on the past. Beside this, lag value of the dependent variable together with the instrument variables fixed the endogeneity problems within the model. Insignificant P-value of the Hansen J-test (26.7%) also ascertains the robustness of the estimation to over-identification and the validity of the instruments (see Table 5), proofing the robustness of the model to over-identification. Similarly, the Sargan statistics also show insignificant P-value (see Table 5), thus, the results suggest the validity of instruments of the system GMM estimator.

Parallel to this, the study also analyzes the long-run results of the system GMM estimator. Table 6 provides empirical evidence of the positive and significant effect of export and technology on economic growth in the long-run. If the export increases by 1%, economic growth (ln$Y$) will follow by 0.18% increase; similarly, if the technology increases by 1%, economic growth will also increase by 0.06%. According to the World Bank (2013), export market diversification has upgraded substantially with exports going to the emerging Asian countries from the other regions of the world. It is followed by cheap labour and quality products for emerging Asian countries.

However, capital, human capital and FDI also have a positive and significant effect on these economies. If the capital rises by 1%, GDP will be followed by 0.16%, if human capital increases by 1%, GDP will be increased by 0.23%, and if FDI increases by 1%, GDP will also be followed by 0.001% (see Table 6).

Overall outcomes suggest that there is positive and significant evidence of export and technology on the economic growth of these emerging economies in the short-run and long-run as well.

5. Conclusions

This empirical study follows the guidelines of the Solow growth model and assesses the impacts of export and technology on economic growth in Asian countries (Bangladesh, China, Hong Kong, India, Indonesia, Iran, Korea, Macao, Malaysia, Pakistan, Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka and Thailand). The study uses the generalised method of moments (GMM) estimator, using a panel data covering the period 2000 to 2016. Using the Cobb-Douglas production function, we found positive and significant effects of export and technology on the economic

growth of the countries. The results are robust in demonstrating positive and significant effects on economic growth, using the Driscoll-Kaary model. The effects of trade and technology on economic growth are also proven in long-run estimation, using the long-term system GMM estimation technique. Thus, the study identified export and technology contributing positively to the sustainable economic growth of the selected emerging economies. Similarly, the capital stock, human capital and FDI also have demonstrated positive and significant impacts on GDP growth in the short-run and long-run.

In summary, the most important finding of the study supports that trade and technology enhance the economic growth of emerging countries. Nations that are more open to international trade and that are more advanced in technology can easily ensure economic growth. As a result, countries such as China, Hong Kong, India, Indonesia, Korea, Macao, Malaysia, Qatar, and Singapore benefit better owing to their experience in technological development and quality exports than the others. Thus, an emerging nation desiring to sustain economic growth has to consider improving the level of technology, innovation, and trade, as it facilitates the economic growth of the region.

Therefore, the results of the study contribute strongly to the internationalisation process of the selected emerging countries and comparably to developing countries. It also might provide an insight to the policymakers and academia about the effects of trade, technology, and knowledge and skill mobility to the internationalisation process. Subsequently, it is necessary to try to boost investment policy and attracts foreign direct investment that will enhance the exports and shift to the technology-intensive industry that may increase economic productivity and growth of the countries.

Similarly, the study identifies that technology improves the productivity, export performances and economic growth of the economies. Therefore, the government of these economies should make a fascinating policy regarding technological development and attract foreign investments to enhance productivity, investments, technology transfer and trade. This would help to boost the competitiveness of the economy by augmenting the quality of exports in the world market. In sum, exports and technology are contributing and will keep on massively contributing to the economic growth of the emerging Asia countries.

Disclosure statement

ORCID

Md Reza Sultanuzzaman 🔟 http://orcid.org/0000-0001-6451-2329
Hongzhong Fan 🔟 http://orcid.org/0000-0003-3656-4396
Elyas Abdulahi Mohamued 🔟 http://orcid.org/0000-0001-9406-3413
Md Ismail Hossain 🔟 http://orcid.org/0000-0002-1666-9046
Mollah Aminul Islam 🔟 http://orcid.org/0000-0003-2162-0375

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