Technology Innovation, Trade Openness and Economic Growth in Saudi Arabia: An Autoregressive Distributed Lag Approach

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Technology innovation and trade openness have been playing strategic roles towards economic development in emerging and developing economies in recent time. This study explores the dynamic relationships between technological innovation, trade openness and GDP in Saudi Arabia between 1989 and 2019. The study used autoregressive distributed lag (ARDL) and the results show that GDP is cointegrated with technology innovation and trade openness, which signifies long run association among the variables. Moreso, using error correction model technology innovation and trade openness have short run impacts on economic growth. Furthermore, Pairwise Granger causality indicates a causality running from each of technology innovation and trade openness to GDP growth with no feedback. This supports an innovation-led and trade liberalisation economy. This result therefore suggests a more strategic opening of the Saudi Arabia's economy to external trade and a massive investment in research and development and technology innovation by the Saudi government for the achievement of a strong, steady and sustainable economic growth by year 2030 and beyond.

Key words: *Technology innovation; trade openness; economic growth; ARDL; Saudi Arabia*

JEL Classification: F43, O32, O53

1. Introduction

Globalization has brought about rapid industrialization in many emerging and developing countries, and the roles being played by trade openness and technology innovation have been very strategic (Romer, 1986; Lucas; 1988; Grossman and Helpman, 1990; Fakher, 2016; Akinwale and Grobler, 2019). Many nations have been able to achieve production capabilities in some sectors as a result of their openness to the external world which afford them the opportunity to export internally produced outputs and import needed items from the outside economies, and also enable them to gain technology and innovative skills which they lack in their economies (Akinwale, in press). The dynamics of linkage between trade openness and growth of GDP has been greatly explored in economic literature (Kim et al., 2011; Keho, 2017; Akinwale and Grobler, 2019). Traditional literature was of the opinion that trade openness would promote opportunities which are important for industrialization process and economic growth (Srinivasan and Bhagwati, 2001; Chen and Gupta, 2006). Comparative theory of trade argues that open economy will enjoy a faster level of income and consumption than closed ones (Awokuse, 2007). Trade liberalisation is regarded as important factor in growth process as it provides positive externalities such as improved technology innovations, indigenous capacity building and higher economies of scale among others (Helpman and Krugman, 1985; Awokuse, 2007; Akinwale and Muzindutsi, 2019).

The new growth theory argues that when a nation open its domestic economy for external trade, this would improve domestic technology innovation which fosters rapid economic growth as against a closed economy (Jin, 2006; Moskalyk and Moskalyk, 2014; Kunze, 2016). Theoretical and empirical efforts such as Romer (1986) and Lucas (1988) suggest that trade openness provide access to the required factor inputs and imported technology which translate to economic growth. Openness to trade could be an avenue to transmit growth-inducing external R&D knowledge from industrialised to less developed nations (Coe and Helpman, 1995; Awokuse, 2007; Akinwale et al., 2012a). Openness provides foreign exchange earnings which warrant imports of capital goods that stimulate GDP growth (Awokuse, 2007). However, there has been divergent position in the literature as evidenced by some empirical works that the nexus between GDP growth and openness of trade is not in tandem with the theoretical propositions (Rodriguez and Rodrik, 2001; ECLAC, 2000; Cimoli and Correa, 2002).

It must be pointed out that few studies (Cimoli, & Correa, 2002; Olufemi, 2004; Akinwale et al., 2012b; Akinwale, 2017) have argued that trade openness may not produce accelerated growth if there is heavy dependence on technology from developed countries without concerted efforts on the indigenous technology innovation capabilities to absorb and apply such within the context of their local economies. This implies that desired growth would remain elusive in such countries if they could not develop their own indigenous technology capabilities (Akinwale, 2020). Some of the early empirical research have queried the effect of trade openness on GDP (Kim & Lin, 2009; Dufrenot *et al*., 2010; Singh, 2011; Shahbaz, 2012; Were,

2015). However, empirical studies which studied the interaction between technological innovation, trade openness and economic growth are scanty in literature in general and in particular for Saudi Arabia.

The Kingdom of Saudi Arabia (KSA) is transiting from a conservative economy to a competitive and more open economy as shown by the recent efforts of the government. The economy overdependence on oil has deprived the country the opportunity to actively develop other sectors of the economy to the level that could make them compete globally. The Vision 2030 of the Kingdom which focuses on diversification of the economy from oil emphasizes on developing other sectors of the economy to be competitive (Akinwale, 2018a). Among the goals are: to raise the country's present position from 25th to the top 10 in the global competitive index, to boost FDI from 3.8% to the global level of 5.7% of GDP as well as to increase the proportion of non-oil exports in non-oil GDP from 16% to 50% (Saudi Vision 2030 document, 2016). All these are expected to bring about inclusive economic growth to KSA, and of course achieving the Vision 2030 would require a lot of strategies in which R&D and technology innovation cannot be left out.

The transfer and adaptation of technologies developed in industrialized countries could contribute significantly in achieving these goals, as these have been evidenced in some emerging economies which have used such strategies (OECD, 2012). The government has started great efforts in creating and signing various bilateral trade agreements with many developed and emerging economies which could be useful towards achieving the vision. The top destinations of exports and imports of Saudi Arabia as at year 2014 are China (12.5% export; 13.4% import), USA (12.65% export; 13% import), Japan (12.2% exports; 5.7% imports), South Korea (9.64% exports; 5% imports), India (8.86% exports; 3.6% imports), Germany (7.2% imports), GCC (7.6% exports; 7.3% imports) (General Authority for Statistics, 2016). This clearly shows that Saudi Arabia is transacting with top countries which can influence the extent of technology diffusion. From the foregoing, this research article aims to assess the interaction between technological innovation, trade openness and economic growth in Saudi Arabia. Apart from section 1 where introduction is presented, extant literature is presented in the second section, methodology, results analysis and conclusion are presented in third, fourth and fifth sections respectively.

2. Literature review

Many of the existing studies have established the presence of positive connection between GDP and trade openness with little divergent view especially in developed countries (Grossman and Helpman, 1990; Kim et al., 2011). Trade openness has positively and significantly impacted economic growth through diffusing technical knowledge, spill over effects of FDI, increasing market size and human capital formation among others (Romer, 1990; Grossman and Helpman 1990; Barro and Sala-i-Martin, 1997; Fakher, 2016). Improved and better institutions have also

been found to improve the contribution of trade openness to GDP growth (Rassekh, 2007). In another group of cross-country studies, trade openness is revealed to have significant impact on GDP growth through improvement in TFP (Yanikkaya, 2003; Alcala and Ciccone, 2004). Deme (2002) investigated trade and growth relationship in Nigeria, and established the long run linkages between trade openness and GDP. This is consistent with Saibu (2005) and Sakyi (2011) who also affirmed long run association between trade openness and GDP in Nigeria and Ghana respectively, although the former further showed that there is causal direction running from GDP to trade openness.

Similarly, Jin (2006) studied the influence of trade liberalization on GDP growth in North Korea, and the results showed that openness improves domestic productivity. This was also established in Philippines by Pernia and Quising (2003). Utkulu and Ozdemir (2004) also concluded that trade policy has significant effects on GDP in Turkey, but the effects of the possible breaks and policy change in 1990s seems inconsistent with the general results. Awokuse (2008) conducted a comparative research on the GDP and trade openness in Argentina, Colombia and Peru, the findings revealed the presence of a positive relation between trade openness and economic growth in Argentina and Peru while a contrary position was established in Columbia.

The presence of long run relations between GDP and trade openness in Australia, India, Bangladesh and Pakistan was established (Singh, 2011; Klasra, 2011; Adhikary, 2011). According to the study conducted by Klasra (2011) on Pakistan and Turkey using ARDL model to ascertain whether the two countries experience growth-driven exports, FDI-led exports or export-led growth. The results showed that there exist a growth-driven exports and openness-growth relations for Turkey and Pakistan respectively in the long run. Akinwale and Grobler (2019) in their study conducted in South Africa with data from 1984 to 2015 using VECM revealed that trade openness and GDP have long-run bidirectional association between them. But causality was only established from trade openness to economic growth with no feedback effects in the short-run. Keho (2017) investigated the influence of trade openness on GDP for Cote d'Ivoire between 1965 and 2014 and found that trade openness has positive effects on economic growth. Foster (2008) used quantile regression to study the connection between trade liberalisation and growth for a group of 75 liberalising nations, and the results showed that nations with the lowest growth rates have the most gain from trade liberalisation, although while such nations gain most in the long-run they have the high likelihood of suffering from short-run negative impact of liberalisation. Also, using quantile regression estimations, Dufrenot et al. (2010) analysed the nexus between trade and growth in developing countries. The outcomes of their study indicated that trade openness has higher impact in countries experiencing low growth rates compared with those countries with high growth rates both in the short and the long run. Meanwhile, the study of Yanikkaya (2003) conducted on a number of countries asserted that trade barriers are positively and significantly related with growth, particularly for developing countries. Nevertheless, there is other evidence of negative or no

association between GDP and trade openness in the previous studies (Ulaşan, 2015; Polat et al., 2015; Hye, 2012; Jin, 2006; Redding, 1999).

Technological innovation is recognized among the crucial factors for achieving sustainable economic growth (Akinwale et al., 2012a). Income generation, wealth creation and distribution could be sustained through appropriate technology innovation designed for industrial development (Nigam, 1986; Akinwale et al., 2018). Majority of the wealth created in industrialised nations originated from technology (Siyanbola, 2011). Maradana et al. (2017) found out in their study of 19 European countries that innovation and GDP per capita have long run relation between them, and the causal direction are both bidirectional as well as unidirectional between the two variables. Pece et al. (2015) also showed that innovation and GDP growth are positively related in their study conducted on Poland, Czech Republic and Hungary. Kunze (2016) investigated the association between innovation and trade in Europe, and the results revealed that innovation is a vital determinant for both imports and exports though not significant for every sector. The result also indicated that innovation through patents has larger effects than innovation through R&D expenditures. Moskalyk and Moskalyk (2014) examined the consequence of technology transfers and trade openness on growth of developing countries, and the results revealed that R&D spillovers and technologically intensive imports from highly innovative countries are responsible for diffusing international technology engendering productivity growth in developing countries.

There are robust studies which affirmed that trade is positively related with growth through channels such as improved capital accumulation, innovation, technology transfers and comparative advantage (Akinwale, 2018b; Schneider, 2005; Yanikkaya, 2003). Azomahou et al. (2013) using country *panel* data which cover the period 1998–2008 for both developed and developing countries proved that internal and external R&D expenditures positively affected the productivity growth. However, Akinwale et al. (2012a) established an insignificant impact of innovation on growth in Nigeria, as the study indicated that the expenditure of government on innovation in Nigeria is too meagre to cause economic growth. The study therefore suggested that government should be upheld special funds to finance R&D activities and innovation to bolster the economy. Generally, while the past studies on economic growth and trade openness are inconclusive, there are limited studies on technology innovation, trade openness and economic growth. This study aims to contribute to the existing research as the authors are unaware of any study combining the three variables in case of Saudi Arabia as at the time of writing this research paper.

3. Econometric Procedures and Method

This section presents the data and methods used in the study.

3.1 Data

For the purpose of examining the dimension of association between technological innovation, economic growth and trade openness, data covering the period 1989–2019 was used. Yearly data on trade openness '*top*' (measured by export plus import as a ratio of population), technological innovation '*tin*' (measured by patent application by residents and non-residents in a country) and GDP per capita '*gdp*' (measured by GDP per capital at constant 2010 US$) are obtained from World Bank's Development Indicator (WDI).

3.2 Methods

ARDL bounds test is adopted to investigate the association between the parameters under consideration as opined by Pesaran *et al.* (2001). This test is superior to others because it can be implemented regardless of the order of integration of the variables as long as none of the variable is I(2).. ARDL is comparatively better for analysis when small and finite data sample sizes are involved. ARDL test provides estimates in a long run model that are unbiased (Harris and Sollis, 2003). The test involves estimating unrestricted error correction model (UECM) considering gdp as a dependent variable.

$$\Delta gdp = a_{01} + \sum_{i=1}^{p} a_{1i} \Delta gdp_{t-i} + \sum_{i=1}^{q} a_{2i} \Delta top_{t-i} + \sum_{i=1}^{q} a_{3i} \Delta tin_{t-1} + b_{11} gdp_{t-1} + b_{21} top_{t-1} + b_{31} tin_{t-1} + \varepsilon_{1t}$$
$$(1)$$

Where gdp is gross domestic product; top is trade openness; tin is technological innovation and Δ is the difference operator.

In ARDL bound test the null hypothesis; H_0: $b_{1i} = b_{2i} = b_{3i} = 0$ is tested against the alternative one; H_1: $b_{1i} \neq b_{2i} \neq b_{3i} \neq 0$ for $i = 1, 2, 3$. If the estimated value exceeds the upper critical value, this indicates the presence of long-run association between the parameters which warrants the rejection of null hypothesis. Similarly, if the estimated value falls below a lower critical value, then no long run relationship exists and null hypothesis could not be rejected. However, the result is adjudged inconclusive if the estimated value falls between these two bounds.

Upon the confirmation of the cointegration among the variables, the short run and long run causality is determined using equation 2. This is particularly important as presence of causality in the long run does not automatically guarantee short run causality. Ensuing from Odhiambo

(2009), Narayan and Smyth (2008) and Belloumi (2014), ECM was estimated to find the short run parameters that are associated with the long-run measurements. While the t-statistic on the coefficient of the lagged error-correction term denote the causal effect in the long run, the F-statistic on the explanatory variables denotes short run effects (Odhiambo,2009; Narayan and Smyth, 2006; and Belloumi,2014). In the ARDL model, the ECM is stated as follow:

$$\Delta gdp = a_0 + \sum_{i=1}^{p} a_{1i} \, \Delta gdp_{t-i} + \sum_{i=1}^{q} a_{2i} \, \Delta top_{t-i} + \sum_{i=1}^{q} a_{3i} \, \Delta tin_{t-1} + \alpha ECT_{t-1} + \varepsilon_{1t} \quad (2)$$

Where a_{1i}, a_{2i}, and a_{3i} are short run coefficients of the variables and α is the coefficient which estimates the speed of adjustments of the model back to long run equilibrium.

4   Results Analysis

4.1   Unit roots test

The standard Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are used to evaluate the order of the integration of the variables being investigated. The outcomes of the unit root test as shown in Table 1 revealed that all the series are stationary at level except trade openness. However, all the data are stationary at I(1) after first differencing.

Table 1:   Unit Root Test

Variables	ADF		PP	
	P-Val at level	**P-Val at 1st Diff**	**P-Val at level**	**P-Val at 1st Diff**
GDP	0.0036	0.0000	0.0031	0.0000
LNTIN	0.0001	0.0000	0.0003	0.0000
TOP	0.6224	0.0156	0.6224	0.0192

4.2   Bound Testing (Cointegration Results)

The Bound testing cointegration result is presented in Table 2. From the bound testing results, the calculated F- Statistic which is 8.1350 is more than the upper bound value (4.85) at 5% significant level. Hence, the null hypothesis is rejected indicating the presence of long run relationship between GDP, trade openness and technology innovation in Saudi Arabia.

Table 2:   Bound Testing Results

The estimated F-Statistic: 8.1350		
Critical Values	**Pesarran _et al._ (2001) Table**	
	Lower Bound	Upper Bound
10%	3.17	4.14
5%	3.79	4.85
1%	5.15	6.36

4.3   Long Run Analysis

Equation (3) reveals a positive long run impact of trade openness and technology innovation on GDP.

$$gdp = 17.738504 + 2.815345\ lntin\ +\ 0.055647\ top$$
(3)

This is synonymous to the study of Pece (2015), Maradana et al. (2017) and Akinwale and Grobler (2019) as regards innovation; and Deme (2002), Kim et al. (2011) and Keho (2017) as regards trade openness. The two variables are statistically significant at 5% level. This further shows that investment on technology innovation and systematic opening of the economy will positively influence the GDP growth of Saudi Arabia.

4.4   Short-run Relationship and ECM results

Table 3 shows the empirical result of short run relationship. The error correction term (-0.8623) is negative and significant signifying at least a long run causation from trade openness and technology innovation to GDP. The value of error correction term also implies that 86% of disequilibrium in the short run that is corrected in the long run. The results further show that both trade openness and technology innovation positively and significantly influence the growth of the economy in the short run. This outcome corresponds with few related studies (Chen and Gupta, 2006; Belloumi, 2014; Sohag et al., 2015).

The short run significant effect of trade openness on GDP growth could be as a result of the large volume of crude oil exportation which contributes significantly to the nation's foreign exchange earnings. The significant positive impact of technology innovation in the short run could be as a result of recent improvement in innovative activities in the universities and imported technologies which led to new patents being granted. There is need to improve on government and private spending on research and technology innovation which can develop indigenous capabilities of Saudi Citizens.

Table 3: ECM results

Variable	Coefficient
D(GDP(-1))	0.4946***
D(LNTIN)	3.0584*
D(TOP)	0.3576**
CointEq(-1)	-0.8623***

*Note: *, ** and *** Significant at 10%, 5% and 1% level of significance respectively*

Table 4 displays the result of the Granger causality test that there is unidirectional causality from each of technological innovation and trade openness to economic growth. Neither trade openness nor technology innovation is found to granger causes each other. This supports trade liberalisation and innovation led hypotheses. Since the results of this study is able to reveal both short- and long-run and significant impact of technology innovation and trade openness on economic growth, it would be more productive if the economy can be opened to the external world through an enhanced trade transactions which is driven by technology innovation.

Table 4:   Results for Pairwise Granger Causality

Null Hypothesis	F- stat.	Prob.	Direction of Causality
LNTIN does not Granger Cause GDP	09.73020	0.0048	LNTIN→GDP
GDP does not Granger Cause LNTIN	0.69302	0.4137	No causality
TOP does not Granger Cause GDP	3.70324	0.0301	TOP→GDP
GDP does not Granger Cause TOP	0.17694	0.6779	No causality
TOP does not Granger Cause LNTIN	0.51851	0.4787	No causality
LNTIN does not Granger Cause TOP	0.61520	0.4408	No causality

4.5   Stability Test

The cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests are conducted to measure parameter stability (Pesaran et al., 2001)). Figures 1 and 2 show the stability of the coefficients because the two statistics fall within the critical bounds of the 5% confidence interval.
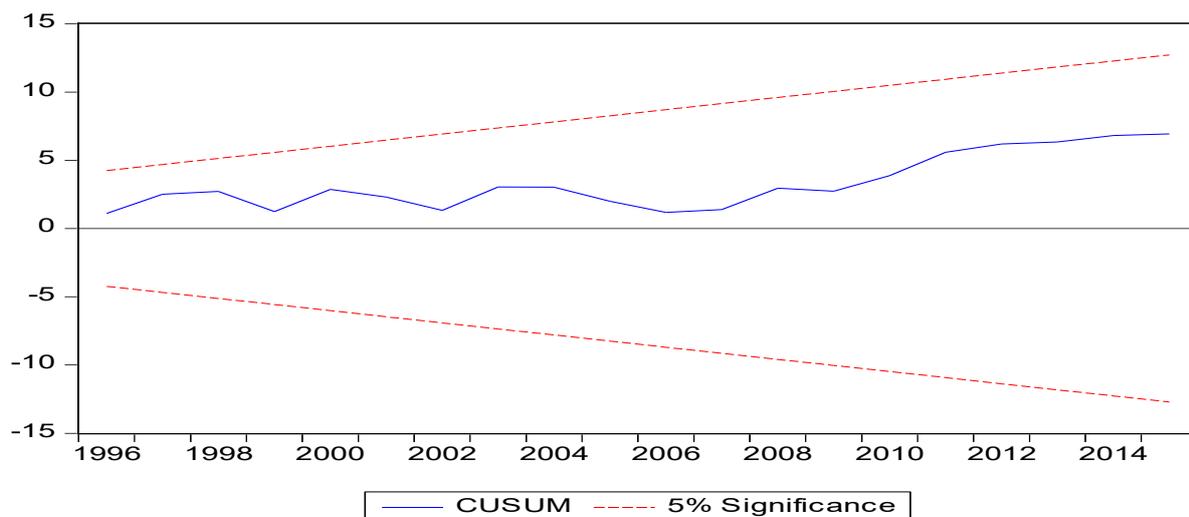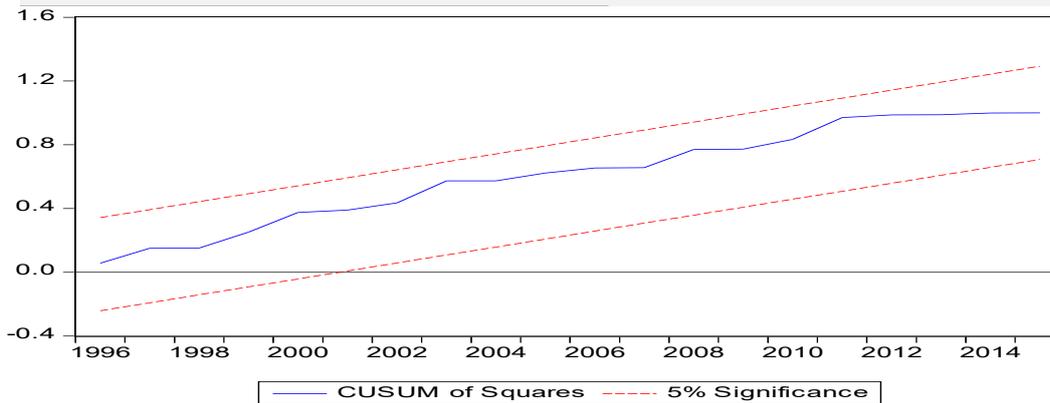

Figure 1:   Plot of CUSUM test

Figure 2:   Plot of CUSUMSQ test

5   Conclusion

The government of Saudi Arabia has put some strategic objectives in place in the 'Saudi Arabia's Vision 2030' to put the economy in the path that would foster sustainable development in the country. However, the importance of technology innovation and trade liberalisation towards sustainable development cannot be undermined. Thus, this research paper examines the dynamic relationships between technological innovation, trade openness and economic growth in Saudi Arabia. The paper contributes to existing literature as there are no previous studies which examine these relationships in Saudi economy as far as the authors are aware as at the time of this study. Since Saudi Arabia is planning to further open her economy and also use non-oil sector to drive the economy as stated in its Vision 2030, thus the relationship between technology innovation, trade openness and economic growth needed to be investigated due to the possible interrelationship among the variables with expectations for long term growth strategies. The empirical approach adopted is ARDL model which examines the existence of long run association among the specified variables. The empirical evidence from the study suggests that there is long run association among the variables as shown from the cointegration results of the bound test. The ECM further confirmed the long run relationship among the variables as well as established the short run positive and significant impacts of trade openness and technology innovation on economic growth.

Furthermore, there is a causality running from each of the trade openness and technology innovation to economic growth, which buttresses the short run results earlier obtained from the ECM. Generally, this study reveals that openness of Saudi economy trade would have positive effect on economic growth in short- and long-term period, and would engender technology innovation through a more diffused knowledge brought into the economy over the period, and this will make innovation to further improve economic growth in the long run. Government should continuously invest in research and technology innovation so as to develop a cutting-edge manufacturing technology as well as improve indigenous capability to absorb imported technology in order to remain competitive and at the same time generate employment opportunities for the Citizens.

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