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Assessing the impact of technological progress on trade in COMESA: a PVECM approach

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Received 14 December 2021
Revised 1 March 2022
Accepted 1 April 2022

Abstract

Purpose – The present study investigates the extent to which technological progress influences trade in the Common Market for Eastern and Southern Africa (COMESA) region over the period 1990–2017.

Design/methodology/approach – Methodologically, this study uses a rigorous dynamic analysis namely a dynamic vector error correction model (PVECM) to carry out the proposed investigation. Such a procedure ensures that the dynamic behaviour under consideration is properly captured, while simultaneously catering for causality issues.

Findings – The results show that technological progress has had a positive and significant effect on trade for the sample of countries in the COMESA region over the years of studies. Also, the long-run results show that local investment and economic growth have a positive impact on international trade. Furthermore, the short-run estimates allowed us to make further analysis of the results. For instance, it is observed that trade as well results in technological progress as per the study. Hence, there is reverse causation or bi-directional causality between trade and technological progress.

Originality/value – Very few research studies have been conducted on the link between technological progress and trade in a macroeconomy. The analysis thus is believed to supplement the dwarf literature on the technological progress and trade nexus by bringing additional evidence from COMESA.

Keywords Technology, Trade, Causality, PVECM, COMESA

Paper type Research paper

1. Introduction

Common Market for Eastern and Southern Africa (COMESA) consists of countries with widely varied sizes ranging from very small island economies to very large nations. In addition, it also encapsulates countries at differentiated levels of industrialisation including least developing economies and middle-income countries. It can be observed that countries such as Burundi, Comoros, Eritrea and Libya have registered negative growth rates while some other nations have experienced relatively smaller growth rates (less than 2%), namely Congo, Egypt, Kenya, Madagascar, Swaziland and Zimbabwe, and finally a third category of member countries have posted higher average gross domestic product (GDP) growth rates which include Djibouti, Ethiopia, Mauritius, Rwanda, Sudan, Seychelles, Uganda and Zambia (Seetanah *et al.*, 2018). Although growth rates registered by member nations were not remarkable, they have been resilient in the face of the global economic downturn, despite the many pertinent challenges faced by them which may be due to improved macroeconomic management, market-based reforms and continued structural progress in many countries (UNECA workshop) [1].

COMESA comprises 21 African member states that came together with the aim of promoting regional integration through trade and the development of natural and human resources for the mutual benefit of all people in the region.

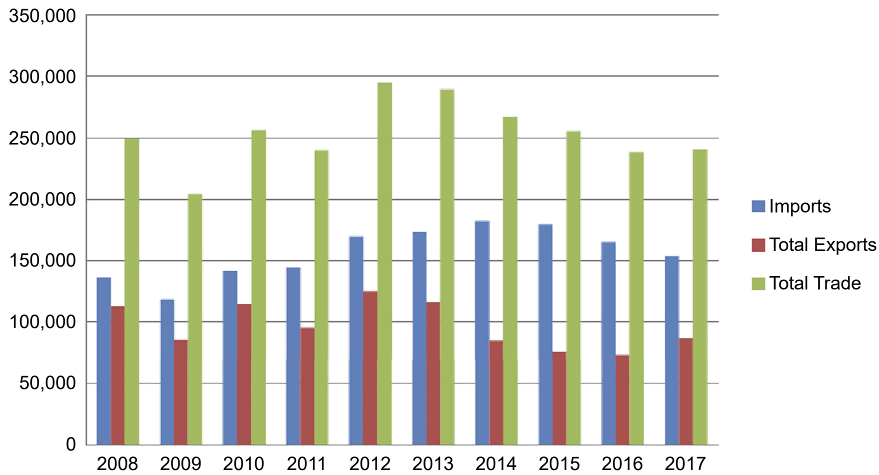
International Trade, Politics and Development
Vol. 6 No. 2, 2022
pp. 61-72
Emerald Publishing Limited
e-ISSN: 2632-122X
p-ISSN: 2586-3932
DOI 10.1108/ITPD-12-2021-0017

The region's fastest growing countries achieved growth performance with quite different sectoral patterns. Productivity is not however only raised by factor reallocation between sectors, but also through modernisation and reallocation within sectors, as well as via better linkages between sectors. Particularly, higher productivity in agriculture can boost food processing and leather manufacturing to the benefit of both sectors.

COMESA countries that recorded notable growth rates in their 2017 exports were DRC (66%), Rwanda (55%), Libya (52%), Sudan (41%), Zambia (25%), Seychelles (22%), Eswatini (19%), Ethiopia (15%), Comoros (12%), Egypt (12%) and Uganda (12%). DRC, Libya, Egypt, Zambia and Sudan together accounted for a combined increase of US$15bn in exports in 2017. Referring to previous studies, it should be noted that COMESA has been identified to have a huge trade potential. However, intra-COMESA trade has remained low and for most times below 10% of total trade due to structural factors. The diagram below provides an overview of global trade trends for COMESA. COMESA's total trade increased by US$2bn from US$238bn in 2016 to US$240bn in 2017. This was mainly due to improved export performance which recorded a rise of 19% from US$73bn in 2016 to US$87bn in 2017. On the other hand, COMESA's global imports dropped by 7% from US$165bn in 2016 to US$154bn in 2017.

The drop in COMESA's global imports was mainly attributed to performance by Egypt, Libya, Ethiopia and Djibouti whose combined imports accounted for a decline of US$20bn in 2017. The, namely, information below depicts the performance of COMESA's global trade over the period 2007–2017 and the trends in trade within COMESA and with its major trading partner, the European Union (EU) (see Figure 1).

In terms of technology, it depends on both the extent to which it is exposed to foreign technologies as well as the capacity of the domestic economy to absorb these technologies. Technology diffusion depends highly on the extent to which products and services flow in the country. This can be through foreign trade, foreign direct investment (FDI) and contact with migrant populations living abroad. This reduces the trade barriers in many developing countries including COMESA. The easing of restrictions on FDI has also contributed to technology diffusion within developing countries. FDI is a major source of process technology and "learning by doing" opportunities. FDI can also have significant spillover effects on domestically owned enterprises.



Source(s): COMSTAT Database and UN COMTRADE

Figure 1.
COMESA global trade trends

Very few research studies have been conducted on the link between technological progress and trade in a macroeconomy. Our analysis thus is believed to supplement the dwarf literature on the technological progress and trade nexus by bringing additional evidence from COMESA.

Given the above, the present paper attempts to fill the mentioned gap and aims at adding to the existing literature by investigating the direct and indirect relationship between technological progress and international trade for the COMESA region. Methodologically, this study uses a rigorous dynamic analysis namely a dynamic panel vector error correction model (PVECM) to carry out the proposed investigation. Such a procedure ensures that the dynamic behaviour under consideration is properly captured, while simultaneously catering for causality issues. In fact, this method often provides superior forecasts compared to theory-based simultaneous equations models. Forecasts from PVECM models are also quite flexible because they can be made conditional on the potential future paths of specified variables in the model. The paper is organised as follows: Section 2 provides a review of the literature, section 3 describes the methodology used, while section 4 discusses the results. Finally, the conclusion and policy recommendations are presented in section 5.

2. Literature review

2.1 Theoretical review

The literature on the link between technological progress and international trade is rather scant. It is important to understand how technological progress can boost trade. Indeed, international trade patterns have changed with countries becoming closely linked through trade and FDI. Technological innovation has also played a crucial role in this world-wide interdependence. Within this framework, international trade theory highlights the importance of technological innovation in explaining the international competitiveness of a country.

The Ricardian model gives a simple explanation of this link. For instance, this model examines how technological differences between countries contribute towards trade and specialisation. The model assumes only two nations and two commodities, free trade, perfect mobility of labour within each nation but immobility between the two nations, constant costs of productions, and no transportation costs. Also, it is assumed that production technology differences exist across industries and across countries, and these are reflected in labour productivity. There is as well perfect competition in the labour and goods markets and firms are assumed to maximise profit, while consumers (workers) are assumed to maximise utility. Under this model, because technology differs between countries, relative prices of the two goods will differ between countries. The price of each country's comparative advantage will be lower than the price of the same goods in the other country. If one country has an absolute advantage in the production of both goods (as assumed by Ricardo), then real wages of workers (i.e. the purchasing power of wages) in that country will be higher in both industries compared to wages in the other country. In other words, workers in the technologically advanced country would enjoy a higher standard of living than in the technologically inferior country. The reason for this is that wages are based on productivity; thus in the country that is more productive, workers get higher wages. The initial differences in relative prices of the goods between countries in autarky will stimulate trade between the countries. Since the differences in prices arise directly out of differences in technology between countries, it is the differences in technology that cause trade in the model [2]. Hence, this theoretical underpinning shows that technological progress causes trade.

The David Ricardo theory of comparative advantage has played an important role in international trade theory. Since it emphasises on labour productivity, this allows the analysis of issues, such as the effects of technological progress on patterns of specialisation and the distribution of gains from trade. However, the model does not explain what causes labour productivity to differ across countries. One major difficulty is that differences in the use of capital provide an important source of variation in labour productivity. For example, capital-rich countries are able to allocate more capital per worker to all economic activities than capital-poor countries. Hence, the problem is more specifically what determines the allocation of capital to industries, and thus labour productivity. This question has led researchers to focus on the determinants of trade flows amongst countries which have more than labour as an input.

The neo-classical theory of international trade discussed the Heckscher–Ohlin (HO) theory. It was propounded by Eli Heckscher in (1919), and was primarily recognised with the publication of Ohlin (1933). While the Ricardian model focuses on differences in technology as the basis for trade, the Heckscher–Ohlin theorem emphasises instead differences between countries in their relative factor endowments and differences between commodities in the intensities with which they use these factors. In this case, costs of production become endogenous and differ between countries in autarky although all countries have access to the same technology. The HO model provides an alternative explanation for trade as well as an explicit basis for conflict in the internal distribution of income. The Heckscher–Ohlin theory argues that international differences in labour, labour skills, physical capital or land (factors of production) create productive differences that explain why trade occurs. Countries have a relative abundance of factors of production and production processes use factors of production with relative intensity.

In 1966, Raymond Vernon published a model that described internationalisation patterns of organisations. He looked at how US companies developed into multinational corporations (MNCs) at a time when these firms dominated global trade, and per capita income in the US was, by far, the highest of all the developed countries.

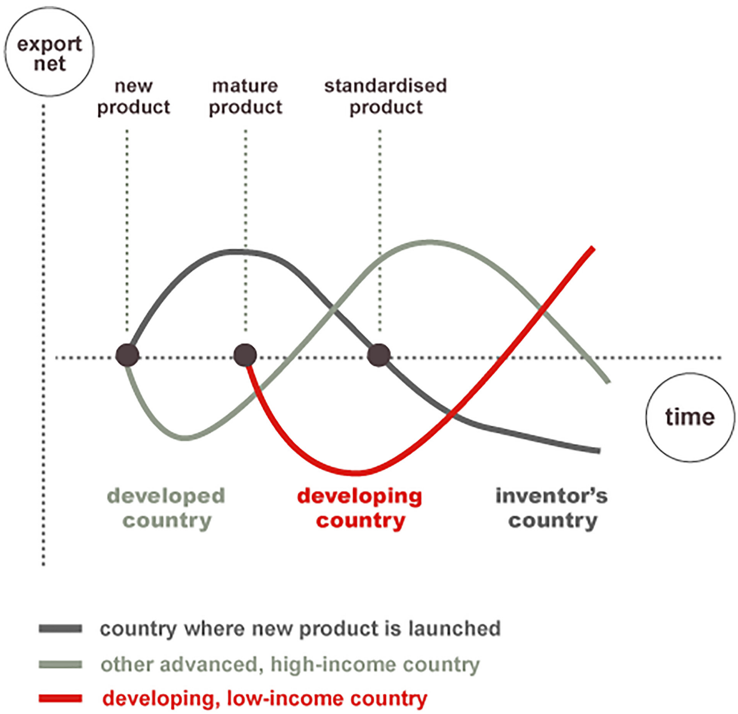
The intent of his international product life cycle model (IPLC) was to advance trade theory beyond David Ricardo's static framework of comparative advantages. There are three stages in the internationalisation process. The first stage is when the company in an advanced economy comes up with a new product by exploiting a technological breakthrough. Hence, a new and innovative product is produced and sold in its home market. At the end of this stage, the country may export to other industrial countries which enable the innovator to increase revenue and to increase the downward descent of the product's experience curve. Also, at this stage, there is competition from a few local or domestic players that produce their own unique product variations.

The second stage is the stage where the product matures. Through time, exports to markets in advanced countries continue to increase which make it economically possible and sometimes politically necessary to start local production. More so, FDI in production plants drives down unit cost because labour cost and transportation cost decrease. Offshore production facilities are meant to serve local markets that substitute exports from the organisation's home market. However, production still requires high-skilled and high paid employees. There is competition from local firms in non-domestic advanced markets. Also, demand for the goods increases from lower income countries. Finally, the last stage is the stage where the product is standardised. Here, the main market has reached its saturation point. The comparative advantage of the innovator is eroded. Hence, the firm starts to focus on the reduction of process cost rather than the addition of new product features. Hence, the product becomes a standard. If economies of scale are being fully exploited, the principal difference between any two locations is likely to be labour costs. To counter price competition and trade barriers, production facilities will relocate to countries with lower incomes. As previously in advanced nations, local competitors will get access to first-hand information and can start to copy and sell the product. Demand for the product in the domestic country falls from the arrival of new technologies, and other established markets will have become increasingly price-sensitive. The market left is shared competitors which are basically foreign firms. Also, the domestic market will have to import relatively capital intensive products from low income countries. The machines that operate these plants often remain in the country where the technology was first invented [3]. The three stages are shown in the diagram below (see Figure 2):

Hence, the above diagram describes an internationalisation process whereby a local manufacturer in an advanced country will start selling a new, technologically advanced product to high income consumers in its home market. Production capabilities are done locally to stay in close contact with its customers and to minimise risk and uncertainty. As demand from consumers in other markets rises, production increasingly shifts abroad enabling the firm to maximise economies of scale and to avoid trade barriers. As the product reaches the maturity stage, there are more competitors. Finally, the innovator from the developed country faces fierce competition in its own home market making it a net importer of the product. This product is produced either by competitors in lesser developed countries or, if the innovator has developed into a multinational manufacturer, by its foreign-based production facilities.

2.2 Empirical review

Empirical studies on this topic have used different proxies for technological innovation. Some of the proxies described by Wakelin (1997) include research and development (R&D) expenditure or the number of scientists and engineers employed in research departments, or an output, such as number of patents. Other studies considered technological innovation as



Source(s): https://www.provenmodels.com/583/international-product-life-cycle/vernon

Figure 2. International product life cycle

intangible and noted that it is difficult to measure it directly. Keller and Wild, (2004) pointed out that three indirect measures include the measurement of inputs (R&D), outputs (patents) and the effect of technological innovation (higher productivity). The paper by Márquez-Ramos (2007) came up with an index to measure the achievement of technological innovation, which relates more to absorptive capacity. They argued that it is difficult to come forward with an index quantifying aspects of technology creation, diffusion and human skills. They introduced an index which measures technological innovation in a rather broad way which is the Technological Achievement Index (TAI). This index has been used in some empirical studies such as Martínez-Zarzoso and Márquez-Ramos (2005); Márquez-Ramos (2007). It includes four dimensions, namely the creation of technology, diffusion of recent innovations, diffusion of old innovations and human skills. These investigations concluded that technological progress boosts trade as measured by exports.

Moreover, the study of Márquez-Ramos and Martínez-Zarzoso (2010) investigated the impact of technological innovation on sectoral exports by using a gravity model of trade. The TAI and its four components, creation of technology, diffusion of old innovations, diffusion of recent innovations and human skills were used as proxies for technological innovation. The two first components were considered as proxies for knowledge acquisition and assimilation (potential absorptive capacity), whereas the last two were taken as proxies for knowledge transformation and exploitation (realised absorptive capacity). Their results show a positive and non-linear effect of technological innovation on export performance, which indicates that there are thresholds for positive signs to occur. Another paper by Márquez-Ramos and Martínez-Zarzoso (2010) shows a "U-shaped" relationship between exports and creation of technology and between exports and diffusion of old innovations. However, an inverted "U-shaped" relationship is found between exports and diffusion of recent innovations and between exports and human skills.

Referring to other empirical literature on the link between trade and technological progress/innovation, it is noted that the effect of technological innovation on exports varies with country characteristics. The study of Loungani *et al.* (2002) examined the importance of information links that associate technological innovation with lower communication costs, and concluded that the negative effect of physical distance on trade could be reduced by reducing the barriers to informational flows. These studies differentiate between developed and developing countries when investigating the extent to which better informational infrastructure can substitute for geographical distance. Their results indicate that the degree of substitution between physical and informational distance varies systematically based on country characteristics.

Another strand of literature used the technology gap approach to investigate the extent to which technology explains trade performance. By considering 8 European countries and 13 manufacturing industries during the period 1995–2002, Granda and Mesa, (2009) observed that technology and economic inequalities affect trade inequality and that the effect depends on the technological content of each industry.

Analysing the empirical literature, we could not really find studies on African countries or more specifically on the COMESA region which investigated this topic. Having identified this gap, and given the importance of technology to foster trade and related economic benefits, we focussed our study on the investigation of technological progress and its impact on trade in the COMESA region. More so, by using the dynamic econometric procedure of PVAR, this study also discusses other determinants of trade.

3. Methodology

The aim of this study is to investigate the extent to which technological progress contributes towards increasing international trade in selected countries of the COMESA region from 1990 to 2017. The following principles as used by Idris *et al.* (2016), is followed, whereby

$$\mathrm{TO} = \mathrm{f}\left(\sum \mathrm{X_{ij}}\right)$$

where

(1) TO represents trade openness

(2) X represents the other variables influencing trade

Hence, the above equation has been augmented with variables like technological progress, FDI and local investment. Thus, the following functional form applies to the "technology-trade model" used in this research:

$$Trade = \beta_0 + \beta_1 TP_{xt} + \beta_2 FDI_{xt} + \beta_3 GDP_{xt} + \beta_4 GDCF_{xt} + \mu_{xt}$$

Because of the variance stabilising properties of log transformation, the log values of the variables are used. In fact, logged variables yield a more clear-cut interpretation of the coefficients in terms of percentage change.

Converting all the variables in logarithmic terms yields:

$$LTrade = \beta_0 + \beta_1 LTG_{xt} + \beta_2 LFDI_{xt} + \beta_3 LGDP_{xt} + \beta_4 LGDCF_{xt} + \mu_{xt}$$

where LTRADE, LTG, LFDI, LGDP, LGDCF are the logs of trade, technological progress, FDI, GDP and domestic investment respectively. $\beta_1 \ldots \beta_4$ represent the parameter estimates and μ_{xt} is the random disturbance term.

3.1 Dependent variable: LTRADE

An improvement in technology can allow countries to produce better quality goods and boost up their trade on the international market. Moreover, as discussed by Keller and Wild, (2004), trade openness as well can give a country better access to technologies developed elsewhere and enhance their catching-up process through adaptation of advanced foreign technologies. Common proxies for trade openness include ratio of exports plus imports to GDP, ratio of exports to GDP and ratio of imports to GDP. Following Loko and Diouf (2009), the ratio of exports plus imports to GDP is used as a proxy.

3.2 Independent variables

(1) Technological progress (TP)

Referring to theoretical underpinnings, trade liberalisation or openness results in productivity gains through increased competition, efficiency, innovation and acquisition of new technology. These factors in turn influence the level and composition of export and import. Trade openness is also considered to expand economic opportunities by enlarging the market size and enhancing the impact of knowledge spillover (Sikdar *et al.*, 2013).

Technological capability can be measured through two basic methods namely the indicators approach and the modelling approach. The indicators approach involves the collection of a range of statistics that describe various aspects of innovation, such as the number of scientific publications and the expenditure on R&D. However, such data are not always available for African countries. The modelling approach has been largely based on the framework of the Solow growth model and its endogenous growth descendants. Using growth accounting or econometric methods with aggregate data, the modelling approach circumvents many data-related problems facing its indicators counterpart. This approach focuses on the change of technological capability (i.e. technological progress) rather than the actual level of the capability. According to the World Bank report, a common measure of technological progress is growth in total factor productivity (TFP). This is the relative efficiency with which an economy produces goods and services given a certain quantity of labour and capital. TFP is an indirect measure because it attributes to technology, all income growth that cannot be explained by investment and increases in labour supply. It is commonly used because measuring technology directly is difficult.

(2) Foreign Presence (FDI)

To investigate the link between FDI and trade openness, the variable foreign presence is included in the study. The degree of foreign presence is measured by the amount of inward FDI for each country in the sample. FDI is calculated by the World Bank as the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. FDI inflow as a percentage of GDP is included in the study.

(3) Economic growth

Referring to the literature on the link between trade openness and economic growth, it is observed that several studies support the notion that trade stimulates long-term economic growth (Barro and Sala-i-Martin, 1995). These empirical studies found a positive link between trade and economic growth. Trade openness is viewed to have the potential to enhance access to goods and services, efficient allocation of resources and enhanced TFP via the diffusion of technology and the spillover of knowledge (Huchet-Bourdon *et al.*, 2018). Similarly there might be a bi-directional link between the two variables where economic growth as well can boost trade. Hence, the study includes GDP per capita as a proxy to measure economic growth and allows us to detect the link between trade and growth in the selected countries included in the study.

(4) Local investment (GDCF)

Local investment as well as FDI can boost the trade sector, precisely the export and import trade. The debate on this link is not unanimous though. While studies show that domestic investment can boost trade in a country (Dutta *et al.*, 2017) others did not find any relationship between these variables. Hence, the gross domestic capital formation as a percentage of GDP is included in the study to measure the level of domestic investment.

$$\mathrm{LnTRAD}E_{it} = \alpha_i + \beta_1 \mathrm{LnT}G_{it} + \beta_2 \mathrm{LnFD}I_{it} + \beta_3 \mathrm{LnGD}P_{it} + \beta_4 \mathrm{LnGDF}C_{it} + \varepsilon_{it} \tag{2}$$

The model is run in its logarithmic form for ease of interpretation, that its coefficient would be interpreted in percentage change (also representing elasticities). The study is based on a sample of COMESA countries, given data availability restrictions, for the period 1990–2017.

3.3 Estimation issues

3.3.1 Panel unit root testing. Variables in a PVAR need to be stationary. If they are non-stationary then the regression results will be spurious. Hence, if the variables are non-stationary, by differencing them, they will become stationary. The stationarity of the underlying variables is tested using panel unit root tests, namely Im, Pesaran and Shin (1988), ADF-Fisher, PP-Fisher and Levin; Lin & Chu tests.

3.3.2 Panel cointegration testing. Next step is to test for the existence of a long-run equilibrium relationship between the variables. Actually, non-stationary variables may deviate from each other in the short run. But the existence of cointegration will cause them to be associated in the long run as they share the same stochastic trends. If the series are cointegrated, the above equation will depict a long-run relationship. A heterogeneous panel cointegration test developed by Pedroni (1999) is used. Pedroni panel cointegration uses a residual-based ADF test. Seven different statistics are included in the Pedroni test's results for the test of the null hypothesis of no cointegration in a heterogeneous panel. The first group of tests includes Panel V-stat, Panel Rho-stat panel, Panel PP-stat and Panel ADF-stat. The second group includes Group Rho-stat, Group PP-stat and Group ADF-stat.

3.3.3 Error correction model. Since the series are cointegrated, an error correction model is being used. Engle and Granger (1987) argued that the presence of cointegration eliminates the likelihood of the estimates being spurious as a result of omitted variable bias and endogeneity. The short-run properties of the series are observed using a PVECM, specified as follows:

$$\Delta(Z_{xt}) = \varphi + \rho\Delta\ (Z_{xt-1}) + \theta_{xt} \tag{3}$$

where: Δ The first difference operator.

Z_{xt} represents a vector of the five variables used in this study

φ is a vector constant term

ρ symbolises a (5x5) matrix of parameters

Z_{xt-1} is a vector of the five variables lagged by 1

θ is the vector error term.

After obtaining the short-run estimates, the long-run relationship will be estimated whereby apart from the two main variables of interest (LTRADE and LTP); the other control variables (LGDP, LFDI, LGDFC) also are able to exercise their influence.

4. Analysis of findings

By applying the augmented Dickey–Fuller (ADF) (1979) unit-roots tests, it is observed that all the variables are integrated of order one and stationary in the first difference.

The Johansen maximum likelihood approach is subsequently used to test the presence of cointegration in a vector error correction model. The results confirm the presence of co-integration and thus it is concluded that a long-run relationship exists in the above specifications.

The equation below shows the long results

$$\text{Ln}\ TRADE = \alpha_i + 2.301^{***}\text{Ln TG}_{it}\text{-}2.277\ \text{Ln FDI}^{*}_{it} + 5.107\ \text{Ln GDP}^{***}_{it} + 1.952\ \text{Ln GDFC}^{**}_{it}$$

**significant at 5%, ***significant at 1%

From the above results, it is observed that the coefficient of technological progress is positive (+2.301) and significant. This suggests that technological progress has had a positive and significant effect on trade for the sample of countries in the COMESA region over the years of studies. In fact, it implies that a 1% increase in technological progress contributed to a 2.301% increase in trade. These results support the empirical findings of Márquez-Ramos and Martínez-Zarzoso (2010), whose study indicated a positive effect of technological innovation on export performance. Several empirical studies have concluded that contribution of technical progress leads to an increase in national income or product and it is much more significant the growth of labour supply or capital accumulation. The effect of technical progress on the growth process and trade is much more complex than that of factor growth. Normally when technological progress occurs in the import-competing industry of the country, it will result in the improvement in the terms of trade of this country. Hence, the result supports this concept.

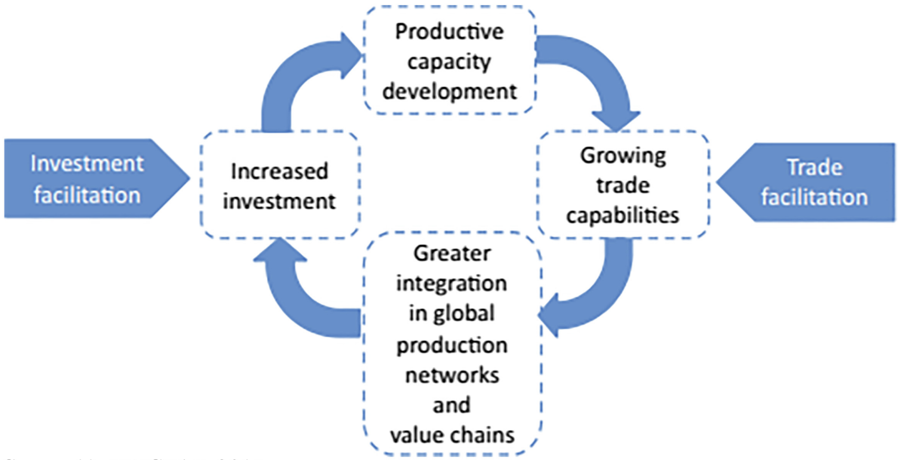
Though the main objective of the paper is to investigate the link between trade and technological progress, we have also analysed the effect of other macroeconomic variables on trade. As expected there is a positive link between economic growth and trade. Similarly, more investment in the countries will lead to an increase in trade. For instance, UNCTAD (2015) identifies the virtuous circle between trade and investment policy; the complementarities between them and the interdependence of trade and investment which require greater coordination at the national, regional and international levels. More investment policies lead to an increase in domestic investment and thus boost international trade. For instance, more trade facilitation measures will have positive effects on export-oriented investment as well as investment that benefits from facilitated (and cheaper) imports. Equally, investment facilitation measures, such as creating a conducive business environment through streamlined registration and licensing procedures, will have a positive effect on trade where they attract export-oriented investment and where they result in the build-up of critical productive assets, infrastructure and capabilities needed for exports. The figure illustrates this circle and shows how targeted policy interventions on both the trade and investment sides could help to boost productive capacities, exports and the eventual structural transformation of the world's poorest economies (see Figure 3) [4].

Overall, the long-run results show that technological progress, local investment and economic growth have a positive impact on international trade for the sample of COMESA countries under this study.

Table 1 is a composite table where each equation can be viewed and analysed as an independent function. For instance, of interest to us primarily is column one which is in fact the trade equation. It is observed that the coefficient of technological progress is positive (+0.18) and significant. This suggests that technological progress has had a positive and significant effect on trade for our sample of countries in the COMESA region over the years of studies. In fact, it implies that a 1% increase in technological progress contributed to 0.18% increase in trade. Our results support the empirical findings of Márquez-Ramos and Martínez-Zarzoso (2010), whose study indicated a positive effect of technological innovation on export performance. Though the main objective of the paper is to investigate the link between trade and technological progress, we have also analysed the effect of other macroeconomic variables on trade.

The short-run estimates allow us to make further analysis of the results. For instance, analysing column 3 of the table, we can see that trade as well results in technological progress as per the study. Hence, there is reverse causation or bi directional causality between trade and technological progress.

Summarising the results, we found that there is a bi-directional causality between trade and technological progress as per the present study. Technological progress not only boosts trade but also results in an increase in GDP.



Source(s): UNCTAD 2015

Figure 3.
Virtuous circle between trade and investment policy

	D(LTRADE)	D(LTG)	D(LFDI)	D(LGDP)	D(LGDFC)
Cointegration	0.001677	0.002065	−0.113294***	0.010084***	0.018998**
LTRADE(-1)	−0.066635	0.137650**	0.388690	−0.068661	0.009092
LTG(-1)	0.178702**	−0.037881	−0.246326	0.163642**	0.273777
LFDI(-1)	0.001563	0.001114	−0.302489***	−0.008664	−0.035219
LGDP(-1)	−0.336955	0.018775	0.449914	0.302554***	0.061547
LGDFC(-1)	0.047392	0.001926	−0.116641	−0.006154	−0.234233*
C	0.010373	−0.021632***	0.096864	0.011177	0.002915

Note(s): *significant at 10%, ** significant at 5%, ***significant at 1%
Source(s): Author's Compilation

Table 1. Short-run estimation

5. Conclusion

Studies investigating the interplay between technological progress and trade are rather scant and even less for the case of the COMESA region. In fact, this can be explained by the problem involved in measuring the level of technology. This study followed the World Bank proposition and used the growth in TFP as a proxy for technological progress. It is in fact the relative efficiency with which an economy produces goods and services given a certain quantity of labour and capital. This study is believed to add to the literature on this topic and further deepen the understanding on the link between trade and technology. Based on the PVEM method, this empirical study investigates whether any links exist between trade and technological progress for the case of COMESA during the years 1990–2017. Referring to the results, technological progress is observed to positively influence trade. In addition to that, it is observed that there is a bi-directional causality between trade and technological progress.

Several measures can be adopted to increase technology diffusion in the countries.

There is a need to improve the spread of older technologies which will accelerate technological progress in the COMESA region. As highlighted by the World Bank report [5], the following policies are required to improve technology diffusion:

(1) Maintaining openness to trade, FDI and participation of migrant populations.

(2) Further improving the investment climate so as to allow innovative firms to grow and flourish.

(3) Strengthening basic infrastructure (roads, electricity and telephony).

Notes

1. http://www1.uneca.org/Portals/rio20/documents/Workshop-Institutional-StrategicFrameworks/Day%20Two/COMESA-Presentation.pdf
2. Quoted from https://saylordotorg.github.io/text_international-trade-theory-and-policy/s05-the-ricardian-theory-of-compar.html
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