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in Regional Integration. Vol 8

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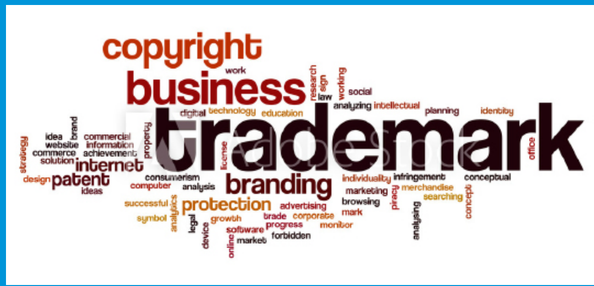
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INTELLECTUAL
PROPERTY


PATENTED

Acronyms and Abbreviations

ADF	Augmented Dickey Fuller
AFREXIMBANK	Africa Export-Import Bank
ASEAN	Association of Southeast Asian Nations
AU	Africa Union
CENSAD	Community of Sahel-Saharan States
CEPII	Centre d'Etudesm Prospectiveset d'InformationsInternationales
CES	Constant Elasticity of Substitution
CFTA	Continental Free Trade Area
CGE	Computable Genral Equilibrium
COMESA	Common Market for Eastern and Southern Africa
COMSTAT	COMESA Statistics
DRC	Democratic Republic of Congo
ECA	Economic Commission for Africa
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
EPO	European Patent Office
EU	European Union
FDI	Foreign Direct Investment
FE	Fixed Effects
FP	Factor productivity
GATT	General Agreement on Tariffs and Trade
GCF	Gross Capital Formation
GCI	Global Competitiveness Index
GCR	Global Competitiveness Report
GDP	Gross Domestic Product
GII	Global Innovation Index
GMM	Generalized Method of Moments
GNP	Gross National Product
HDI	Human Development Index
HT	High-technology
ICT	Information Communication Technology
IGAD	Intergovernmental Authority on Development
IIF	Innovation Incubation Facilities
IMF	International Monetary Fund
IOI	Innovation Output Index
IP	Intellectual Property

IPR	Intellectual Property Rights
IPRI	Intellectual Property Rights Index
IPS	Im-Pesaran-Shin
IT	Information Technology
IV	Instrumental Variable
KTI	Knowledge and Technology Intensive
LDC	Least Developed Countries
LL	Likelihood Ratio
LLC	levin, Lin and Chu
LM	Lagrange Multiplier
LP	Legal and Political
LR	Likelihood-Ratio
MNC	Multinational companies
NNBR	Negative Binomial Regression
NBM	Negative Binomial Model
OECD	Organisation for Economic and Cooperation Development
OLS	Ordinary Least Squares
PP	Fisher's Phillips-Perron
PPML	Poisson Pseudo-Maximum Likelihood
PPP	Physical Property Rights
RE	Random Effects
REC	Reginal Economic Community
ROW	Rest of the World
SADC	Southern African Development Community
SEM	Structural Equation Modeling
SITC	Standard International Trade Classification
SME	Small and Medium Enterprises
SPRU	Science Policy Research Unit
ST	Scientific and technical journal articles (ST)
STI	Science Technology and Innovation
TAI	Technological Achievement Index
TCF	Technology Contribution Factor
TFP	Total Factor Productivity
TFTA	Triprtite Free Trade Area
TM	Trademark
TRIPS	Trade-Related Aspects of Intellectual Property Rights
TTOs	Technology Transfer Offices
TVET	Technical Vocational Education Training
UAE	United Arab Emirates
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
UNCTADSTAT	United Nations Conference on Trade and Development Statistics
UNECA	United Nations Commission for Africa
US	United States
USA	United States of America
USD	United States Dollars
VAR	Vector Auto Regression
WDI	World Development Indicators
WEF	World Economic Forum
WGI	World Governance Indicators
WIPO	World Intellectual Property Organization
WITS	World Integrated Trade Solutions
WTO	World Trade Organisation

PREFACE

Key Issues in Regional Integration is an annual publication of COMESA Secretariat. To date seven editions have been published and this eighth edition focuses on promoting intra-COMESA trade though innovation. There is a close link between innovation and trade. Dynamic gains from trade arise from increased competition and the transfer of technology, knowledge, and innovation that trade engenders. In effect, there is a "two-way" link between trade and innovation. On the one hand, innovation creates technological advantage, which together with differences in factor endowments is a source of comparative advantage, which in turn drives trade. Therefore, technology gaps have been identified as a key determinant of trade and investment between nations. On the other hand, trade and investment also spur innovation through the effects of competition, technology transfer, and spillover (including learning from exporting and learning by investing). Trade that exposes domestic firms to international markets and forces them to compete against sophisticated global competitors is a strong driver of innovation and productivity growth. Indeed, data from the Organization for Economic Co-operation and Development Innovation Microdata Project show that exposure to international markets has a strong positive effect either on firms' incentives or their ability to innovate.

This volume consists largely of empirical and a few theoretical research papers under the overall theme "promoting intra-COMESA trade through innovation". The papers address themselves to a wide range of topical themes namely: technology diffusion, absorption and trade in COMESA; innovation productivity and its connection to the innovation market in COMESA; role of intellectual property rights in promoting investment in innovation and trade in COMESA; role of governance in enhancing innovations and trade in COMESA; and innovation and Socio-economic transformation through trade in COMESA

The purpose of this edition is to educate the reader on the various linkages between innovation and trade and how, through innovation, intra-COMESA trade can be promoted. It stretches the scope of readership to cover researchers on international trade, innovation and regional integration and provides insightful dimension of issues at the frontier of integration debate in the COMESA region and the African continent.

The journey of writing this edition commenced with presentation of research papers at the sixth COMESA-Annual Research Forum held in Nairobi, Kenya in September 2019. Following a rigorous peer review process, select papers were presented at the plenary session of the Forum where they were discussed and subjected to further sit-in review and comments by participants. In the final round, a small set of papers were selected for publication on the basis of their relevance, conceptual and methodological robustness. Nonetheless, some good papers were dropped for lack of relevant and up to date data in addition to the inability of authors to complete revisions within scheduled timelines.

Majority of the empirical papers relied on secondary sources of data. A few, however, collected primary data through field surveys in different countries. The novelty in this edition however, is found in the empirical basis of analysis deployed and the participation of academia and industry at the Research Forum and peer review process.

Several institutions and people were instrumental in the process leading up to this publication and their involvement is gratefully acknowledged. The COMESA Secretariat under the leadership of The Secretary General Ms Chileshe Mpundu Kapwepwe, and the Division of Trade and Customs under the stewardship of Dr Christopher Onyango deserve special mention. The support of the editorial team (Benedict Musengele, Jane Kibiru and Mwangi Gakunga) is highly appreciated.

Drivers and Role of Innovation in Trade within the Common Market for Eastern and Southern Africa

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Abstract

Innovation plays a significant role in enhancing competitiveness which in turn promotes trade between nations. Yet empirical studies explaining the drivers of innovation and the role of innovation in trade within the region are inadequate. With the current recognition of the role of science technology and innovation (STI) by COMESA, there is need to study the determinants of innovation and establish the link between innovation and COMESA trade. This study reviewed and discussed the determinants of innovation and established the relationship between innovation and COMESA trade using the gravity model. The discussion revealed that innovation is driven by government policy, industry characteristics, firm characteristics as well as international factors. Secondary panel data for years 2005 to 2015 from COMSTAT data hub and World Bank was used. The study used high technology exports and scientific and technical journal article publications as proxies for innovation. Results indicate that both high technology exports and scientific and technical article publications positively influence COMESA trade meaning that innovation positively influences trade. Therefore, governments of COMESA Member States ought to boost innovation and hence trade, by instituting favorable government policy through proper institutional framework, increased public expenditure on R&D and promotion of training in ST&I through technical vocational training institutions and universities.

1. Introduction

International markets are characterized by greater competition than domestic markets. Rodriguez and Rodriguez (2005) state that this demanding competitive environment is reflected both on the demand side (qualitatively), where consumers demand high quality products and low prices, and on the supply side (quantitatively). Firms face local competitors along with international rivals. This makes it necessary for firms to dedicate part of their efforts and resources in search of competitive advantages in order to confront the competition and survive in these markets.

Innovation is one way that firms use to establish a competitive edge. It is a source of comparative advantage when combined with factor endowments and it drives international trade. This view of the link between innovation and trade holds that technology gaps are a key determinant of trade and investment between nations. Additionally, competitive markets benefit innovative firms, leading to increased market share. According to Virasa and Tang (1998), this is the case for most developed countries where innovation and diffusion of new technologies within a country are a basis for market power, and lead to international trade flows.

Furthermore, generating and sustaining competitive advantages requires that strategic resources and capabilities available to the firm add value to it, do not have strategic substitutes and above all are either inimitable or difficult to imitate. Among these strategic resources, intangible ones stand out. Among intangible resources, technological resources are significant as they provide the firm with an innovative capacity (for products and/or processes). They are important for creation of competitive advantage, especially based on differentiation which gives a firm superior competitiveness to participate in international and global markets (Rodriguez & Rodriguez, 2005).

The idea that innovation is a source of international trade is not the only view of the link between the two. Trade can also be a source of innovation through the effects of competition, technology transfer, and spillover. International trade exposes local firms to sophisticated international competition thereby forcing them to innovate in order to remain afloat. International trade permits freer flow of technologies across borders. This has been supported by Virasa and Tang (1998) who state that for developing countries, the evolution of trade leads to the development of national technological capabilities, thus through trade, a country can move from an inefficient production capability to a point on its production frontier. The underpinning principle of this idea is that international trade permits higher possibilities of freer flow of technologies across nations. It means that trade is the vehicle for transmission of new ideas, new technology, and new skills. Therefore, the key issue is the ability of a country or region to learn how to utilize innovations to strengthen its competitiveness (Virasa & Tang, 1998).

According to Yenilmez and Demir (2011), technology innovation plays a significant role in the trade patterns of industrial countries as opposed to developed countries. They observed that most trade theory assumes that technological activity plays no role in the comparative advantage of developing countries, and that the main determinants remain relative factor endowments. As such, developing countries are assumed to be technological followers, importing innovations from developed countries and using them passively. This remains to be confirmed for the COMESA region.

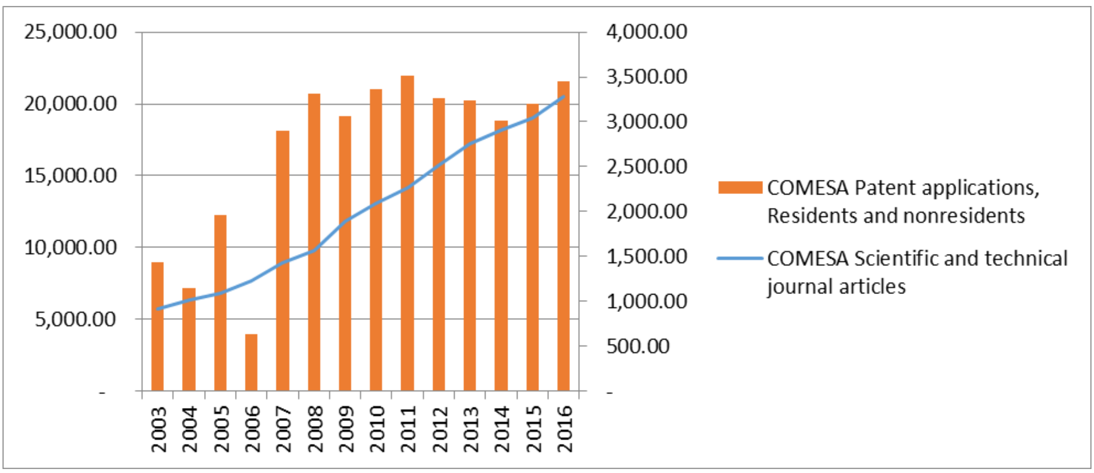
The COMESA region is one of the largest regional economic organizations in Africa with a population of 482 million people as of 2017 and total GDP of over USD700 billion (COMSTAT, 2017). COMESA Member States recognize the importance of Science, Technology and Innovation (STI) in socio-economic and cultural development and have agreed to cooperate in various fields as stated in the decision of the 2010 COMESA Summit on Science and Technology Development. The importance of technology was underscored in the June 2012 first ministerial committee. In this regard, there is need to establish the drivers of innovation within the region and establish the effect of innovations on trade among member states.

1.1 Innovation in COMESA

COMESA Member States have recognized the importance of innovation in socio-economic and cultural development. The region has turned to STI to foster trade and investment. COMESA has undertaken to facilitate and celebrate African stories in innovation and encourage Africans to use their energy and potential in science and technology to solve the continents economic challenges. In this regard, member states agreed to cooperate in various fields as stated in the decision of the 2010 COMESA Summit on Science and Technology Development. This was followed up in June 2012 with the COMESA Ministerial Committee agreeing on the critical importance of implementing the decisions on STI at the national level by each Member State. Furthermore, COMESA launched the innovation awards scheme at the 17th annual summit of the Heads of State in 2014 to recognize and celebrate individuals and institutions that have used STI to further the regional integration agenda.

The limited data on innovation, as proxied by various indicators, within COMESA indicates that the region has reported significant growth. For example, the number of patent applications by both residents and non-residents for the region has grown steadily from only 1436 applications in 2003 to over 3400 applications as of 2016. Similarly, the number of journals published within the member states of COMESA in the fields of science, technology, engineering and mathematics has grown from 5713 in 2003 to over 20,000 in 2016. These trends have been depicted in figure 1.1. Despite the persistent growth in patent applications in the region, the figures are far below those of economies that the region would benchmark with, such as China. World Bank data indicates that China recorded 173,372 patent applications in 2005 and over 1.3 million applications in 2016. Similarly, the number of technical and scientific journal articles published in China stood at 426,165 indicating a difference of more than 400,000 articles between the Chinese economy and COMESA as a region.

Figure 1.1: Patent Applications and Scientific and Technical Journal Articles in COMESA



Source: World Bank (2018), World Development Indicators.

Despite the above, the allocation to Research and Development (R&D) expenditure as a percentage of GDP among COMESA Member States has remained very low. Available data from World Bank Group

(2018) shows that none of the member states has achieved the proposed share of R&D expenditure of 1 percent share of Gross Domestic Product (GDP). Among the member states Egypt and Tunisia have come close to the 1 percent target with their R&D expenditure being 0.71 percent and 0.60 percent of GDP respectively in 2016. In comparison with other economies, the region's allocation to R&D is still low and is growing as sluggish pace. For example, China's allocation to R&D as a percentage of GDP has grown from 1.3 percent in 2005 to 2.1 percent in 2016.

1.2 Role of Innnovation in Trade

The global economy has become interconnected and competitive. Innovation is considered to be a primary success factor for the survival of firms (Shabbir, 2015). At the macro level, innovation is crucial in establishing a country's comparative advantage. Ahmed (1998) regards innovation as the best way to achieve comparative advantage because it is vital for adaptation to changing technology, markets and global competition.

According to Rodriguez and Rodriguez (2005) technological innovations can generate a double competitive advantage for a firm. First, is through costs, via the development of new and efficient processes. Secondly, they confer competitive advantages based on differentiation, by means of product innovations, allowing the firm to tailor-make products according to customer requirements, or develop products of a higher quality. This is one of the key elements of success in foreign trade.

Moreover, in the current globalized economy characterized with high levels of market segmentation and customers who increasingly demand for customized products, firms and indeed economies have to compete via differentiation. Economies that have superior innovations will have a higher degree of competitiveness in international markets. Caves (1982) argues that firms that produce innovations have incentives to expand into other markets in order to earn higher returns from their investments, since the appropriability regime is improved when widening the market of a product.

In a nutshell, and with reference to the Heckscher-Ohlin model, innovation boosts international competitiveness thereby contributing to trade and economic development. It also gives firms incentives to enter foreign markets which lead to greater production.

1.3 Determinants of Innovation

Factors that drive innovation range from national level characteristics, industry characteristics and firm level features. At national level, government has the role of putting in place proper institutional measures to promote innovation. Chryssochoidis (2003) considers national institutions as a key driver of innovation. Business external environmental factors such as the level of uncertainty, dynamism or competion in the business environment as well as demographic factors also affect innovation. Challanges such as financial constraints, lack of information, knowledge infrastructure, weak inter-firm linkages and regulatory burdens may hamper innovation.

1.4 Statement of the Problem

The debate on the link between innovation and trade is far from over. Within the COMESA region, it's not empirically established how the two relate. Statistics from World Bank Group (2018) indicate that the number of innovations within COMESA have grown over the past two decades. At the same time, the volume of trade within the region has grown tremendously. These trends give rise to two pertinent issues. First, is the question of the factors that drive innovation within the region. Second, is whether innovation has helped to boost COMESA trade and hence promote regional integration. Considering the efforts by the COMESA Secretariat to promote innovation in the region, there is an urgent need to establish the drivers of innovation to inform the governments of COMESA countries on some of the variables to consider to spur innovation, and to establish the link between innovation and trade within the region. There is also a huge gap in literature on innovation that needs to be filled.

1.5 Research Objective

The general objective of the study was to establish the role of innovation in trade within the COMESA region. The specific objectives were;

i) To discuss the determinants of innovation.
ii) To establish the relationship between high technology exports and trade in COMESA.
iii) To determine the effect of scientific and technical journal publications on COMESA trade.

2.0 Literature Review

2.1 Theoretical Literature

Innovation and technological differences as a source of trade were ruled out of the neo-classical factor endowments theory of trade as the proof of this theory involved the assumption that the techniques for producing goods were the same across countries. The work that has followed in this tradition has thus, in general, ignored the role of differences in technology in influencing which goods are traded and with whom. This was demonstrated by the Leontief's paradox. Another more recent challenge has been the domination of total trade by trade between developed countries with similar factor endowments. Trade between these countries is also often characterized by intra-industry trade that is the simultaneous export and import of the same goods by a country. The traditional Heckscher-Ohlin theory fails to give any explanation of this phenomenon.

According to (Verspagen & Wakelin, 2002), this failure prompted both the formulation of new theories of trade and the reformulation of traditional theories. The result of the reformulation was the neo-endowment theory of trade as well as formulation of the trade theories which stressed on the motivations for trade within a monopolistic competition setting. These involve the introduction of factors such as product heterogeneity, economies of scale and monopoly power. Attempts were also made to put technological innovation at center stage from the 1960s. Among the theories which consider technological innovation as an important variable in international trade are; the neo-technological trade theories of the 1960s, the technology gap (Posner, 1961) and the product cycle theories (Vernon, 1966). Both the technology gap theory and the product cycle theory relied principally on the ideas of (Schumpeter et.al., 1947).

The Neo Technology Theory of Trade:

This theory extends the traditional neo-classical model of trade by including other factors in addition to labour and capital. The theory considers knowledge as an endowment to the economy implying that knowledge can be country specific and becomes a stock which can accumulate over time. Therefore, countries which have large endowments of knowledge will produce knowledge intensive goods and can be said to have a comparative advantage in those goods. Leading work on this model was based on the Ricardian trade theory and the Hecksher-Ohlin trade theory.

The Ricardian trade theory takes cross-country technology differences as the basis of trade. By abstracting from the roles of cross-country factor endowment differences and cross-industry factor intensity differences, Ricardo's trade theory offers a simple and yet powerful framework for addressing many positive and normative issues of international trade. Ghanbari and Ahmadi, (2017) deduced that the theory properly explains the effects of country sizes, technology changes and transfers, and income distributions on international trade.

Similarly, the Heckscher-Ohlin model indicates that trade will increase the demand for the goods produced by the country's abundant resource. Since the abundant resource in most developing countries is labor, the prediction is an increase in demand for labor intensive goods. On the other hand, the abundant resource in developed countries is technology (capital) meaning that developed countries can initially export capital intensive goods. This will explain the fact that developing countries will import capital intensive goods while exporting majorly labor intensive goods.

The Technology Gap Theory:

In an attempt to explain trade in manufactured goods between developed countries, Posner (1961) developed the technology gap theory. The theory postulates that absolute technological advantage of one industry in a country relative to an industry in another country generates both an absolute advantage and a temporary monopoly in trade until the point when the second country imitates. Posner alluded that innovation could confer an advantage in two ways. First is by increasing the number of techniques available for production, which leads to cost advantages though the implementation of more efficient methods. The second is with the introduction of new capital and consumer goods, which grant a temporary monopoly to the innovating country. According to him, this can increase the variety of goods available, which, in an oligopolistic model of trade provides part of the rationale for intra-industry trade.

Therefore, according to this theory, trade flows from the country with technological advantage to the country with technological disadvantage, thus, trade is generated by differences in the rate and nature of innovation. However, since knowledge is a public good, it will flow to other developing economics. This flow is subject to imitation lags, which is dependent on the capacity of foreign producers to adapt their production structure to produce new goods with cheaper labor.

The Product Cycle Theory:

While Posner (1961) places more emphasis on comparative costs brought about by technological and innovation advantage, Vernon (1966) places emphasis on the timing of innovation. Vernon's 'product cycle' model held that innovation in leader countries helps to produce new products which pass through different stages of maturity. Initially the innovator country is the only producer of the new product. Once the new product reaches a particular phase, the production starts in other developing economies, where labor costs are lower. In line with this, the theory propounds that developed countries tend to have a comparative advantage in producing those commodities that are newly developed. Therefore, they tend to export more of the newly developed products while developing countries import such items.

2.2 Empirical Literature

Empirical literature on the determinants of innovation and the link between innovation and trade abound. Studies on the determinants of innovation have been largely qualitative with a few of them relying on OLS to establish the determinants. Studies attempting to establish the link between innovation and trade have mostly applied the gravity model. However, they vary in methodology, from country to country and region to region. This section gives a review of some of the studies pertaining to innovation and trade.

Empirical Literature on Determinants Of Innovation

The survey of literature in Chryssochoidis (2003) sought to establish the factors responsible for product innovations. The study involved an extensive literature review covering 400 scientific journals during a 10 year period (1991-2001). The author identified and reviewed over 2500 relevant journal articles. The study concluded that innovation is determined by various factors. First institutional capacity of a country, the nature of the industry that is business external environmental factors such as the level of uncertainty, dynamism or competition in the business environment and demographic characteristics such as the age and maturity of the organization, the population characteristics of management and staff as well as customers and competitors. Lastly, the attitude of top management was found to have a significant bearing on the level of innovation within firms. Their personality, skill, and entrepreneurial ability largely influenced the level of innovation.

Abdu and Jabir (2018) examined the determinants of a firm's innovation in Nigeria. The study utilized enterprise survey data developed by the World Bank, which were analyzed using probit and tobit regression models. The findings showed that investing in research and development (R&D), formal training, a firm's size, exporting status, competitors, location, type and sector, or activity of firms all positively drive the propensity of a firm to innovate. Surprisingly, it was also established that the firm's age and employee education negatively affect the chances of innovation. This contravened the findings by Knoben et.al., (2014) who established that their was a positive correlation between human capital and innovation in Kenya, Uganda, and Tanzania. Abdu and Jabir (2018) also found that almost the same factors (investing in R&D, formal training, a firm's size, type, and sector) were the significant determinants of product, process, organizational, or marketing innovation.

Another study by Dotum (2015) examined the determinants of innovation in SMEs in Southeastern Nigeria and found that eight factors were significant in influencing innovative activity. These are accessibility to foreign inputs, government support, level of education, competition, R&D subsidies, foreign celebration, and availability of patents and copyright.

The study by Bhattacharya and Bloch (2004) examined how firm size, market structure, profitability and growth influence innovative activity in small to medium sized Australian manufacturing businesses. They conducted regression analysis to determine the factors that significantly affect subsequent innovative activity for the full sample of businesses, as well as for sub-samples of firms from high and low-technological opportunity industries. Most variables, including size, R&D intensity, market structure and trade shares were found to be conducive to further innovative activity for the full sample and for high-tech firms. For low-tech industries, fewer variables are significant.

Azarmi (2016) undertook a study to come up with a comprehensive list of influential elements on technology innovation and its commercialisation in firms. Their results indicate that the main factors that infleunce innovation are support systems, knowledge, technology, the market, management, individual characteristics such as education level, general envrironment, availability of resources and the ideology of the firm.

In addition to the above studies, Choi and Lim (2017) empirically explored the relationship between innovation performance and the internal and contextual factors driving technological innovation in manufacturing small and medium-sized enterprises (SMEs) in metropolitan areas of Korea using structural equation modeling (SEM). Their analysis was based on firm-level data. Their results indicate that SMEs' innovation capacity was positively related to skills and technology acquisition. They concluded that both skills and technology acquisition and government and public policies are important contextual factors which can increase SMEs' innovation performance.

Empirical Literature on the Relationship between Innovation and Trade

There is a growing literature that attempts to investigate the relationship between innovation and trade performance, either for one country, or for a group of countries, taking into account Science, Technology and Innovation as explanatory variables.

Wakelin (1998) investigated the determinants of bilateral OECD trade with particular emphasis on the role of innovation. The model used in the study considered relative innovation, labour costs and investment rates as determinants of export performance in a cross-section of 36 intra-OECD bilateral trade flows. The study used R &D as a proxy for relative innovation. The study found that a positive relationship existed between relative innovation and bilateral trade performance at an aggregate level, and for a number of manufacturing sectors. Sectors were also classified as either net users or producers of innovations and the differences in innovation appeared to have more impact on trade performance for the net producers of innovations than the net users of innovations.

In order to establish a conceptual framework for examining the relationship between technology factors and trade performance in the context of developing countries, Virasa and Tang (1998) assumed that the relationship between technology factors and trade performance can be extracted and demonstrated by trade characteristics, production characteristics, and technological capability characteristics in each development stage of a particular industry. They incorporated technological capabilities and production characteristics what they called technology contribution factor (TCF). On the other hand, they measured trade characteristics by trade performance indicators. They identified multi-attribute indicators for measuring TCF and trade performance and used the two indices to indicate an industry's status at a particular point in time. A higher value of the TCF index implied greater enhancement of technological capabilities and the improvement of an industry's production. Similarly, a higher value of the trade performance index implied greater international competitiveness for the industry. The conceptual model indicated existence of a positive relationship between technological development and international trade.

Lachenmaier and Woussmann (2004) empirically examined whether innovation causes exports in Germany. They conceived innovation as new changes and substantial improvements of products as well as production and process techniques including the information technique in office and administration by firms. Using firm-survey-based innovation measure, they found that innovation leads to an increase in the export share of German manufacturing firms.

Rodriguez and Rodriguez (2005) sought to examine the relationship between technology and export behavior using the resource based model. According to the model, the best way of regarding a firm is as a collection of productive resources, imperfectly imitable and specific to each firm, which allows it to compete successfully against other firms. Thus, a firm's resources are the main sources of its competitive advantage and its capacity to enter and sell products in international markets requires a high degree of competitiveness. By studying a sample of Spanish manufacturing firms, they found that product innovations, patents and process innovations positively and significantly affect both the decision to export and the export intensity. R&D spending intensity did not significantly affect the decision to export, although it significantly impacted on export intensity

In another study to establish the effects of innovation on international trade, Marquez-Ramos and Martínez-Zarzoso (2010) used the gravity model. They applied the technological achievement index (TAI) and its four components which are: creation of technology, diffusion of old innovations, diffusion of recent innovations and human skills as proxies for technological innovation. The first two components were considered proxies for knowledge acquisition and assimilation (potential absorptive capacity), while the other two were taken as proxies for knowledge transformation and exploitation (realized absorptive capacity). They found a positive and non-linear effect of technological innovation on export performance. This indicated that there were thresholds for positive relationship to exist.

Hasanov, Abada and Aktamov (2015) attempted to find the relationship between innovation indicators and export performance among Asian countries. They used patents, trademarks, industrial design, number of scientific journals and R&D expenditures as indicators of innovativeness of the countries. They constructed an unbalanced panel data for 48 Asian countries with time series from 1997 to 2011. Using OLS regression they found that the only innovativeness indicator which positively associated with export performance was the number of registered industrial design in the country. The rest of innovativeness indicators did not show any significant relationship with export performance of the country.

Ghanbari and Ahmadi (2017) sought to establish the effect of innovation on international trade in Iran using selected medium and high technology industries in the country. The study examined the impact of R&D as a proxy of innovation on three medium high-tech industries exports in Iran, Japan, Korea and Australia using panel data method over a period of 10 years. They used a gravity model to estimate the effects of innovation on the volume of bilateral trade at industry level. The findings of the study indicated a positive and significant effect of innovation on export performance of medium high-tech industries. In addition, the study found that there exists a positive relationship between colonial ties and trade.

2.3 Summary of Literature

The review of empirical literature on the determinants of innovation reveals that institutional/ government support, financial resources, nature of the business or industry competition, education level and demographic characteristics are the main determinants of innovation. The link between innovation and international trade has been based on the new trade theories and the relationship established using the gravity model in most cases. The studies indicate that innovation plays a key role in international trade.

There is need to establish the determinants of innovation within COMESA in order to inform the STI policy. In addition, it is important to clearly identify how innovation affects trade within the region. To the best of our knowledge, there are no past empirical studies that have sought to address this matter.

3. Methodology

3.1 Relationship between Innovation and Trade-model Specification

In order to analyze the effect of innovation on trade in COMESA, a gravity equation was specified and estimated. The application of gravity equations to empirical analysis of international trade was pioneered by Tinbergen (1962). He described the patterns of bilateral aggregate trade flows between two countries i and j as "proportional to the gross domestic products of those countries (GDPi and

GDPj) and inversely proportional to the distance between them (Dij)," as illustrated below.

$$Trade_{ijt} = A * \frac{(GDP_{it}^{\alpha_1} * GDP_{jt}^{\alpha_2})}{D_{ij}^{\alpha_3}} \quad (1)$$

The above general gravity model has been modified by trade economists such as Helpman (1987), Mátyás (1997), Soloaga and Winters (2001), Josheski and Fotov (2013) to include other variables affecting trade between the trading countries. Such variables include innovation, technology, free trade agreements and Common Unions, infrastructure development, real exchange rates, common language, colonial ties and common borders among others. The early general gravity equation took the following log-linearized form:

$$\ln IM_{ij} = \alpha_0 + \alpha_1 \ln Y_i + \alpha_2 \ln Y_j + \alpha_3 \ln Dist_{ij} + u_{ij} \quad (2)$$

Where IMij is the imports from country i to j, Yi and Yj denote the aggregate income of county i and j respectively while Distij is the geographical distance between capital cities of country i and j. The coefficients α1 and α2 are expected to be positive while α3 is expected to be negative going by past empirical studies.

This study extended the general gravity model to take into account the effect of innovation in the specified equation 3 that follows:

$$\ln TRD_{ij} = \alpha_0 + \alpha_1 \ln Y_i + \alpha_2 \ln Y_j + \alpha_3 \ln HT_i + \alpha_4 \ln ST_i + \alpha_5 \ln Dist_{ij} + \alpha_6 comlang + u_{ij} \quad (3)$$

Where In denotes natural logarithms; TRD_{ij} is trade between country *i* and *j*, Y_i and Y_j are the incomes in the exporter's country and in the destination country, respectively; HT_i is high technology exports in country i; ST_i refers to the scientific and technical journal articles in country i; $Dist_{ij}$ is the geographical distance in kilometers between capital of i and j; $comlang_{ij}$ is a dummy for countries sharing a common official language.

Due to the sample size limitations of the R&D data, the study used high technology exports data to proxy innovation. The variable was chosen based on the fact that high-technology exports are products with high R&D intensity and hence can be used to measure the level of innovation in a country. The number of scientific and technical journal articles was taken as a proxy of innovation given that it is used to measure the innovation performance of a country. According to Hasanov, Abada, & Aktamov, (2015), establishing and publishing of new articles about research results and achievements in scientific and technical fields are a hard and long process. Therefore, they considered it a suitable indicator to show the level of overall innovativeness of the country.

In order to achieve the second and third objectives of the paper, equation 3 was estimated using Ordinary Least Square (OLS) method. The technique was considered appropriate since no zero values were included among the trade flows. OLS results would therefore be robust and unbiased.

3.2 Definition, Measurement and Expected Signs of Variables

High-technology (HT) exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. Data are in current U.S. dollars. High technology exports proxy innovation. They are expected to positively influence trade. Source: World Development Indicators (WDI)

Scientific and technical journal articles (ST) refer to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences. They are expected to positively influence trade. Source: World Development Indicators (WDI)

Income (Y) is proxied by real GDP. It is measured at current prices (US dollars). Y_{it} is GDP for COMESA while Y_{jt} is GDP for COMESA trading partner.

Distance (Dist) refers to distance in kilometers between capitals of trading partners. It is measured in kilometers. In relation to trade volume, it is expected to have a negative sign because more trade occurs between economies within a short distance.

Common language (comlang) is dummy for common language where 1 is when COMESA Member States and trading partners have the same language or otherwise 0. It is expected to have positive effect.

Trade (TRD) the sum of COMESA's exports and imports. It is measured at current prices (US dollars).

3.3. Panel Data Tests

Panel Unit Root Test:

Prior to estimating equation 3, unit root test was conducted to ascertain whether the variables were stationary or not. The unit root test on panel data is necessary to avoid spurious regression which may yield misleading estimates. The test is also instrumental in determining the order of integration of the variables. The study used the Im-Pesaran-Shin (IPS) panel unit root test (Im, Pesaran, and Shin, 2003). The IPS test assumes heterogeneous coefficient among the individual components. The test is superior to other panel unit root techniques in analyzing long-run relationships in panel data with fewer time observations. The null hypothesis for the test is that all panels contain unit roots against alternative that at least one panel is stationary.

Specification Test:

When using panel data it is imperative to test for homogeneity in order to determine whether the model specification is heterogeneous or homogenous. This study used the F-test to test for unobserved country effects in the Fixed Effects (FE) model and Lagrange Multiplier (LM) test for Random Effects (RE) model. For the F-test, if the F-statistic is statistically insignificant, no panel models need to be specified, as all individuals are sufficiently homogeneous. For the LM test, the null hypothesis is that variances across units are zero, that is, no panel effect. If the chi square is statistically significant, the null hypothesis is rejected hence, the RE model is appropriate.

Hausman Test:

The Hausman test was applied to ascertain whether the fixed effects (FE) method or the random effects (RE) method of estimation is appropriate. The hypotheses were as follows:

H_0 = Individual effects are uncorrelated with the regressors (RE)

H_1 = Individual effects are correlated with the regressors (FE).

Under the null hypothesis, the theoretical model is specified with individual RE while under the alternative hypothesis; the model is specified with individual FE. If the null hypothesis is not rejected, the RE model is favored over its FE counterpart and vice versa (Hausman & Taylor, 1978)

3.4 Data Type and Sources

The study used secondary data from various statistical abstracts. The data on gross domestic product, high technology exports and scientific and technical journal articles were obtained from World Bank[3]. Data on distance was computed from MAPCROW and Google map calculator while data on trade was extracted from COMSTAT[4]. The data on all variables, except distance is annual observations from 2005 to 2015. The countries considered for analysis based on data availability were; Burundi, Comoros, Egypt, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Swaziland, Uganda, Zambia and Zimbabwe.

4.0 Presentation and Discussion of Results

4.1 Drivers of Innovation

Our survey of literature revealed that innovation is a complex, multifaceted phenomenon and it is influenced by large number of factors. Various researchers have demonstrated the factors that drive innovation. Crespi (2004) indicated that property rights regime; the market structure; financial structure and corporate governance within organisations; geographical factors; demand; human capital; technology policy and regulations are the main factors that drive innovation.

Elsewhere, Abdu and Jabir (2018) estabslished that innovation was driven by investment in R&D, firm's size, formal training of staff and management and the firm's age.

Chryssochoidis (2003) found that innovation level is determined by institutional capacity of a country, the nature of the industry for example; level of uncertainty, dynamism or competition in the business environment and demographic characteristics such as the age and maturity of the organization, the population characteristics of management and staff as well as customers and competitors. The attitude of top management was found to have a significant bearing on the level of innovation within firms.

Bhattacharya and Bloch (2004) found that firm size, R&D intensity, market structure and trade shares were major drivers of innovation.

Azarmi (2016) found that support systems, knowledge, technology, the market, management, individual characteristics such as education level, general environment, availability of resources and the ideology of the firm support innovation.

Lastly, Choi and Lim (2017) established that both skills and technology acquisition and government and public policies affect innovation among firms. Jegede et.al., (2012) found that educational qualifications, training and prior work experience of the heads of technical departments, number of R&D staff and training and R&D expenditure by firms positively influence innovation.

From these sources, this study summarized the drivers of innovation as: Government policy and support, firm characteristics, research and development, universities, culture of the general population and industry characteristics. The factors were summarised and presented in Figure 4.1.

3 World Bank Group. (2018). Kenya (Data). Retrieved 2019, from World Development Indicators (WDI) Online Database.
4 COMESA. (2013). COMESA statistics database (COMSTAT). Retrieved from http://comstat.comesa.int/Home.aspx.

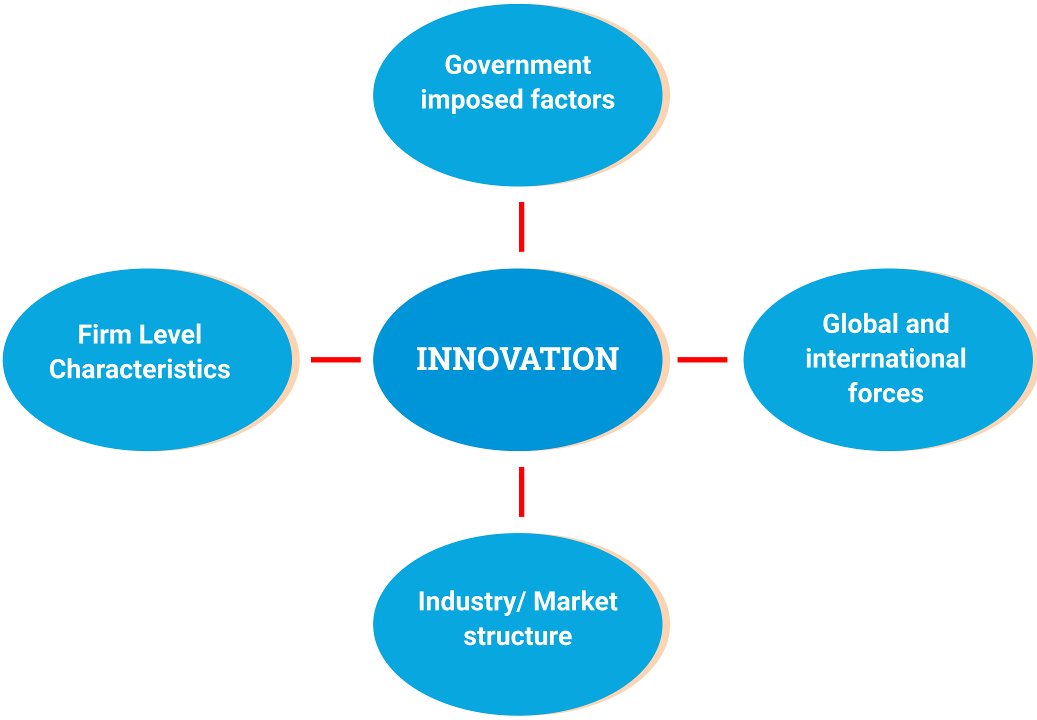


Figure 4.1. Drivers of Innovation

Source: Authors' own compilation

Role of Government in Promoting Innovation

According to Reiljan and Paltser (2015), government intervention in the innovation processes is necessitated by the need to eliminate market and system failures that hinder innovation. Government intervenes through the innovation policy which is a subset of the STI policy. The main pillars that make up the STI policy are: institutional frameworks for innovations (intellectual property rights regime); public expenditure on R&D and expenditure on training personnel in research; public communication and advocacy as well as management of diffusion processes.

The Institutional Framework for Innovations

Production of innovations often involves scientific knowledge yet knowledge shares some typical characteristics of public goods such indivisibility, non-rivalry and non-excludability in consumption (Arrow, 1962). These characteristics of knowledge creates huge difficulties in terms of the ability of market forces to produce a Pareto efficient allocation of resources devoted to innovative activities (Crespi, 2004). Therefore, there is need for a proper intellectual property rights regime to ensure that producers of new knowledge are able to sell it without losing the derived monopolistic power.

Some COMESA countries like Kenya have made efforts to strengthen the Intellectual Property Rights (IPR) regime in order to maximize incentives for the generation, protection and utilization of intellectual property by all types of inventors and foster achievement (Kenya, 2008). Patents make it easy for the entry in markets of firms which are less able to protect their innovations in alternative ways. Therefore, patents support investments in creation of new knowledge in highly competitive environments.

The idea that patents encourage innovations has been supported by Moser (2013) who observed the historical events that concern patents systems and innovation. His study makes reference to evidence dating back to 1474 when the Venetian Republic began to offer exclusive rights to inventors and entrepreneurs who had invented or brought new technologies to Venice. The success of this policy in encouraging innovation prompted most European rulers to copy and implement the system of patents. In addition, using data from 706 firms competing in ten manufacturing industries across 29 countries, Allred and Park (2007) found that there was a strong positive influence of patent rights and changes in patent rights on a firm's propensity to invest in innovation.

The role of institutional framework in supporting innovations has also been supported by Barney, (1991), Jegede et.al, (2012), Tebaldi and Elmslie (2013) and Barasa et. al., (2017). Barney (1991) considers inadequate intellectual property rights as the main feature of poor institutional framework. The implication of lack of intellectual property rights according to him is that firms cannot extract value from their R&D investments and innovations and are therefore discouraged. Jegede et.al, (2012) reported that role of government as an institution is critical for innovation. According to them, the institutional role of government includes design and implementation of innovation-friendly policies, effective monitoring of these policies, procuring innovative products from domestic firms and creating a stable political and economic ambience. On their part, Tebaldi and Elmslie (2013) asserted that firms in poor institutional environments are less likely to conduct any research and still if they would, they would not benefit from the research in terms of innovations. Barasa et.al.,(2017) also demonstrates that in institutional environments where few imitation restrictions exist, it is likely that firms will be unsuccessful in transforming their R&D investments into innovative output. They also note that corrupt environments reduce the magnitude of the possibility for firms to invest in R&D and subsequently profit from them.

Public Expenditure on R&D

Government expenditure on R&D plays a crucial role in promoting innovation. This has been demonstrated by Alinaitwe et. al., (2007) who found that innovation is positively associated with R&D expenditure. According to them, R&D at the national level increases the knowledge intensity of the processes of generating, producing and commercializing new goods and services and therefore fosters innovation in different fields. In addition, Guellec and Pottere (2010) demonstrated that direct government funding of R&D performed by firms has a positive effect on innovation. They also found that tax incentives have a positive effect on business-financed R&D which is a precursor for innovation by firms. However, they demonstrate that investment in defense R&D negatively affects private investment in R&D and hence business innovation. Other notable studies that have indicated the importance of public sector R&D spending in promoting innovation are Guloglu et. al. (2012) and Abdu and Jabir (2018).

Technical Vocational Training Institutions and Universities

Universities are major drivers of innovation (Juma, 2016). He alluded that the current low level of investment in higher technical training and research is a barrier to innovation in Africa. He pointed out that strengthening research, community service, and commercialization in teaching universities and setting up new innovation universities would spur innovation. Therefore, there is need for government to fund training in science and technology in universities. The universities also need to build their innovation management capacity, strengthen relations with industry and partner. Juma also suggested that within these institutions, national projects that seek to recognize and reward innovation would spur innovation.

Okafor and Chukwuedo (2015) *argue that STI policy should not only consider the advanced level technology but also integrate the lower or indigenous level technology; hence STI policy should not neglect the TVET indigenous technologies. In fact, if the relationship between skills, experience and knowledge of employees positively affects innovation within firms, then the underlying vocational learning and training system, can exert an important impact on innovation in developing countries since a large proportion of the* labour force are trained within these institutions.

Industry Level Characteristics (Market structure)

In his two Schumpeterian hypotheses, Schumpeter (1942) made great contribution to literature concerning the relationship between market structure and innovation. His first hypothesis deals with the relationship between innovation and monopoly power and stresses the idea that concentrated market structure boosts innovative activity. The second hypothesis is concerned with the relationship between firm size and the attitude to invest in innovative activities. The view from his first hypothesis is that monopolists tend to and are able to engage in innovative activity more than firms in perfectly competitive markets.

Opposed to the ideas of Schumpeter, Arrow (1962), alluded that perfect competition encourages innovation. In Arrow`s model a monopolistic firm appears to invest in R&D less than the competitive one. Arrow argues that incentives to invest in R&D are greater in competitive markets. Nelson and Winter (1982) concured with Arrow and stated innovation tends to grow with a reduction in market concentration.

Kamien and Schwartz (1976) developed an intermediate position between monopoly and perfect competition. They pointed out that innovation does not increase monotonically with concentration but, intermediate market environments between perfect competition and monopoly, are more likely to produce the best conditions to perform innovative activities. Furthermore, they found that the key determinant of the pace of innovation is not concentration but effective rivalry. High rivalry implies that after an innovation has been introduced, the imitation process from rivals begins rapidly thereby reducing extra-profits earned by the innovative firm.

Most empirical findings however indicate that competion encourages innovation. Examples are Raider (1998) and Aghion et.al., (2014) who establsihed that firms facing competitive environments, in high constraint markets, show greater R&D intensity and faster rates of innovation than firms in industries facing less competitive pressure. Additionally, Tomohiko et. al. (2008) found that when incumbents'technology level is close to the technology frontier in their industry, competition from new entrants induces these firms to make efforts to increase their productivity in order to escape competition. However, they found that competition discourages innovation in firms far from the industrial technology frontier.

Firm Level Determinants

Firm Size

In general, there exists a positive effect of firm size on innovation, since larger firms tend to be less financially constrained (Martinez-Ros , 2000). Schumpeter (1942) stated that firms with higher market power have more resources for R&D and hence innovation. Nutter (1956) shows large firms can hedge against the technical uncertainties associated with innovation by undertaking several projects simultaneously. Their findings were reported by Abdu and Jabir (2018). However, Araci and Gulenc (2010) argue that it may also happen that larger firms view themselves as less threatened by competition and lower the rate of innovation. Their argument is empiricaly supported by Acs and Audretsch (1988) who found a negative relationship between firm size and innovation. Zemplinerova (2010). Aghion et.al., (2004) found an inverted-U shaped relationship between R&D intensity and the firm's size. Hromádková and Zemplinerová (2012) attributes the lack of consisetncy in these findings to the existence of industry specific characteristics such as knowledge externalities and appropriability that can determine innovation activity.

Investment in R&D Expenditure

Innovation is often times a product of extensive investment in R & D by firms. Therefore, private investment in R&D plays an important role in promoting innovation. Several studies have demonstrated this fact. These are Barasa et. al., (2017), Conte and Vivarelli (2013), Alinaitwe et. al. (2007), Abdu and Jabir (2018) and Dotum (2015) among others. Barasa et. al., (2017) linked the ability of firms to innovate to the fact that invetsmnet in R&D extends their scientific and/or technical knowledge base, which allows them to design and develop new innovative products or services. Conte and Vivarelli (2013) found that R&D expenditures significantly and positively impact on the level of innovation by both small and large firms. However, the impact of R&D over innovative turnover tends to be larger and more significant in the large companies that in small ones.

Employee Characteristics

Innovation initiatives often rely on employees' knowledge, expertise, and commitment as key inputs in the value creation process (Youndt et.al, 1996). Therefore, there is need to have entrepreneurial employees who are well skilled and experienced to be constantly seeking opportunities to create new products and processes. Jegede et.al., (2012) demonstrated that that educational qualifications, training and prior work experience of the heads of technical departments, number of R&D staff and training and R&D expenditure by firms positively influence innovation.

Financial Structure, Ownership and Management

The separation between corporate ownership and control generates the agency conflicts between managers and shareholders. Corporate governance consists of measures put in place to minimize the conflict in goals. According to Crespi (2004), different governance systems produce different effects on innovative activity.

Investments in R&D boost the divergence between the interests of the principal (shareholders) and the agent (managers) because they are characterized by a high degree of uncertainty but also high potential returns. Shareholders are usually attracted by investments in innovative activities because of their high potential returns and because they can spread risk among their portfolio of investments. In contrast, managers will be more attracted by R&D projects associated with a low risk level since their utility is related to the outcome of the project. In this respect, Munari and Sobrero (2003) argue that if corporate governance systems are ineffective the pace of innovation might be negatively affected.

They give three propositions to counter the problem. First, strategic control appears to be more complete and appropriate than financial control in dealing with innovative and fast evolving environments because, within it, long-term strategically relevant criteria are used. Secondly, stock ownership concentration has a positive influence on R&D expenditures because it allows a major control on manager's decisions and reduces their risk aversion. Lastly, the composition of the board of directors appears to be relevant in the process of resource allocation devoted to innovative activities. Insiders seem to be better suited as decision-makers than independent directors are because they have appropriate information about firm's activities and this is fruitful to enhance innovation.

Effect of Globalization

Globalization, through international trade is also a good source of innovation through the effects of competition, technology transfer, and spillover. Exposure by local firms to global competition forces them to innovate in order to remain afloat. Openness among countries permits freer flow of technologies across borders. Virasa and Tang (1998) found that for developing countries, the evolution of trade leads to the development of national technological capabilities, thus through trade, innovations will increase in the domestic economy. They assert that trade is a channel for transmission of new ideas, new technology, and new skills. Dotum (2015) found that accessibility to foreign inputs positively affects innovation.

4.2 Innovation and Trade

Unit Root Test Results

The study applied the Im-Peseran-Shin panel unit-root test to determine the presence of a unit root and the order of integration of the variables. The results of the panel unit-root test are presented in appendix 1. Based on the output, GDP for COMESA, trade, high technology exports and scientific and technical journal articles were stationary at levels and integrated of order zero, I(0). On the other hand, GDP for COMESA's trading partners was non-stationary at levels. Therefore, it was first differenced to be stationary. Thus it is integrated of order one, I(1).

Hausman Test Results for Fixed Effect Model and Random Effect Model

Hausman test was used to ascertain the appropriate model between FE and RE. The results presented in table 4.1 shows that FE model was selected over RE following rejection of the null hypothesis.

Table 4.1 Hausman Test

Correlated RE (Hausman test)		
Test Summary	Chi-Square Statistics	Probability
Cross-section random	259.744801	0.0000

Source: Authors' own computation

Relationship between Innovation and Trade

The regression results (Table 4.2), show that all the coefficients of variables except that of the GDP of the trading partners are significant and with the expected signs. The coefficient of GDP for COMESA trading partners was not significant in explaining trade in COMESA. The overall R^2 is 0.853 indicating that about 85 percent of the variations in COMESA trade are explained by its GDP, high technology exports, scientific and technical journal articles, the distance between the countries' capital cities and a common language dummy.

The coefficient of GDP for COMESA is positive and significant implying that trade elasticity with respect to economic growth is high. For every unit increase in GDP of COMESA, trade increases by about 0.28. The findings are consistent with those of Wakelin (1998).

The coefficient of the distance between headquarters of COMESA and the capital cities of the trading partners is negative and significant as expected. This indicates that for every additional kilometer covered between Lusaka and the capital city of the COMESA trade partner, trade reduces by about 0.48 units.

Based on the output, the existence of common language boosts trade within COMESA. This is supported by the coefficient of the dummy for common language which significant and positive. The findings suggest that speaking a common language between countries enhances trade by about 0.7 units.

The coefficient for high technology exports was found to be positive and significant. This underscores the important role of innovation as proxied by high technology exports in boosting intra-COMESA trade. The findings indicate that a unit increase in innovation increases trade within COMESA region by 0.06 units. These findings are consistent with results in Wakelin (1998), Virasa and Tang (1998), Rodriguez and Rodriguez (2005) and Ghanbari and Ahmadi (2017).

The results further indicate that the coefficient for scientific and technical journals is positive and significant. As a proxy for innovation, this implies that an increase in the output of Research and Development is vital for trade growth. Precisely, when the journals increase by a unit, it is expected that trade increases by 0.55 units. The results are consistent with Hasanov et. al., (2015)

Table 4.2 Effects of Innovation on Trade.

Dependent variable Trade			
Independent variable	**Coefficient**	**t-stat**	**P-value**
GDP COMESA	0.2773***	1.6847	0.0946
GDP trade partners	-0.1939	-0.4509	0.6529
High tech exports	0.0568**	2.0927	0.0384
Scientific and Technical Journals	0.5478*	14.5563	0.0000
Distance	-0.4809*	-5.1560	0.0000
Common language	0.6945*	5.2558	0.000.
Overall R2 0.8525			
F-statistic 118.485	Probability 0.000		

*The asterisks *, ** and *** denote that the coefficient is statistically significant at 1%, 5% and 10 % levels respectively.*

5. Conclusions and Policy Recommendations

This paper sought to provide empirical evidence on the relationship between innovation and COMESA trade. Specifically, the study aimed at discussing the main factors that can drive innovation and determining the relationship between high technology exports and publications of science and technical journals and COMESA trade. In order to achieve the first objective, a comprehensive review of literature was conducted and the various drivers of innovation discussed. To achieve the second and third objectives, the study used high technology exports and scientific and technical journal publications in the gravity model for determining COMESA trade.

The discussion on determinants of innovation reveal that innovation is determined by government policy, industry characteristics, firm level characteristics and the effect of the international environment. The study concludes that these factors can be expatriated to the COMESA. The regression results show that high technology exports and science and technical journal publications positively and significantly influence COMESA trade. The GDP of COMESA and common language also positively and significantly affected trade. However, distance between the countries' capital cities negatively impacted trade.

Consequently, the study recommends that COMESA Member States institute a proper intellectual property rights regime, increase budgetary allocation to R&D, support the general business environment by reducing bottlenecks such as corruption and support universities in science and technology training. Government can also promote innovations by recognising and rewarding innovators. All these measures will enhance innovation which will in turn boost trade. Competitive markets should be encouraged as opposed to monopolies to foster innovation within COMESA. Firms need to invest in R&D, train their staff and management, provide funding for research and hire staff who are well skilled to foster STI. Firms should also be encouraged to grow in order to have sufficient resources to finance R&D in order to boost innovation and subsequently trade. Domestic economies should also be alive and open to learn from other economies across the world.

There is also need for COMESA countries to increase exports of high technology products and promote research in science and technology to increase the number of publications in scientific and technical journals in order to enhance trade.

References

Palangkaya, A. (2012). *The Link between Innovation and Export:Evidence from Australia's Small and Medium Enterprises.* Economic Research Institute of ASEAN and East Asia.

Abdu, M., & Jabir, A. (2018). Determinants of firms innovation in Nigeria. *Kasetsart Journal of Social Sciences, 39*, 448-458.

Acs, Z. J., & Audretsch, D. B. (1988). Innovation in Large and Small Firms: An Empirical Analysis. *The American Economic Review, 78*(4), 678–690.

Aghion, P., & et.al. (2014). *The Causal Effects of Competition onInnovation: Experimental Evidence.* Working paper.

Aghion, P., Bloom, P., Blundell, N., & Griffith, W. (2004). *Competition and Innovation:An Inverted U Relationship.* SSRN eLibrary.

Ahmed, P. K. (1998). Benchmarking Innovation Best Parctices: Benchmarking for Quality Management and Technology. *MCB University Press, 5*(1), 45-58.

Alinaitwe et. al. (2007). Innovation Barriers and Enablers that Affect Productivity in Uganda Building Industry. *Journal of Construction in Developing Countries, 12*(1).

Allred, B. B., & Park, W. G. (2007). The influence of patent protection on firm innovation investment in manufacturing industries. *Journal of International Management, 13*, 91-109.

Araci , O., & Gulenc , F. (2010). *Innovation Success And Firm Size: An Emprical Study In The Chemistry Industry In Turkey.* Kocaeli University, Turkiye .

Arrow , K. J. (1962). Economic welfare and the allocation of resources for invention . *Review of Economic studies*.

Azarmi, D. (2016). Factors Affecting Technology Innovation and Its Commercialisation in Firms. *Modern Applied Science, 10*(7).

Barasa et. al. (2017). Institutions, resources and innovation in EastAfrica: A firm level approach. *ResearchPolicy, 46*, 280-291.

Barney, J. (1991). Firm resources and sustained competitive advantage. *J. Manage, 17*(1), 99-120.

Bhattacharya, M., & Bloch, H. (2004). Determinants of Innovation: Evidence from Small and Medium Sized Australian Manufacturing. *Small Business Economics, 22*(2), 155-162.

Caves, R. E. (1982). *Multinational enterprise and economic analysis.* Cambridge: Cambridge University Press.

Choi, S. Y., & Lim, U. (2017). Contextual Factors Affecting the Innovation Performance of Manufacturing SMEs in Korea: A Structural Equation Modeling Approach. *Yonsei University,, 9*.

Chryssochoidis, G. (2003). Factors Affecting Product Innovations: A Literature Review. *Agricultural University of Athens, 4*(1), 47-62.

COMSTAT. (2017, February). *COMESA statistics database (COMSTAT).* Retrieved from COMESA statistics: http://comstat.comesa.int/Home.aspx.

Conte, A., & Vivarelli, M. (2013). Succeeding in Innovation: Key Insights on the Role of R&D and Technological Acquisition Drawn from Company Data. *Institute for the Study of Labor (IZA)* .

Crespi, F. (2004). Notes on the Determinants of Innovation: A Multi-Perspective Analysis. *Social Science Research Network Electronic Paper Collection*.

Dotum, F. O. (2015). The key determinants of innovation in SMEs in southwestern. *European Scientific Journa, 11*(3), 438-441.

E, M. (1981). Composition of R&D Expenditures, Relationship to Size of Firm, Concentration and Innovative Output. " *Review of Economics and Statistics, 63*(2), 610-615.

Gani, A. (2009). Technological Achievement, High Technology Exports and Growth. *Journal of Comparative International Management, 12*(2), 31-47.

Ghanbari, A., & Ahmadi, M. (2017). The Effect of Innovation in International Trade: Selected Medium-High-Technology Industries, Evidence on Iran. *Iran Economic Review*, 21-44.

Guellec, D., & Pottere, B. V. (2010). The impact of public R&D expenditure on business R & D. *Economics of Innovation and New Technology*, 225-243.

Guloglu, B., Tekin, & Baris, R. (2012). A Panel Causality analysis of the relationship among R &D, Innovation and Economic growth. *Eurasian Economic Review*, 32-47.

Hasanov, Z., Abada, O., & Aktamov, S. (2015). Impact of innovativeness of the country on export performance: evidence from Asian countries. *IOSR Journal of Business and Management, 17*(1).

Hasanov, Z., Abada, O., & Aktamov, S. (2015). Impact of Innovativeness of the Country on Export Performance: Evidence From Asian Countries. *Journal of Business and Management, 17*(1), 33-41.

Hasanov, Z., Abada, O., & Aktamov, S. (2015). Impact of innovativeness of the country on export performance:evidence from Asian countries. *IOSR Journal of Business and Management (IOSR-JBM), 17*(1), 33-41.

Hausman, A., & Taylor, E. (1978). Specification Tests in Econometrics. Econometrica, 46. *Econometrica, 46*.

Helpman, E. (1987). Imperfect Competition and International Trade: Evidence from Fourteen Industrial Countries. *Journal of the Japanese and International Economics, 1*(1), 62-81.

Hromádková, E., & Zemplinerová, A. (2012). *Determinants of innovation.* Prague Economic Papers.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics, 115*, 53-74.

Jegede , O. O., Ilori , M. O., & Sonibare, J. A. (2012). Factors Influencing Innovation and Competitiveness in the Service Sector in Nigeria: a Sub-Sectoral Approach. *Scientific and Academic Publishing, 2*(3), 69-79.

Josheski, D., & Fotov , R. (2013). Gravity Modeling: International trade and Research and Development. *Goce Delcev" University*.

Juma, C. (2016). Education, Research, and Innovation in Africa: forging Strategic Linkages for Economic Transformation. *Belfer Center for Science and International Affairs | Harvard Kenne*.

Kamien , M., & Schwartz , N. (1976). On the Degree of Rivalry for Maximum Innovative Activity. *Quarterly Journal of Economics, 90*, 245-260.

Kenya, G. o. (2007). *Vison 2030; The popular version.* Nairobi: Government Printer.

Kenya, R. o. (2008). *Science, Technology and Innovation Policy and Strategy.* Nairobi: Ministry of Science and Technology.

Knoben, J., Van-Uden, A., & Vermeulen, P. M. (2014). *Knoben, J., van Uden, A., & Vermeulen, P. M. (2014).* World Bank, Department of International Development. Human capital and innovation in developing countries: A firm level study.

Lachenmaier, S., & Woussmann, L. (2004). Does Innovation cause exports? Evidence from exogeneous innovation impulses and obstacles using German microdata. *Research gate*.

Leamer, E. E. (1995). *The Heckscher-Ohlin In Theory and Parctise.* Princeton: Princeton University.

Márquez-Ramos, L., & Martínez-Zarzoso, I. (2010). The Effect of Technological Innovation on International Trade. *Economics E-Journal, 4*.

Martinez-Ros , E. (2000). Explaining the desicions to carry out product and process innovations :The Spanish case. *The Journal Of High Technology Management Research, 10*(2), 223-242.

Mátyás, L. (1997). Proper Econometric Specification of the Gravity Model. *The World Economy, 20*(3), 363-368.

Miller , D., & Friesen, P. H. (1983). Strategy Making Environment: The Third Link. *Startegic Manegemnt Journal, 4*, 221-235.

Moser, P. (2013). Patents and Innovation: Evidence from Economic History. *Journal of Economic Perspective, 27*(1), 23-44.

Munari , F., & Sobrero , M. (2003). *Corporate Governance and Innovation.* Edward Elgar Publishing.

Ndemo, B. (2015). Effective Innovation Policies for Development: The Case of Kenya. *The Global Innovation Index 2015*, 131-137.

Nelson , R. R., & Winter, S. G. (1982). *An evolutionary theory of economic change.* Camnridge: Harvard University Press.

Nordhaus , W. D. (1969). *Invention growth and welfare.* Cambridge: The MIT Press.

Okafor, C. B., & Chukwuedo, S. 0. (2015). *The Place of Technical and Vocational Education and Training (TVET) in Science, Technology and Innovation (STI) Policy: The need for policy reformation in Nigeria.* Lagos: SVIETMAS.

Posner, M. (1961). International trade and technical change. *Oxford Economic Papers*, 323-341.

Raider, H. J. (1998). Market Structure and Innovation. *Social Science Research, 27*(1), 1-21.

Reiljan, J., & Paltser, I. (2015). The Role of Innovation Policy in the National Inoovation System: The Case of Estonia. *TRAMES, 19*(3), 249–272.

Rodriguez, L., & Rodriguez, R. (2005). Technology and export behaviour: A resource-based view approach. *International Business Review*, 539-557.

Schumpeter, J. A. (1942). *Capitalism, Socialism and Democracy.* New York : Harper & Row.

Shabbir, M. S. (2015). Innovation and Competitiveness Lead to Industirial Trade. *International Journal of Information Technology, 1*(1), 1-6.

Soloaga, I., & Winters,, L. (2001). Regionalism in the Nineties: What Effect on Trade? *North American Journal of Economics and Finance, 12*, 1-29.

Souitaris, V. (2003). Determinants of Technological Innovation Current Research Trends and Future Prospects. *International Handbook on Innovation*.

Tebaldi, E., & Elmslie, B. (2013). Does institutional quality impact innovation? Evidence from cross-country patent grant data. *Applied Economics, 45*(7), 887–890.

Tomohiko, I., Atsushi, K., & Tsutomu, M. (2008). *Do Competitive Markets Stimulate Innovation?: An Empirical Analysis Based on Japanese Manufacturing Industry Data*. Tokyo: RIETI.

Ustabaş, A., & Ersin, Ö. O. (2016). The Effects of R&D and High Technology Exports on Economic Growth: A Comparative Cointegration Analysis for Turkey and South Korea. *INTERNATIONAL CONFERENCE ON EURASIAN ECONOMIES*, 44-55.

Vernon, R. (1966). International investment and international trade in the product cycle. *Quarterly Journal of Economics, 80*, 90-207.

Verspagen, B., & Wakelin, K. (2002). *International Competitiveness and its Determinants.*

Virasa, T., & Tang, J. C. (1998). The Role Of Technology in International Trade; A Conceptual Model for Developing Countries. *The Journal of High Technology Management Research, 9*(2), 195-205.

Wakelin, K. (1998). The Role of Innovation in Bilaterla OECD trade perfomance. *Applied Economics*, 1334-1346.

World Bank Group. (2018). World Development Idicators (WDI). *Online Data Base*.

Yenilmez, I. M., & Demir, H. M. (2011). The Hecksher-Ohlin Trade Theory and Technologiocal Advantages; Evidence from Turkey. *Asian Transactions on Basic & Applied Sciences, 1*(4), 17-21.

Youndt , M. A., Snell, S. A., Dean, J. W., & Lepak , D. P. (1996). Human resource management, manufacturing strategy, and firm performance. *Acad Manage, 39*(4), 836-866.

Appendix

Appendix 1: Panel Unit Root Test –Im, Pesaran and Shin (IPS)

Variables	Levels		First difference		Conclusion
	Constant,	Constant	Constant	Constant	
	no trend	trend	no trend	trend	
LGDPj	- 0.32421	-1.16710	-5.03318*	-1.99341*	I (1)
LGDPi	-7.93066*	-3.17738*	-	-	I (0)
LHIGHT	-2.31912**	-2.12200**	-	-	I (0)
LSCIEN	0.12898	-2.82948*	-	-	I (0)
LTRD	-1.03240*	-0.91216*	-	-	I (0)
LDIST	0.19857*	-2.29908*	-	-	I (0)

*The asterisks, * and ** denote 1%, and 5% significance levels respectively. I(0) and I(1) denote integration of orders zero and one respectively. Source: Authors own computation from study data.*

The Trade-Innovation Nexus: **A Case of COMESA**

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Abstract

Having demonstrated that innovation promotes economic development, scholarly arguments posit that innovation is positively influenced not only by factors directly associated with the generation of new knowledge but also by a country's innovation environment such as openness to international trade, protection of property rights and institutions that encourage entrepreneurship. This study investigates the direction of causality in the trade-innovation nexus and thereafter the contribution of trade on innovation as measured by the number of patents & scientific journals. It employs the Negative Binomial Model (NBM) method on a sample panel of 15 COMESA Member States for the period 2000 to 2016.The results from the NBR analysis show that trade (both with the rest of the world and intra-COMESA trade), country size, income level, R&D investment and human capital are important factors in determining innovative activities in COMESA Member States. Whereas the effect of trade has a significant positive impact on innovative activities, the effects are strong with in comes to international trade but weak in intra-COMESA trade. This suggests that increases in international trade due to the growing integration of the world economy have had a positive effect on COMESA Member States' rates of innovation. These findings lead to the recommendation that COMESA Member States need to diversify by increasing openness to international trade as it contributes to a more robust level of innovativeness and hence more output in terms of patent applications and scientific journals. There is also need to carry out relevant policy reforms to support provision of quality tertiary education that will give rise to creative class of individuals in the region and promote human capital accumulation. In addition, there is need for an increase in research funding and set up incubation centers to facilitate incubation and research outputs.

1. Background to the Study

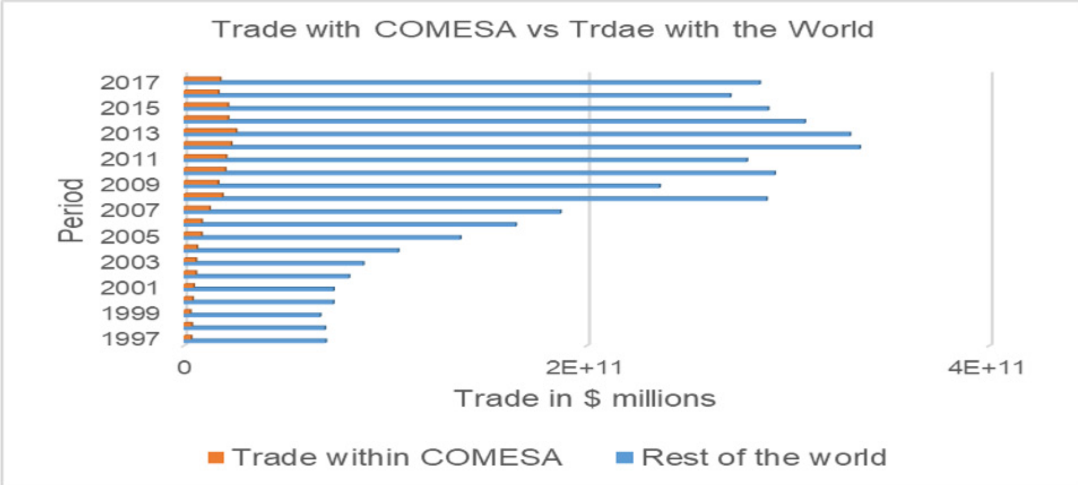
There has been a rising debate about the direction of Africa's growth that has highlighted the importance of innovation, trade and industrialization in Africa. The debate on trade-growth nexus has long existed. However, there has been renewed curiosity in the role of trade underpinned by the recent role of globalization that has been characterized by not just intensive trade integration and openness, but also linked to technological revolution (IMF, 2016). Trade is considered a major channel through which knowledge and technology transmission occurs among countries (Hakura and Jaumotte,1999); (Almeida, 2008); (Baldwin *et al*,. 2005) and (Sala-i-Martin and Barro, 1997). A large free trade area in Africa strengthens the potential for socio-economic transformation in the region by augmenting the gains from Foreign Direct Investment (FDI), as well as integrating the sources of innovation.

The pursuit of trade expansion is partly embodied in the increased creation of regional trade agreements and trading partnerships across the world (REO, 2019). Given the fiscal constraint challenges that many Less Developed Countries (LDCs) are facing around the world, trade is predicted to be a key pillar of growth and development. A discussion of the global development agenda that fails to take cognizant of the global trade dynamics is, thus, bound to be incomplete (REO, 2019). That notwithstanding, the disparity in trade impacts can easily get covered by the changing global dynamics and the overall focus on the global picture. For instance, even though the general share of developing countries in world trade has been increasing, Africa as a continent still accounts for a very low share of world trade - only 2.8% of world's exports over the decade 2000–2010 (UNCTAD, 2013). The LDCs, most of which are in Africa, remain particularly vulnerable with their share of the world exports at about 1% (Escaith and Tamenu, 2013).

COMESA countries have long taken cognizance of the importance of trade, innovation and structural transformation for sustainable growth in the region. Furthermore, public expectations from trade agreements are evolving in line with social concerns such as unemployment, sustainable development and socio-economic transformation among others. These Member States can gain from innovation spillovers generated by investments in intra-trade among themselves. Additionally, LDCs in the COMESA region stand a better chance to gain the most from their international trade relationships, since these countries can draw from the stock of knowledge already accumulated by the more advanced trading partners. However, the region has not successfully strengthened trade among its member states as compared to the region's trade with the rest of the world.

Figure 1 shows the value of trade among COMESA Member States as compared to the value of the region's trade with the rest of the world from 1997 to 2017.

Figure 1: Trade among COMESA Member States versus the Regions Trade with the rest of the World (U.S Dollars).



Source: Author's computations from Comstat database

It is clear that the region is still lagging behind when it comes to the volume of trade among themselves. For the period considered in the study, the region's trade with the rest of the world exceeds intra-trade within the COMESA region. In light of the changing global environment and the need for sustainable job creation, it is essential to consider domestic and regional economic and trade policies that will drive innovation and socio-economic transformation in the region.

There are several reasons for the weak regional trade performance in COMESA and Africa in general, one of which is that the line of attack to regional integration on the continent has mainly focused on the elimination of tariff on goods and less on the development of the productive capacities required for trade (IMF, 2016). Whereas the riddance of trade barriers is undoubtedly essential, it will not have the anticipated effect if it is not supplemented with policy measures to boost supply capacities. The limited inclusion of the private sector in regional integration initiatives and efforts has also contributed to the weak trade performance of the continent. This is because even though trade agreements are signed by governments, it is the private sector that understands the constraints facing enterprises and is in a position to take advantage of the opportunities created by regional trade initiatives.

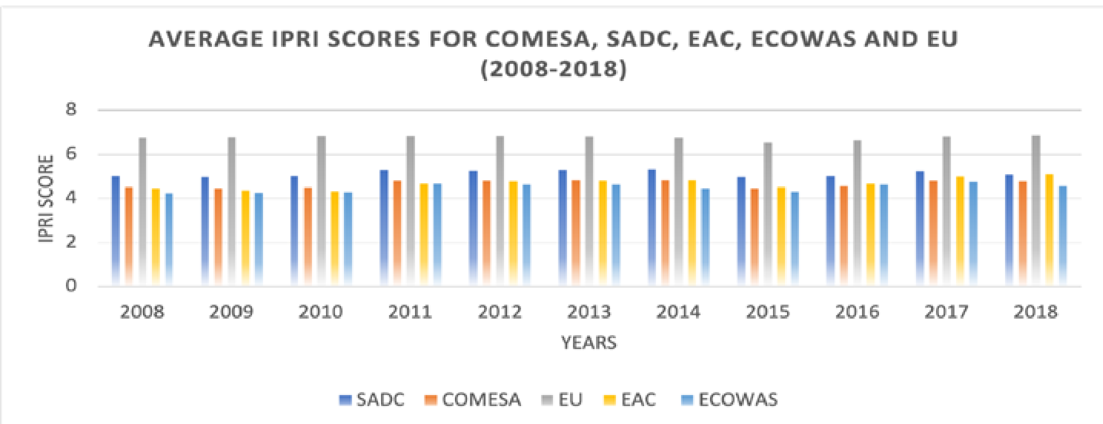
Intra-African trade has huge potential to create job opportunities, fast-track investment and foster growth in Africa (REO, 2019). Since gaining political independence in the 1960s, African governments have made numerous efforts to exploit this potential of trade for growth, the latest being the establishing the African Continental Free Trade Area (AfCFTA) at the African Union summit in March 2018. This could be a game changer for the continent as the agreement focuses on addressing nontariff obstacles to intraregional trade, and ultimately create a continental single market with free movement of labor and capital.

Hakura and Jaumotte (1999) demonstrated that it is less likely that countries in the COMESA region will close the technology gap with say Organization for Economic Co-operation and Development (OECD) through the trade channel, but more likely to close the technology gap with other less advanced countries in the vicinity of the COMESA region. Therefore, it is important to maximize on regional trade and strategize on what trade and industrial policies can be used as tools for the development of regional Research & Development (R&D) projects to create "domestic" innovations that can easily be spread across the region. The question then is, what does geography and intra-trade imply for innovation in the COMESA region?

Theoretical contributions have argued that innovation promotes economic development (Aghion and Howitt, 1992; Aghion, 2004). For instance, Aghion and Howitt (1992) introduced a model in which innovation, endogenously generated by a competitive research sector, raises productivity through a process of Schumpeterian "creative destruction" thereby promoting economic growth. The empirical arguments similarly suggest that national innovative capacity and the gains associated with innovation are important sources of economic growth (Fagerberg *et al*, 2007). Due to the beneficial role of technological progress in economic growth and development, subsequent scholarly contributions have set out to identify the determinants of innovation. These studies have found that innovation is not only positively influenced by factors directly associated with the generation of new knowledge such as R&D spending, the quality of education and specialization in industrial sectors but also by a country's innovation environment (Aghion, 2004; Varsakelis, 2006). For instance, existing research suggests that innovation may also be promoted by openness to international trade, a strong protection of property rights and sound institutions that encourage entrepreneurship (Varsakelis, 2006).

Africa and indeed the COMESA region has experienced a significant wave of globalization that has been characterized by not just regional trade integration and trade openness, but has also been accompanied with technological revolution. COMSTAT (2017) indicates that the share of international trade has grown steadily over the last three decades. Figure 2 that shows the trends in both intra-regional and extra-regional trade in the COMESA region depicts that the level of intra-COMESA trade has grown, but not as fast as the growth in COMESA's trade with the rest of the world, especially China. A contribution of t paper is to examine the trade element of a country's innovation environment. It builds on existing literature in three ways: first, since the reverse causality in the trade-innovation relationship it is not scientifically established, this study first tries to enrich the empirical literature based on the theoretical assumption of a reverse innovation-trade link. Second, the study investigates the influence of trade on innovation for 15 COMESA countries between 2000 and 2016. Lastly, this study distinguishes between the impact of trade on innovation through intra-COMESA trade and a total trade (trade with the rest of the world) effect.

Figure 2: COMESA Trade 1997-2017



Source: Comstat merchandise trade database 2018

The objective of the study is to examine the relationship between trade and innovation as measured by the number of patents and scientific journals in COMESA Member States. The specific objectives are to:

i. To establish the direction of causality between trade and innovation in COMESA Member States.
ii. Determine the contribution of trade (intra-COMESA trade and COMESA Member States' trade with the rest of the world) on innovation (Patents & Scientific Journals).

2. Overview of Trends and Composition of Intra-COMESA Trade

The level of intra-COMESA trade has grown, rising from $3.5billion in 1997 to $25.8billion in 2013, but thereafter it gradually fell to 18billion in 2017 (see figure 2). It experienced positive growth in all years except for 1999 and 2009. Such negative growth trends corresponded with world recessions, indicating a possible sensitivity of intra- COMESA trade to world economic conditions. However, after 2013, the declining numbers can be attributed to a faster rate of growth in COMESA's trade with the rest of the world, especially China rather than to a slowdown in intra-African trade per se (REO, 2019). For instance, from 2012 to 2017, intra-COMESA trade averaged $21.3billion but COMESA's trade with China averaged $36.3billion for the same period.

When it comes to intra-trade of other regional economic communities[7], it is clear from Table 1 below that with the exception of the ECCAS, African regional economic communities tend to undertake a significant part of their trade within their own regional trade blocks. This confirms that the formation of regional blocs in Africa has facilitated the creation of trade among its member countries (Cernat, 2001).

Table 1: Intraregional Trade by different Regional Groups, 1997–2017 US$ Millions)

Intraregional Exports and Imports, 1997-2017								
	Total Exports ($ millions)				Total Imports ($ millions)			
	1997-01	2002-06	2007-11	2013-17	1997-01	2002-06	2007-11	2013-17
AMU	558.2	1,254.7	3,550.3	3,622.1	595.3	1,704.6	2,975.4	3,008.2
CEN-SAD	944.1	2,090	5,847	5,328	787	2,011	4,442	4,704
COMESA	2,040.5	3,423	9,122	10,490	3,207	3,691	8,879	10,850
EAC	732	1,266	2,293	3,612	600	1,089	2,625	3,519
ECCAS	337	480	1,373	2,004	209	192	956	1,624
ECOWAS	78	194	599	686	77	169	280	409
IGAD	708	1,289	3,218	3,986	651	1,235	2,551	3,247
SADC	2,176	3,720	7,213	12,201	4,216	5,918	12,852	15,783

Source: UNCTADstat database

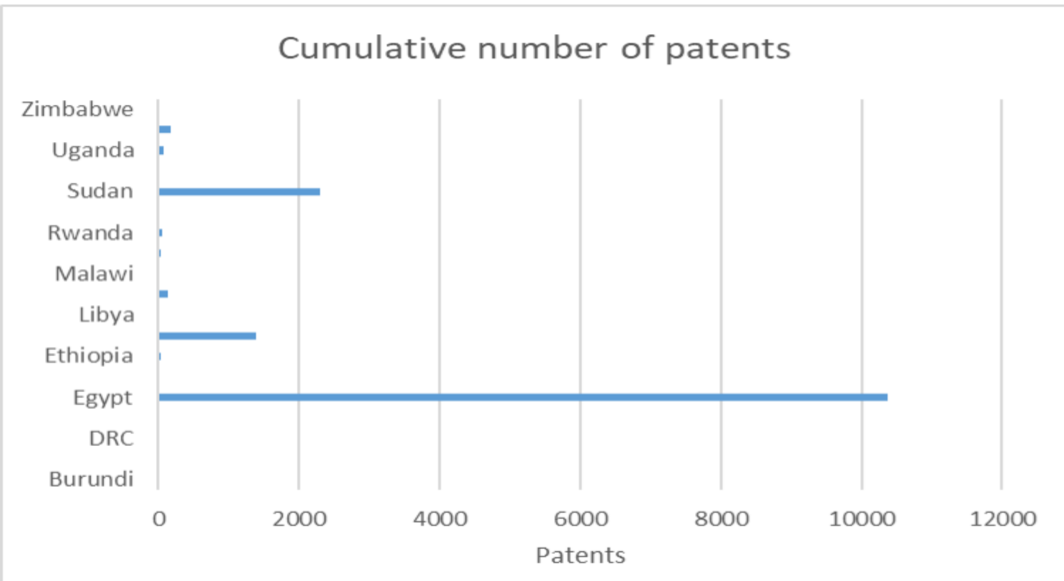
7 AMU - Arab Maghreb Union, CEN-SAD - Community of Sahel-Saharan States, EAC - East African Community, ECCAS - Economic Community of Central African States, ECOWAS - Economic Community of West African States, IGAD - Intergovernmental Authority on Development and SADC - Southern African Development Community.

From Table 1, it can also be observed that of all eight African regional economic communities, the share of exports and imports was highest, and on an ascending trend in EAC and SADC respectively. However, UNCTAD (2013) reported for example that, due to a nonexistence of factories and capacity limitations at home countries, some African countries such as Nigeria export crude oil and then import refined oil. As a result, such infrastructure bottlenecks could be impeding intra-trade opportunities in Africa when it comes to the fuels sector. COMESA Member States can capitalize on intra-trade opportunities by tackling nontariff bottlenecks which includes strategic investments to improve domestic refinery facilities, education and skills development, economic reforms among others.

Patents and Economic Growth in COMESA.

The paper also considered the state of play of patents in COMESA. Figure 3 shows that COMESA Member States have patents, which demonstrates that knowledge is being produced. New knowledge (both internal knowledge generated within the region and external knowledge flowing into the region) is imperative in providing the base for innovative products. Innovations are manifested by the number of patents. However, the number of patents in African countries remains low compared to Organization for Economic Co-operation and Development (OECD) countries (Bansi, R., 2016). This can be attributed to lack of prioritization and inadequate provision of infrastructure services such as Technology Transfer Offices (TTOs) and Innovation Incubation Facilities (IIFs).

Figure 3: Cumulative Number of Patents for COMESA Member States



Source: World Intellectual Property Organization

It is envisaged that the role of intra-COMESA trade as stipulated in COMESA Member States' economic policies, is to gear these policies to price stability, balanced growth, rising and converging standards of living, high employment and external equilibrium. The COMESA region has also focused on strengthening business linkages and intra-regional trade in the COMESA-EAC-SADC tripartite region through the Local Sourcing Project for Partnerships, and most recently the AfCFTA. This will provide COMESA Member States with an opportunity to further improve regional integration that will churn out the required fiscal revenue, leading to enhancement of welfare and income distribution.

3. Review of Literature

3.1 Theoretical Review

Recent developments in the theory of international trade and economic development have identified several channels through which productivity of countries are interrelated (Grossman and Helpman, 1991). Four channels stand out in particular. First, international trade enables a country to employ a large variety of intermediate products and capital equipment which enables the productivity of its own resources. These inputs can be complementary to each other, or they can differ in quality and vertically differentiated. Second, international trade provides a channel of communication that stimulates cross-border learning of production methods, product design, organizational methods and market conditions. Third, it enables a country to copy foreign technologies and adjust them to domestic use. Finally, international trade can raise a country's productivity in the development of new technologies thereby indirectly affecting the productivity level of its entire economy.

For a country to gain from international trade in these ways, it needs to have trade partners that are capable of providing it with products and information in which it is in short supply. This depends on the trade partner's accumulated knowledge that is embodied in its products and technologies. Thus, by trading with countries that have larger stocks of knowledge, a less developed country stands to gain in terms of both the products it imports and direct knowledge it can acquire by trading.

The empirical equations in this study are based on the model developed by Grossman and Helpman (1991) that relates technology diffusion to trade patterns. Their assumption is that technology diffuses as better inputs, developed and produced in the inventing country are exported for use in production in other countries. Consider a world consisting of n = 1,...,N countries. Output in country n (Y_n) is produced by combining intermediate inputs subject to a contant-returns-to-scale Cobb Douglas production function,

$$\mathrm{Ln}(Y_{nt}/J) = J^{-1}\int_0^J \ln\left[Z_{nt}(j)\, X_{nt}(j)\right]d_j \qquad (1)$$

Where $X_{nt}(j)$ is the quantity of input j produced at time t in country n and $Z_{nt}(j)$ is the quality of that input. The range of inputs is assumed to be fixed over time and the same across countries. Output is homogeneous and tradable across countries while inputs are nontraded. Units are chosen such that to produce any input at rate x requires labour services at rate x. Output expands as the quality of (Z) improves. To keep track of this process, the aggregate index of technology, which is closely related to labour productivity, in country n is defined as;

$$\mathrm{Ln}(A_{nt}) = J^{-1}\int_0^J \ln\left[Z_{nt}(j)\right]d_j \qquad (2)$$

The quality of inputs rises due to invention. If an invention is adopted domestically, the quality of a specific input increases by a given percentage, a step size, which takes on a random variable Q drawn from the exponential distribution such that Pr [Q<q] = 1 - $e^{(-\theta_q)}$. The average inventive step of domestic inventions is therefore $\frac{1}{\theta}$. An invention of size q applicable to input j raises the quality of that input from Z(j) to Z'(j) = $e^q Z(j)$. The size of the invention is allowed to be stochastic rather that deterministic to allow for heterogeneity in patenting decision. Letting ε_{nit} be the marginal probability that an invention that occurred in country i at time t be applicable in country n, these parameters empirically represent international technology diffusion.

From the theory of technological catch-up by Eaton and Kortum (1994), it is assumed that a larger inventive step is a technologically less advanced country. Therefore, the step size of an invention from country i, adopted in country n, is drawn from the exponentioal distribution with parameter θ $(\frac{A_i}{A_n})^{-w}$ Q, where w>0. This gives rise to the invebtion in the adopting country being estimated as Q_{ni} = $(\frac{A_i}{A_n})^{w}$ Q, depending on its relative productivity.

The model further assumes that research workers are drawn from the same distribution of talent in each country and that they engage in R&D activity. The distribution is such that R_i workers doing research out of a total workforce of L_i in country i, then the rate of producing inventions is $\alpha R_i^{\beta} L_i^{1-\beta^{\alpha}}$, where α and β are parameters. Ideas thus flow into country n from country i at time t at a rate $\alpha \varepsilon_{nit} R_{it}^{\beta} L_{it}^{1-\beta}$ where the mean step of these inventions is $\frac{(\frac{A_i}{A_n})^{w}}{\theta}$.
Given the rate at which ideas from around the world penetrate country n and the average inventive step of these ideas, the country's growth rate g_{nt} is:

$$g_{nt} = \frac{\dot{A}_{nt}}{A_{nt}} = \frac{\alpha}{J\theta} \sum_{i=1}^{N} \varepsilon_{nit} R_{it}^{\beta} L_{it}^{1-\beta} \left(\frac{A_i}{A_n}\right)^{w} \qquad (3)$$

Consider a situation where ε_{ni}, R_{it} and L_{it} are constant over time for all countries, defining the variable $\mu_{nt} = A_{nt}^{w}$, we can state the dynamics of productivity growth among N countries in terms of a system of linear differential equations as:

$$\dot{\mu} = \Delta\mu \qquad (4)$$

Where Δ has a typical element:

$$\delta_{ni} = \frac{w\alpha}{J\theta} \varepsilon_{nit} R_{it}^{\beta} L_{it}^{1-\beta}$$

As in Grossman and Helpman (1991), bertrand competition allows the owners of an invention to charge the highest price at which production without that invention is unprofitable. Let A_{nt} denote the wage in country n at time t. A firm producing an input with invention of size q in country n at time t will charge p_{nt}= $e^{q} w_{nt}$. Total purchases of new input are $\frac{Y_{nt}}{Jp_{nt}}$. Given the pricing equilibrium, the profit accruing to the owner of the invention of size q in country n at time t is $\pi_{nt}(q)$ = (1 - e^{-q}) $\frac{Y_{nt}}{J}$.

An inventor earns the profit generated by their invention in a country as long as it is adopted there and has not been imitated or rendered obsolete by a more advanced technology. Assuming inventions are imitated at a rate that depends on whether the inventor has a patent in that country, we denote the hazard od imitation of the idea from country i in any country n as i_{ni}^{pat} if it was patented and i_{ni}^{not} if it was not. For a patent in country n to have any value to an inventor from country i requires that $i_{ni}^{pat} < i_{ni}^{not}$.

The hazard of obsolescence depends on the rate of inflow of ideas into a country and the probability that they will apply to a given industry. The steady state of obsolescence in country n is thus:

$$o_n = \frac{\alpha}{J} \sum_{i=1}^{N} \varepsilon_{nit} R_{it}^{\beta} L_{it}^{1-\beta} = \theta g_n - \frac{\alpha}{J} \sum_{i=1}^{N} \varepsilon_{nit} R_{it}^{\beta} L_{it}^{1-\beta} \left[\left(\frac{A_i}{A_n}\right)^{w} - 1\right]$$

In steady state, the hazard of obsolescence is lower in countries with a lower level of technology since these countries obtain fewer inventions. If the expected value at time t of an invention from country i of size q that is applicable to country n is $V_{nit}(q)$, the probability of it not becoming obsolete by time s > t is $e^{-o_n(s-t)}$, while the probability of it not having been copied by then is $e^{-i_{ni}^{k}(s-t)}$ where k ϵ {pat,not} depending on whether or not the invention was patented. Therefore:

$$V_{nit}^{k}(q) = \int_{0}^{\infty} \pi_{nt+s}(q)\, e^{-(r+i_{ni}^{k})s}\, e^{-o_n(s-t)}\, ds = \frac{(1-e^{-q})Y_{nt}}{J(r+\, i_{ni}^{k} +\, 0_n - g)}$$

Here again k = pat if the idea was patented and k = not if otherwise, and r is the discount rate which is treated as constant over time. A patent gives the inventor incremental benefit of a lower hazard of imitation and therefore it is worth $V_{nit}^{pat}(q)$ - $V_{nit}^{not}(q)$. Hence, if it costs an inventor from country i c_{nit} to patent in country n then the inventor will seek patent protection in that country if $V_{nit}^{pat}(q)$ - $V_{nit}^{not}(q)$ exceeds c_{nit} and not otherwise. The returns to patenting increases with the quality of the invention q. Hence the condition:

$$V_{nit}^{pat}(q) - V_{nit}^{not}(q) = c_{nit} \qquad (5)$$

Determines a threshold of quality level q_{nit} such that inventions of higher quality are patented. With constant output growth and constant rate of arrival of inventions, the equation for the quality threshold is:

$$q_{nit} = -\ln[1 - \frac{J(r + i_{ni}^{pat} + 0_n - g)\,(r + i_{ni}^{not} + 0_n - g)}{i_{ni}^{not} - i_{ni}^{pat}}\,(\frac{c_{nit}}{Y_{nt}})]$$

Given this threshold and the distribution function for the inventive step, inventors from country i choose to seek protection in country n on a fraction of these inventions given by:

$$f_{nit} \equiv e^{-\theta\left(\frac{A_i}{A_n}\right)^{-w} q_{nit}} = \left(\max\left\{1 - \mathcal{y}_{ni}\frac{c_{nit}}{Y_{nt}}, 0\right\}\right)^{\theta\left(\frac{A_i}{A_n}\right)^{-w}} \qquad (6)$$

Where $\mathcal{y}_{ni} \equiv \frac{J(r+i_{ni}^{pat}+0_n-g)\,(r+i_{ni}^{not}+0_n-g)}{i_{ni}^{not}-\, i_{ni}^{pat}}$. Therefore the number of patent applications from country i for protection in country n, p_{nit} is:

$$p_{nit} = \alpha\varepsilon_{nit} R_i^{\beta} L_i^{1-\beta} f_{nit} \qquad (7)$$

The patent equation (7) can be approximated without solving for the model's implications for growth and technology levels. In order to obtain an equation that is linear in logs, we take a first order approximation to $\ln f_{ni}$ and apply the approximation to equation (7) and impose constant returns to scale in the production of ideas. Other determinants of patent applications may also be introduced into the equation at shown in the preceding chapter.

3.2 Empirical Review

Several studies have been done on the relationship between trade and innovation and technology transfer. This section presents a review of studies done to evaluate these relationships on both developed and developing countries.

Akcigit et al., (2018) employed open-economy general equilibrium framework of endogenous growth and trade to evaluate the effectiveness of innovation and trade policies in improving the competitiveness of U.S. firms. Findings suggested that increased and thus foreign competition, encourages more domestic innovation through stronger incentives for defensive and expansionary R&D. However, in the medium and long term, trade openness generates welfare losses due to retaliation from the foreign economy.

Bloom *et al*., (2016) used the outcomes of a survey of up to half a million firms across twelve European countries for the period 1996 to 2007 to examine the impact of Chinese import on patenting, Information Technology (IT), R&D and Total Factor Productivity (TFP). By estimating the two instrumental variable (IV) method to control for endogeneity, they found that TFP, patenting, R&D and IT have risen in firms that were more exposed to increases in Chinese imports. They further found in sectors that were more exposed to Chinese imports, employment fell in low-tech firms as compared to high-tech firms. By contrast, import competition from developed countries had no effect on innovation.

Mold and Mukwaya (2016) analysed the the economic impact of the proposed COMESA-SADC-EAC Tripartite Free Trade Area (TFTA) on 26 African countries. By using Computable General Equilibrium (CGE) model, he measured the effects of the establishment of the TFTA on manufacturing GDP, trade flows and consumption in the TFTA. Results suggested that a boost to intra-regional trade of nearly a third (29.2%), particularly intra-trade in manufacturing and processed foods. This reinvigorates the role of regional integration as an key engine of industrialisation (UNECA, 2015).

UNECA (2016) analysed the role of trade and R&D spillovers in transferring technology within the EAC. The results showed that total production in the EAC would increase as a consequence of the productivity changes with the spillover effects. The study goes a step further to recommend ways in which regional intergration can be enhanced to further trade which would in turn result to R&D spillovers. These included increasing collaboration in joint R&D projects in key sectors such as agriculture and manufacturing.

Tavassoli and Carbonara (2014) investigated the role of knowledge (both internal knowledge generated within the region and external knowledge flowing into the region) through trade in explaining regional innovation, as measured by patent applications in 81 regions in Sweden for the period 2002-2007. The analysis that utilized the negative binomial regression model, provides evidence that both the variety and intensity of internal and external knowledge matter for regions' innovation. When it comes to variety, related variety of knowledge plays a superior role. This implies that having related industries within a region enhances the regional innovation as a result of knowledge spillover occurring between those related industries. Hence, regions need to develop the range of complementary sectors.

The study by Meierrieks (2014) investigated the effect of financial development on innovation for 51 countries between 1993 and 2008. Consistent with expectations from Schumpeterian models of finance, entrepreneurship and economic growth, the study finds that higher levels of financial development coincide with stronger innovative activity. Further, banking crises does not matter in the finance-innovation nexus. In summary, findings suggest that financial intermediaries may indeed encourage investment in innovative entrepreneurial activity. Thus, economic policies that strengthen a country's financial system may also improve its innovative capacity, which in turn promotes economic growth.

According to Eaton and Kortum (2006), in the absence of any technological diffusion at all, countries devote the same share of resources toward research and innovation regardless of the volume of trade activities. The study which employed a dynamic Ricardian model we examine the effects of faster international technology diffusion and lower trade barriers on the incentive to innovate argues that openness to trade does not alter research specialization. This implies that given that the level of trade activities, faster diffusion shifts research activity toward the country that does it better.

Brazil's trade liberalization in the early 1990s presents a focused policy experiment to trace effects of trade on productivity change. Using a sample of 9,500 medium-sized to large Brazilian manufacturers is followed over the period from 1986 until 1998, Muendler (2004) finds that foreign competition pressures firms to raise productivity significantly, whereas the use of foreign inputs plays a minor role for productivity change. Furthermore, he finds that the probability of shutdown of inefficient firms rises with competition from abroad, thus contributing positively to aggregate productivity.

Furman *et al* (2002) analyzed the determinants of country-level production of international patents in an attempt to explain the differences in innovation intensity across advanced economies using 17 OECD countries from 1973 to 1996. The study found that, while a great deal of variation across countries is due to differences in the level of inputs devoted to innovation (R&D manpower and spending), an extremely important role is played by factors associated with differences in R&D productivity (policy choices such as the extent of IP protection and openness to international trade, the share of research performed by the academic sector and funded by the private sector, the degree of technological specialization, and each individual country's knowledge "stock"). Furthermore, national innovative capacity influences downstream commercialization, such as achieving a high market share of high-technology export markets.

Eaton and Kortum (2002) used a Ricardian trade model to analyse the role of trade in disseminating the gains of new technology in 19 OECD countries and found that trade allows a country to gain from foreign technological advances through spillover effects. However, the extent of the benefits from foreign innovations was dependent on the country's proximity to the innovating country. This implied that geography was important for foreign R&D to be effective through the trade channel.

Hakura and Jaumotte (1999) found that intra-industry trade was more effective than inter-industry trade for technology transmission because countries were more likely to absorb foreign technologies when their imports were from the same sectors as the products they produced. Furthermore, the distribution of technology imports has implications for R&D in the region because geography and distance matter for the intensity of foreign spillovers. Their study focused on a panel of 87 countries over the period 1970 to 1993, of which 20 were Sub-Saharan African countries. Hakura and Jaumotte (1999) demonstrated that it is less likely that countries in the COMESA region will close the technology gap with say, OECD through the trade channel, but more likely to do so with other less advanced countries in the region. Therefore, it is important to maximize on regional trade and strategize on what industrial policies can be used as tools for the development of regional R&D projects to create "domestic" innovations that can easily be spread across the region. The question then is, what does geography and intra-trade imply for innovation in the COMESA region?

Coe, Helpman, and Hoffmaister (1997) studied empirically the role of trade as a measure of diffusion. They found that total factor productivity in a panel of seventy-one developing countries is significantly related to the stock of R&D carried out by trading partners. In their analysis, trade, particularly the imports of machinery and equipment, facilitates the diffusion of knowledge.

3.3 Overview of Literature

Several studies have been done on the relationship between trade and competition, innovation and technological spillovers (Bloom *et al*,. 2016; Eaton and Kortum, 2002; Hakura and Jaumotte, 1999). Most of these studies focused on establishing the channels through which trade contributes to innovation and productivity among firms. The studies differ greatly in terms of the sample countries used (developed, developing or emerging), model specification (the explanatory factors included) and how the key variable, trade is represented.

However, few studies have investigated the "two-way" link between trade and innovation in Sub-

Saharan Countries. Therefore, the study contributes to the existing body of knowledge by examining the direction of causality in the trade-innovation. In addition, the study separates the impact of the two types of trade i.e. intra-regional trade and trade with the rest of the world.

4. Methodology

4.1 Research Design

The study used a non-experimental causal design involving panel data for the period 2000 to 2016 for 15 COMESA Member States[8]. The choice of the starting period was determined by the availability of data for most of the countries. The data unavailability issue also resulted in four COMESA countries being dropped from the sample[9]. The main sources of data were World Bank Database, the COMSTAT, the UNCTAD database and the African Development Bank. The data for patents was obtained from World Intellectual Property Organization (WIPO) Database.

4.2 Empirical Model

To achieve objective one, the study assessed if there exists a two-way causation between innovation activities and trade. The Granger causality test will answer the following question: is it trade that causes, in the Granger sense, patent applications/scientific journals or not? More generally, trade is said to Granger cause patent applications/scientific journals if, given the past values of patent applications/scientific journals, past values of trade are useful to predict patent applications/scientific journals.

In dealing with panel data analysis, the cross-sectional variation is a crucial issue; this type of variation may be addressed with a fixed effect model. Dumitrescu and Hurlin (2012) proposed a Granger test for heterogenous panel data models. However, it requires a strongly balanced panel, which is not the case as the study's sample is highly unbalanced. In this case, a basic *k*-variate panel Vector Auto Regression (VAR) of order *p* with panel-specific fixed effects represented by equation 8 is estimated.

$$Y_{it} = A_1 Y_{it-1} + A_2 Y_{it-2} + \cdots + A_{p-1} Y_{it-p+1} + A_p Y_{it-p} + BX_{it} + \varepsilon_{it} \quad (8)$$

Where i=1,...,15 and t=1,...,17, Y_{it} is a 1xk vector of dependent variables, X_{it} is a 1xk vector of exogenous covariates, ε_it is a vector of the dependent variable-specific fixed-effects and idiosyncratic errors and the (kxk) matrices $A_1, A_2, ..A_{p-1}, A_p$ and B are parameters to be estimated.

Thereafter, a post-estimation Granger causality Wald tests is done for each equation of the underlying panel VAR model as proposed in (Abrigo and Love, 2016). The results from the Granger Non-causality tests are presented in Table 5. Once the direction of causation is verified, the study can then investigate the relationship that exists between innovation and trade as discussed in the following paragraph.

The empirical model of the study employs innovation, as measured by the number of patent applications and scientific journals as the dependent variable. On the other hand, the trade variables are the independent variables of interest. The model further includes a group of other explanatory variables which, based on literature review, are assumed to affect innovation activities. Inclusion of these variables is important as it helps in minimizing specification bias particularly the omitted variable bias (Gujarati, 2009).

Henceforth, to estimate equation (7) that investigates the relationship between innovation and trade,

8 Burundi, Congo Democratic Rep., Egypt, Ethiopia, Kenya, Libya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Sudan, Eswatini, Rwanda and Zambia.

9 Comoros, Djibouti, Eritrea and Zimbabwe.

a Poisson model is applied. The estimator is selected because the dependent variable is count data (Cameron and Trivedi, 2010). Using the Poisson regression model, the general specification for is written as follows:

$$Pr(y_{it} = \widetilde{y_{it}}) = \frac{e^{(-\lambda_{it})}\,(\lambda_{it})^{y_{it}}}{y_{it}!} \qquad (9)$$

Where y_{it} is the number of patent applications/scientific journals in country i in year t and λ_{it} is the intensity/rate parameter given by:

$$\lambda_{it} = \exp(\beta_j X_{it}) \qquad (10)$$

Where X_{it} is the vector of innovation inputs such as trade and R&D investments and β_j, are the coefficient parameters to be estimated. However, a Poisson model requires equality of the mean and variance of the intensity parameter in equation 10. This is a restrictive property and often fails to hold in practice, i.e. there is over dispersion in the data. In this case, the Negative Binomial Model (NBM) is employed. Combining equations 9 and 10, the NBM is specified as follows:

$$Pr(y_{it} = \widetilde{y_{it}} \mid trade_{it}, X_{it}, \varepsilon_{it}) = \frac{e^{(-\lambda_{it})} \text{ x } (\lambda_{it})^{y_{it}}}{y_{it}!} \qquad (11)$$

$$\widetilde{y_{it}} = 0,1,2,3,..,\qquad i = 1,2,\ldots..,15;\ t = 1,2,\ldots\ldots.,17$$

Where, $\lambda_{it} = \exp(\beta_1 trade_{it} + \beta_j X_{it})\ \exp(\varepsilon_{it})$ and ε_{it} is the error term. $\exp(\varepsilon_{it})$ is assumed to have a gamma distribution with mean 1 and variance alpha which is the also the over dispersion parameter that corrects for over dispersion by adjusting the variance independently from the mean (Cameron and Trivedi, 2010).

The control variables included in vector **X** are: (i) R&D investments (rd) to capture the intensity of internal knowledge; (ii) average years of schooling and returns to education[10] (*hc*) which is used as a proxy for human capital to accounts for the effect of education and skills development on innovation; (iii) population size (pop) which is included to control for the country size; (iv) high-technology exports as a ration of manufactured exports, as a measure of global competitiveness; (v) institutional quality as proxied by governance index, to capture the effect of the general leadership and policy environment on innovation; and (vi) GDP per capita as a proxy for the income level. All the explanatory variables are expected to have a positive sign as they are hypothesized to contribute to innovation.

4.3 Estimation Technique

The choice of the estimation method is guided by the nature of the dependent variables. The dependent variables, patent applications and number of scientific journals are count data. The model also suffers over-dispersion as the sample variance and mean are not equal as shown in the descriptive statistics in Table 2. In order to handle such a situation, literature suggests various models including the negative binomial model and Zero-Inflated Negative Binomial (ZINB). If the dependent variable has many zero values, the ZINB is preferred to the NBM[11].

10 The human capital index by Penn World Tables is based on the average years of schooling from Barro and Lee and an assumed rate of return to education, based on Mincer equation estimates around the world. It is an advancement of the human capital index data initially developed by Barro and Lee

11 Even if there would be many zero values in the data, it does not necessarily mean that ZINB is the best option (Cameron and Trivedi, 2008), since it must be possible to distinguish between true zeros and excess zeros. The method of distinguishing these two zeros is not clear in patent applications and hence it is plausible to compare both results.

5. Estimation and Discussion of Results

5.1 Descriptive Statistics

Descriptive characteristics summarize the data for the 15 COMESA Member States for the period 2000 to 2016. The variables employed in the main model include: number of patents (*pat*), number of science and technology journals (*joun*), trade as a ratio of GDP (*tradegdp*), exports as a ratio of GDP (*expgdp*), imports as a ratio of GDP (*impgdp*), intra-COMESA imports (*intraimp*), intra-COMESA exports (*intraexp*), intra-COMESA trade (*intratrade*), population size (pop), human capital index (*hc*), high-technology exports as a ratio of manufactured exports (*hightech*), research and development expenditure as a ratio of GDP (*rd*) and real GDP per capita (*gdppc*).

The summary statistics of these variables are presented in Table 2 displaying the mean, standard deviation and number of observations of each variable. The results show that the patent applications and science & technology journals averaged 114 and 604 respectively while trade and intra-COMESA trade averaged 73.3 percent of GDP and 735 million US $ respectively.

The number of patent applications and science & technology journals had a standard deviation of 210 and 1731 respectively while trade and intra-COMESA trade had a standard deviation of 44.6 percent of GDP and 880 million US $ respectively. A large standard deviation implies that the countries in the sample are non-homogeneous and thus there may be issues of convergence of this group of countries.

Table 2: Descriptive Statistics

Variables	Mean	Std. Deviation	Min	Max	Obs
Pat	114.27	209.74	1	918	114
Joun	604.25	1731.62	2.5	10807	210
Tradegdp	73.28	44.62	15.06	225.02	255
Expgdp	32.49	23.13	4.69	108.00	244
Impgdp	40.56	22.06	10.92	117.15	244
Intratrade	735M	880M	14.3M	4.64B	255
Intraimp	364M	441M	283333	2.80B	255
Intraexp	371M	539M	625258	2.48B	255
Pop	26.9M	27.6M	81131	104M	255
Hc	1.77	0.34	1.21	2.60	165
Rd	0.28	0.17	0.01	0.79	81
Hightech	5.36	9.00	0.00	83.64	186
Gdppc	6057.96	7413.50	545.30	29493.86	255

Source: Author's computation from the study data

5.2 Unit Roots Test Results

Unit roots tests were carried out using Fisher's Phillips-Perron (PP) methods and the results are presented in Table 3 below. The Fisher's PP type test is preferred as it allows for gaps in the panel data and it is more robust compared to Augumented Dickey Fuller (ADF) Fisher's type test because it takes care of serial correlation that may arise as the process uses lags of the variables. The tests were carried out both with and without trend. The PP unit root test results showed stationarity without a trend at 1% and 5% levels of significance for all the variables.

Table 3: Panel Unit Root Test

Variables	**Phillips-Perron (PP) test**		**Remarks**
	Levels		
	Constant	**Trend**	
	Statistic	*Statistic*	
Pat	40.4014***	84.3162***	Stationary
Joun	12.9555	56.7699***	Stationary
Expgdp	44.7507**	54.2340***	Stationary
Impgdp	42.3131*	51.9487***	Stationary
Tradegdp	44.1777**	44.3940**	Stationary
Intratrade	40.8556*	61.1295***	Stationary
Intraexp	44.0739**	59.2036***	Stationary
Intraimp	44.4185**	69.7255***	Stationary
Pop	89.7116***	110.5056***	Stationary
Hc	40.8697***	33.9440**	Stationary
Rd	64.5144***	62.6185***	Stationary
Hightech	109.0099***	91.5508***	Stationary
Gdppc	40.8721*	50.5315***	Stationary

*Note: The asterisks *, ** and *** denote levels of significance at 10%, 5% and 1% respectively.*

5.3 Granger Causality Test

To address objective one, the study estimates equations 12 to check if there is a two-way causation between innovation and trade. A post-estimation command *pvargranger* performed Granger causality Wald tests for the underlying panel VAR model and the results are as presented in Table 4. The results are under the null hypothesis that the excluded variable does not Granger-cause the equation variable. From the results, there is evidence of a bidirectional relationship, albeit not robust, between innovation and trade. This implies that trade granger-causes the number of patent applications and scientific journals and the number of patent applications and scientific journals also granger-causes trade. However, the results show that there is a unidirectional relationship between intra-COMESA trade and innovation was found, i.e. it was found that intra-COMESA trade granger causes the number of patent applications and scientific journals but the of patent applications and scientific journals does not granger cause intra-trade.

Table 4: Granger Causality Wald Tests Results

Equation\Excluded	*Prob > chi2*	*Equation\Excluded*	*Prob > chi2*
Patents		Patents	
Trade/GDP	2.847*	Trade/GDP	10.757***
Imports/GDP	0.205	Imports/GDP	3.086*
Exports/GDP	1.262	Exports/GDP	5.935**
Intratrade	5.900**	Intratrade	1.105
Intraimports	7.194***	Intraimports	0.167
Intraexports	6.250**	Intraexports	1.408
Equation\Excluded	*Prob > chi2*	*Equation\Excluded*	*Prob > chi2*
Journals		Journals	
Trade/GDP	4.089**	Trade/GDP	1.334
Imports/GDP	0.591	Imports/GDP	4.896**
Exports/GDP	3,234*	Exports/GDP	0.015
Intratrade	12.10***	Intratrade	0.199
Intraimports	7.203***	Intraimports	0.082
Intraexports	9.022***	Intraexports	3.030

*Significant coefficients are indicated by * (10% level), ** (5% level) and *** (1% level).*

These findings imply that the regression specified in equation 16 can be estimated to examine the impact of trade on innovative activities. In order to correct for potential endogeneity and the presence of reverse causality between innovation and trade, lagged forms of the trade variable are employed and the results are discussed below.

5.4 Discussion of Negative Binomial Regression Estimation Results

The second objective of the study was to determine the contribution of trade on new knowledge and innovation (patents & science and technology journals). The results of the Negative Binomial Regression (NBR) Estimation are presented in Table 5. The first two models (Columns 1 and 2) consider patent applications as the proxy for innovation while the last two models (Columns 3 and 4) consider the number of scientific and technology journals as the proxy for innovation. Furthermore, the key variable trade is specified both as trade with the rest of the world (herein referred to as *tradegdp*) and intra-COMESA trade (herein referred to as *intratrade*) to distinguish the effects of each.

The results show that the Wald x2 statistics for all the regressions are highly significant indicating the joint significance of the explanatory variables. The Likelihood-Ratio (LR) test of panel versus pooled is statistically significant across all the models hence proving the suitability of the panel application of negative binomial model. In addition, the LR test of including alpha, the over-dispersion parameter, is statistically significant across the models therefore showing that the negative binomial is a preferred estimation over the Poisson or Zero-Inflated Poisson Model.

Table 5: Negative Binomial Regression Results

Dependent variable	Number of Patents	Number of Patents	Number of journals	Number of journals	
Intratrade	-2.0682			0.2650***	
	(1.60)			(5.27)	
L.intratrade	0.5976***				
	(2.62)				
Intraimports	0.9488		-0.2886***		
	(0.96)		(5.81)		
Intraexports	0.9335**			0.0878***	
	(2.07)			(2.50)	
Tradegdp		-0.0045			0.0087***
		(1.29)			(5.98)
L.tradegdp		0.0223**			
		(2.35)			
Importsgdp		-0.0262***		-0.0179***	
		(3.07)		(3.70)	
Exportsgdp		0.0220*		-0.0120***	
		(1.94)		(6.87)	
Population size	0.5443	1.0075***		1.3523***	1.7894***
	(1.52)	(11.14)		(17.29)	(13.09)
Human capital	5.9260**	1.0138*		0.4266	-0.3904
	(2.51)	(1.87)		(0.63)	(1.29)
R&D expenditure	0.8742**	2.1966***	0.8344***		-0.0630
	(1.96)	(3.77)	(6.20)		(0.98)
Hightech manufactured goods	-0.0229	0.0079***		0.0028***	0.0010***
	(1.36)	(4.18)		(3.06)	(3.66)
Real GDP per capita	1.362***	0.8139**		1.2535***	2.3392***
	(3.70)	(2.00)		(4.98)	(9.48)
Constant	-21.785***	-21.717***	-29.404***		-41.53***
	(2.86)	(7.32)	(10.38)		(12.23)
Observations	125	115		210	231
Wald x2 Test	93.19***	1434.14***		1945.80***	5537.94***

LR test vs. pooled	10.14***	0.27	141.4*** 139.4***
LR Test of Alpha = 0	219.98***	224.67***	230.99*** 225.7***

Source: Author's Computation using STATA 14

*Note: The t statistics are in parenthesis. Levels of significance: *** 1 %, ** 5 % and * 10%.*

The results indicate a statistically insignificant negative relationship between the trade variables and the number of patent applications in the current year. However, this relationship turns positive and statistically significant with the first lag of the trade variables. This implies that the effect of trade on innovation activities takes time to become effective and therefore current patent applications depend on trade activities that occurred in the previous period. On the other hand, since there was no evidence of reverse causality between the number of scientific journals and trade variable, the lags of the trade variables were not included in regressions under Columns 3 and 4. Table 5 shows that the coefficient of the trade variables are positive and significant implying that that the number of scientific journals depends also on the volume of foreign trade. Notice however that the effects are strong with in comes to trading with the rest of the world but weak in intra-COMESA trade. This suggests that increases in international trade due to the growing integration of the world economy have had a positive effect on COMESA Member States' rates of innovation. Although statistically significant, the coefficients of imports and exports indicated mixed effects on innovation activities and therefore inconclusive.

These results are consistent with those obtained by Xu and Chiang (2005) and Cameron, *et al* (2005). On this aspect, it is also worth noting that different studies define differently the concept of innovation. As detailed in chapter 2, other empirical studies measured innovation through the estimation of other indicators: the growth of total factor productivity (Naceur *et al*., 2017); the sum (stock) of utility patents granted to scholars (Lederman and Saenz,2005); or the R&D expenditure (Hasan and Tucci, 2010).

As expected, the coefficient of human capital index and R&D expenditure (% of GDP) are positive and statistically significant in regressions 1 and 2, confirming the importance of highly educated individuals for producing patents, and that there are positive externalities to schooling and R&D-based innovation. As for the population size, it was positive and significant implying that member states with a higher concentration of people perform better in terms of applying for patents and particularly, producing scientific and technology journals. The study further found a positive significant relationship between income level and innovation. This confirms the importance of innovation in high income countries. The positive effect of the log of GDP per capita on the number of patent applications and scientific journals implies that higher income countries have higher growth rate in innovative activities.

When it comes to the effect of high-tech manufactured goods on innovation activities, results indicate a statistically significant positive contribution. This confirms the findings of Tavassoli and Carbonara (2014) who argued that manufacturing sectors have a higher propensity to participate in innovative activities

6. Conclusion and Policy Implications

The main motivation for the study was to examine the direction of causality between trade and innovation activities and thereafter assess the impact of the interaction between trade and innovation among COMESA Member States. Granger Non-Causality tests revealed that trade variables granger cause patent applications and vice versa. As a result, the study deduces that the relationship between patent applications and trade is bidirectional. and scientific journals. However, trade granger causes the number of scientific journals but the number of scientific journals does not cause trade. Therefore, the study deduces this relationship is unidirectional.

The study employed the Negative Binomial Regression method to examine the impact of trade on the number of patents and scientific journals. This estimation technique is preferred because the dependent variables are count data and in addition, the dependent variables suffer from over-dispersion. In the case where patent applications are used as dependent variable, the lags of the trade variables are used to control for reverse causality.

The results from the NBR analysis show that trade (both with the rest of the world and intra-COMESA trade), country size, income level, R&D investment and human capital are important factors in determining innovative activities in COMESA Member States. Whereas the effect of trade has a significant positive impact on innovative activities, the effects are strong with in comes to international trade but weak in intra-COMESA trade. This suggests that increases in international trade due to the growing integration of the world economy have had a positive effect on COMESA Member States' rates of innovation.

Accordingly, the study recommends that the COMESA should:

i. Support provision of quality tertiary education that will give rise to creative class of individuals in the region and promote human capital accumulation.
ii. Diversify by increasing openness to international trade as it contributes to a more robust level of innovativeness and hence more output in terms of patent applications and scientific journals.
iii. Enhance/increase research funding and set up incubation centers to facilitate incubation and research outputs.
iv. Strengthen the innovation ecosystem by developing and implementing policies on the same. This should ensure that intellectual property management system is robust and properly incentivized.

References

Abrigo, M. R., & Love, I. . (2016). Estimation of panel vector autoregression in Stata. *The Stata Journal*, 16(3), 778-804.

Aghion, P. . (2004). Growth and development: A Schumpeterian approach. . *ANNALS OF ECONOMICS AND FINANCE*, 5, 1-26.

Aghion, P., & Howitt, P. (1992). A model of growth through creative destruction. *Econometrica*, 60, 323-351.

Akcigit, U., Ates, S. T., & Impullitti, G. . (2018). Innovation and trade policy in a globalized world (No. w24543). *National Bureau of Economic Research*.

Almeida, R., Fernades, A.,. (2008). Openness and technological innovations in developing countries: evidence from firm-level 423. *The Journal of Development Studies*, 44(5), 701-727.

Arellano, M., & Bond, S. . (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations . *The review of economic studies*, 58(2), 277-297.

Baldwin, R.E., Braconier, H., Forslid, R.,. (2005). Multinationals, endogenous growth, and technological spillovers: theory and evidence. . *Review of International Economics*, 13(5), 945-963.

Bansi, R. (2016). Commercialization of university innovation in South Africa.

Barro, R. J. . (1991b). Economic growth in a cross section of countries. *The Quarterly Journal of Economics*, 106(2), 407-443.

Bhattacharya, M., & Bloch, H. (2004). Determinants of innovation. *Small Business Economics*, 22(2), 155-162.

Bloom, N., Draca, M., & Van Reenen, J. (2016). Trade induced technical change? The impact of Chinese imports on innovation, IT and productivity. *The Review of Economic Studies*, 83(1), 87.

Bloom, N., Draca, M., and Van Reenen, J. . (2016). Trade induced technical change?The impact of Chinese imports on innovation, IT and productivity. *The Review of Economic Studies*, 83(1), 87-117.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. . *Journal of econometrics*, 87(1), 115-143.

Cameron, A. C., & Trivedi, P. K. . (2010). *Microeconometrics using stata (Vol. 2).* College Station, TX: Stata press.

Cameron, G., Proudman, J., & Redding, S. . (2005). Technological convergence, R&D, trade and productivity growth. *European Economic Review*, 49(3), 775-807.

Canh, N. P., Schinckus, C., & Thanh, S. D. (2019). Do economic openness and institutional quality influence patents? Evidence from GMM systems estimates. *International Economics*, 157, 134-169.

Cernat, L. (2001). Assessing regional trade arrangements: Are South-South RTAs more trade diverting? *Global Economy Quarterly*, 2(3), 235-59.

Coe, D.T., Helpman, E.,. (1995). International r&d spillovers. *European economic review*, 39(5), 859-887.

Dumitrescu, E. I., & Hurlin, C. . (2012). Testing for Granger non-causality in heterogeneous panels. *Economic modelling*, 29(4), 1450-1460.

Eaton, J., & Kortum, S. . (1994). International patenting and technology diffusion (No. w4931). *National Bureau of Economic Research*.

Eaton, J., & Kortum, S. . (2006). Innovation, diffusion, and trade (No. w12385). *National Bureau of Economic Research*.

Eaton, J., & Kortum, S. (2002). Technology, geography, and trade. *Econometrica*, 70(5), 1741-1779.

Fagerberg, J., Srholec, M., & Knell, M. . (2007). The competitiveness of nations: Why some countries prosper while others fall behind. *World development*, 35(10), 1595-1620.

Furman, J. L., Porter, M. E., & Stern, S. . (2002). The determinants of national innovative capacity. *Research policy*, 31(6), 899-933.

Gabrisch, H. . (2009). Vertical intra-industry trade, technology and income distribution: A panel data analysis of EU trade with Central-East European countries. . *Acta Oeconomica*, 59(1), 1-22.

Grossman, G. M., & Helpman, E. . (1991). Quality ladders in the theory of growth. *The review of economic studies*, 58(1), 43-61.

Grossman, G. M., & Helpman, E. . (1991). Trade, knowledge spillovers, and growth. *European economic review*, 35(2-3), 517-526.

Gujarati, D. N. . (2009). *Basic econometrics.* Tata McGraw-Hill Education.

Gujarati, D. N., & Porter, D. C. (2003). *Basic Econometrics.* New York: 4th;McGraw-Hill.

Hakura, M. D., & Jaumotte, M. F. (1999). The role of inter-and intraindustry trade in technology diffusion. . *International Monetary Fund.*

Hasan, I., & Tucci, C. L. . (2010). The innovation–economic growth nexus. *Global evidence. Research Policy*, 39(10), 1264-1276.

Le Goff, M., & Singh, R. J. (2013). Does trade reduce poverty? A view from Africa. . *The World Bank.*

Lederman, D., & Saenz, L. (2005). Innovation and Development around the World, 1960-2000. *The World Bank*.

Martínez-Zarzoso, I., & Nowak-Lehmann, F. . (2003). Augmented gravity model: An empirical application to Mercosur-European Union trade flows. *Journal of applied economics*, 6(2), 291-316.

Meierrieks, D. . (2014). Financial development and innovation: Is there evidence of a Schumpeterian finance-innovation nexus? *Annals of Economics & Finance*, 15(2).

Mold, A., & Mukwaya, R. . (2016). Modelling the economic impact of the tripartite free trade area: Its implications for the economic geography of Southern, Eastern and Northern Africa. . *Journal of African trade*, 3(1-2), 57-84.

Muendler, M. A. . (2004). Trade, technology and productivity: A study of Brazilian manufacturers 1986-1998.

Naceur, M. S. B., Blotevogel, M. R., Fischer, M. M., & Shi, H. . (2017). Financial development and source of growth: New evidence. *International Monetary Fund*.

Pam Zahonogo. (2016). Trade and Economic growth in developing countries: Evidence from sub-Saharan Africa. *Journal of African Trade*, 3(1-2), 41-56.

Roodman, D. . (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal*, 9(1), 86-136.

Sala-i-Martin, X. X., & Barro, R. J. . (1997). Technological diffusion, convergence, and growth . *Journal of Economic Growth* , 2 (1), 2–26.

Sargan, J. D. . (1958). The estimation of economic relationships using instrumental variables. . *Econometrica: Journal of the Econometric Society*, 393-415.

Solow, R. M. . (1956). A contribution to the theory of economic growth. *The Quarterly Journal of Economics*, 70(1), 65-94.

Tavares, J., & Wacziarg, R. (2001). How democracy affects growth. *European economic review*, 45(8), 1341-1378.

Tavassoli, S., & Carbonara, N. (2014). The role of knowledge variety and intensity for regional innovation. . *Small Business Economics*, 43(2), 493-509.

UNCTAD. (2013). *Intra-Africa Trade: Unlocking Private Sector Dynamism.* Geneva: United Nations Publication.

United Nations Economic Commission for Africa (UNECA). (2016). The Impact of Trade Regimes on Industrialisation; Trade and Technological Diffusion in the East African Community.

Varsakelis, N. C. . (2006). Education, political institutions and innovative activity: A cross-country empirical investigation. *Research Policy*, 35(7), 1083-1090.

Were, M. . (2015). Differential effects of trade on economic growth and investment: A cross-country empirical investigation. *Journal of african trade*, 2(1-2), 71-85.

Wooster, R. B., Banda, T. M., & Dube, S. (2008). The contribution of intra-regional and extra-regional trade to growth: Evidence from the European Union. *Journal of Economic Integration*, 161-182.

Xu, B., & Chiang, E. P. . (2005). Trade, patents and international technology diffusion. *The Journal of International Trade & Economic Development*, 14(1), 115-135.

Leveraging Innovation to Increase Intra-COMESA Trade

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Abstract

This paper analyses the role of technology innovation on the volume and value of COMESA exports to COMESA Member States and other 43 major importers by using a gravity model. The role of technology innovation on export trade was estimated using a panel data set of 12 years (2007-2018) with the Poisson Pseudo-Maximum Likelihood (PPML) technique given its advantage in handling several estimation challenges. The study found that technology innovation has a high potential in the COMESA region to enhance the overall quality of exports, increase competitive advantage and consequently increase the volume and value of exports. The study recommends that COMESA should increase investments in innovation, strengthen and build institutions that support technology innovation in addition to the ongoing tariff reduction and trade facilitation efforts.

Keywords: *Exports trade, technology innovation, gravity model, patent, R&D, ppml,*

1.0 Background

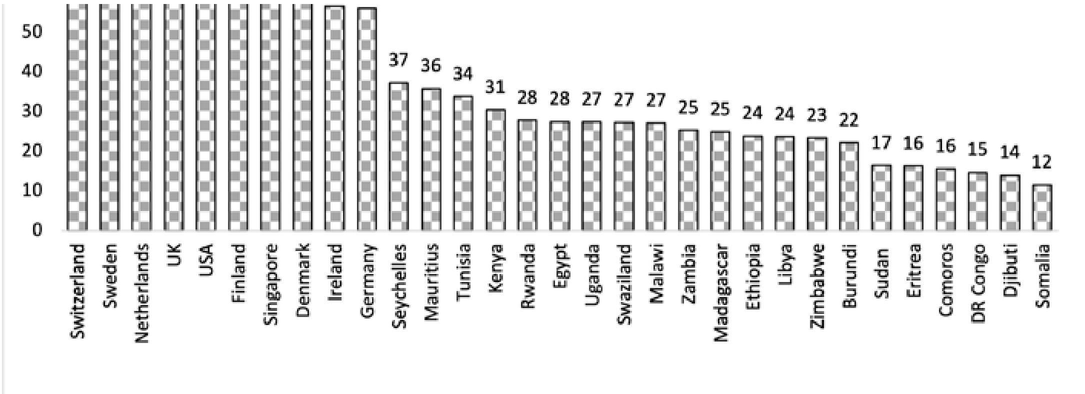
Innovation is an important factor of the non-price competitiveness of a nation's products (Buxton *et al.*, 1991). It enables and drives the expansion of varieties of products or quality improvements for a range of existing kinds of products that a country or a region can put on the market. Recent trends in international trade in especially developed countries demonstrate a strong impact of innovation activity on export performance. Although there is agreement that innovation increases trade, there is no agreement on the predictions about how innovation increases exports (Chen, 2013) and by how much. There is a strand of literature that predicts that innovation has a positive impact on extensive margin of trade, by introducing new products and varieties that a country exports (Grossman and Helpman, 1989). On the other hand, Grossman and Helpman, (1991) stress, the impact of innovation on intensive margin of trade by increasing product quality and Eaton and Kortum (2001, 2002) argue for productivity. International trade theory highlights the importance of technological innovation in explaining a country's international competitiveness (Fagerberg, 1997). Accordingly, technological innovation is defined as the countries' capacity to put new ideas into practice by developing new products and processes which play a key role in international trade. This helps to introduce a new quality of a good, or a new use of an already existing good, a new production method, opening of a new market, and a change in economic organization (Márquez-Ramos and Martínez-Zarzoso, 2009).

1.1 Context

Innovation generates greater competitiveness and trade, boosting integration, growth and development (ECA, 2016). Generally, countries at the top of the Global Innovation Index (GII) are also at the top of the Competitive Industrial Performance Index. African countries have very low rankings on both indices, as illustrated in Figure 1A in the Appendix. Regional integration is both a driver and beneficiary of innovation. It enables favourable conditions for innovation. Moreover, when members of a bloc such as Common Market for Eastern and Southern Africa (COMESA) grow in innovative capacities, they are likely to integrate even more with each other through investments and production (value chains), trade and knowledge mobility, and so on.

Although there are different efforts at regional level and specifically COMESA, these have not significantly improved Africa's science, technology and innovation (STI) performance. African countries still perform poorly on three main indicators: tertiary education institutions, intellectual property and innovativeness and productivity and competitiveness (ECA, 2016). African countries perform poorly on intellectual property in general, implying that formulated policies have not yet stimulated intellectual property and innovations based either on research and development or routine learning and practice. No African country ranks in the top 20 countries for patent applications, according to the World Intellectual Property Organization (WIPO). Figure 1 shows the average GII for the period 2009 – 2018 for the top 10 countries globally and COMESA countries. Whereas the GII for the top countries is 56-65, that for the COMESA Member States ranges between 12 and 37 demonstrating the significant gap in innovation achievements. This suggests that the levels of technology innovation, are significantly lower among the COMESA Member States compared to the rest of the world.

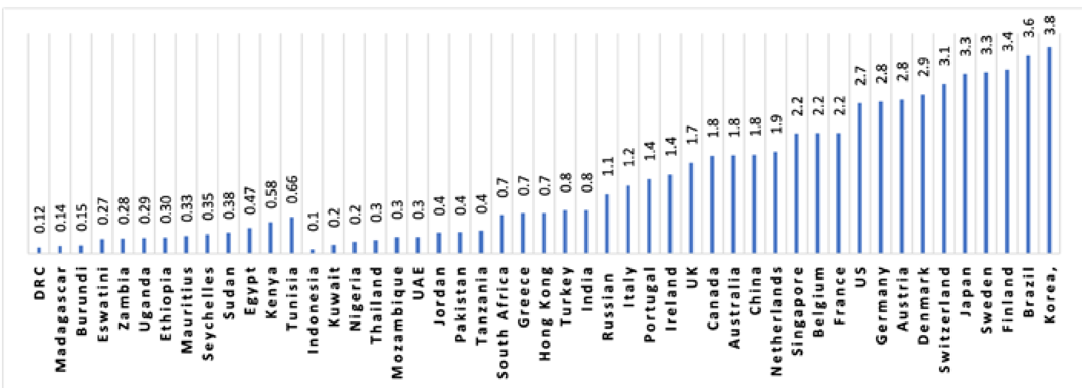
Figure 1: A comparison of the GII average Scores for the Top Ten and COMESA Countries



Data Source: www.globalinnovationindex.org

The limited levels of technology innovation are partly explained by the low funding for the same. Countries that have made significant investments accompanied with visible outcomes in innovation are more likely to have increased Research and Development (R&D) funding as a proportion of their GDP. The main objectives of R&D are to develop existing and new core competencies, to further existing and new products, and to develop existing and new business processes through invention and innovation. The R&D process is the engine that drives product and process differentiation. Figure 2 gives an average of R&D funding as a proportion of GDP for the period 2008-2016 for only 13 out of the 21 COMESA Member States and the other importing countries. [12] The statistics suggest that whereas the COMESA countries for the analyzed period allocated less than one percent of GDP, the other importing countries range between less than 1 and 3.8 percent. Note that the GDP of different countries significantly differ in absolute terms (refer to table 3) with COMESA Member States likely to have lower GDP compared to the other importing countries. This further illustrates the limited funding of R&D in the COMESA region. This suggest that any meaningful progress should be accompanied by significant increases in budgetary allocations.

Figure 2: Average Research and Development Funding as a proportion GDP 2008-2016



Data source: World Development Indicators

The limited funding to technology innovation in the COMESA region is partly reflected in the number of a country's patents. Patents are an indicator for monitoring the innovation of technologies, the technology competitiveness of a country or the economic performance of a company or country.

12 The rest of the countries did not have data and there are many gaps and therefore we left them out.

They play a prominent role in the entire technology life cycle, from initial R&D to the market introduction (demonstration to diffusion) stages, where competitive technologies can be protected with patents and licensed out to third parties to expand financial opportunity. Table 1 gives an average of patents obtained by countries between 2007 and 2017.

Table 1: Average patents between 2007 and 2017

COMESA		Other importers			
Burundi	0.5	Algeria	2.2	Morocco	131.9
Comoros	0.1	Australia	4,602.2	Mozambique	-
DRC	0.5	Austria	5,450.0	Netherlands	15,482.2
Djibouti	0.3	Belgium	4,730.5	Nigeria	2.1
Egypt	87.6	Brazil	893.6	Pakistan	9.7
Eritrea	0.1	Canada	10,555.5	Portugal	310.6
Ethiopia	1.1	China	152,823.8	S. Korea	105,807.4
Kenya	6.5	Hong Kong	943.0	Russian	24,098.7
Libya	0.7	France	36,130.3	Saudi Arabia	397.1
Madagascar	0.2	Germany	76,202.2	Singapore	1,932.2
Malawi	0.1	Greece	510.9	South Africa	1,128.7
Mauritius	29.5	India	2,677.0	Spain	4,820.6
Rwanda	-	Indonesia	20.3	Sweden	11,054.1
Seychelles	43.4	Iraq	1.2	Switzerland	16,864.5
Somalia	0.1	Ireland	1,657.4	Syrian	2.0
Sudan	-	Italy	11,871.5	Thailand	92.0
Swaziland	1.0	Japan	289,826.2	Turkey	544.5
Tunisia	9.0	Jordan	24.2	UAE	68.5
Uganda	0.5	Kuwait	45.8	UK	18,091.5
Zambia	0.7	Lebanon	14.8	Tanzania	0.2
Zimbabwe	2.1	Malaysia	591.6	USA	211,744.7
				Yemen	0.3

Data source: WIPO

It is evident that the majority of the COMESA Member States have an average of less than 1 patent with the exception of a few like Tunisia, Mauritius, Seychelles, and Egypt which have average patents between 9 and 87. When contrasted with the other main importers of COMESA products, it is illustrated how huge the gap is with Japan having close to 0.3million average patents. This suggest that technology innovation has not been given adequate attention in the COMESA region.

1.2 COMESA Current Technology Innovation Status and Initiatives

In the past, the National Systems of Innovation for Science and technology among COMESA Member States were narrowly defined to mean R&D. There was little emphasis on innovation aspects such as technology prospecting, procurement and diffusion. There was lack of explicit innovation policies in an environment of few and weak institutional linkages and collaboration, weak engineering and entrepreneurship capabilities and limited financial resources for technological innovation. This can be summed as a state of low levels of technological readiness and innovation capacities characterized by neglected and poor R&D infrastructure. This is however changing over from the last decade. There is evidence that COMESA Member States recognize the importance of STI in socio-economic and cultural development and have agreed to cooperate in various fields as stated in the decision of the 2010 COMESA Summit on Science and Technology Development.

For that matter, in June 2012 the first COMESA ministerial committee met and underscored the critical importance of implementing the decisions on STI, at the national level by each Member State.[13] This was envisaged to be achieved through a number of activities that led adoption of the following decisions by the COMESA Summit:

i. Establish science and technology parks and artisanal and industrial clusters;
ii. Establish a COMESA Innovation Fund;
iii. Create a database of scientist and engineers that can be organized and networked to provide a critical mass of expertise to advance the STI program;
iv. Harmonize ICT curriculum in the region;
v. Provide master plans and blueprints for harnessing knowledge from around the world;
vi. Provide programs for commercialization of R&D;
vii. Coordinate and harmonize national frameworks on STI;
viii. Promote nanotechnology, biotechnology and new materials such as polymers; and
ix. Allocate at least 1 percent of GDP to R&D.

This called for the establishment of a COMESA Committee on STI which has been done; and the office of advisor on STI at national level and at the COMESA secretariat. In addition there was a proposal to establish a university for regional integration with a component of an academy of science, technology and engineering and establishment of an innovation award which started in 2013.

1.3 Problem Statement

One way to generate competitiveness against imported products from without the COMESA region and promote intra-regional trade among members state is to increase the level of innovation partly to meet the required regional standards, increase variety and productivity. Although there are different efforts in COMESA, these have not significantly improved Africa's STI performance as observed. COMESA like the rest of Africa does not perform well on many measurements of innovation and competitiveness. Furthermore, there is a tendency for the COMESA Member States to trade more with the rest of the world than among themselves. This is partly explained by the technology deficits within the COMESA region to supply the quality and type of products imported from the rest of the world. In addition, the region trades in similar products. The question is; how much innovation is likely to generate a given quality of intra-COMESA exports? What is the potential of technology innovation on intra-COMESA export trade?

1.4 The Purpose of the Study

This paper seeks to contribute to policy and empirical literature by providing a quantitative measurement of the influence of innovation on the extra and intra-COMESA trade. Specifically the study seeks to:

13 COMESA (2012) First Ministerial Meeting on Science and Technology

1. Compare the structure of the COMESA intra-export trade and the exports to the rest of the world in relation to imports into the region; and
2. Estimate the impact of innovation on extra and intra-COMESA exports

The rest of the paper is organized as follows: Chapter 2 is the review of selected literature and chapter three is the analytical framework and the methods used in the study. Chapter 4 is presentation of the results and finally chapter five is the conclusion and policy implications. In addition, there is the appendix that contains extra information deemed necessary and not in the main body of the paper.

2.0 Litrature Review

2.1 Theoretical Review

From a theoretical perspective, innovations and trade are part and parcel of the new trade theories of Heckscher and Ohlin, which focus on specialization as per endowment (Leontief, 1953). Countries endowed with capital are likely to innovate more and improve on the production base, hence resulting into gains from trade. According to Schumpeter (1942), the main force that brings about this structural change is the "perennial gale of creative destruction". Creative destruction is a process whereby waves of innovative activity hit the economic system in different points of time, resulting in the destruction of the old economic structure and the creation of a new one. There are various types of innovations: the introduction of new products, new methods of production and new forms of business organization as well as the penetration of new input and output markets Schumpeter (1919).

Technological innovation can be defined as the countries' capacity to put new ideas into practice by developing new products and processes which play a key role in international trade and economic development (Márquez, & Martínez, 2009). Innovation is also an important factor of the non-price competitiveness of a nation's products. This is because it takes the form of an expansion of the number of varieties of products or quality improvements for a range of existing kind of products (Buxton *et al.*, 1991). Innovations are more than just small changes put together but rather "new combinations" that disturb whatever equilibrium exists in the economic system, Schumpeter (1940). Galbraith (1967) builds on this by formulating the so-called "Schumpeterian thesis", which proposes that large firms are more innovative than small firms.

Accordingly, to (Fagerberg 1997) international trade theory highlights the importance of technological innovation in explaining the international competitiveness of a country. Although the classical trade theory of international trade that stressed international differences in technology as a source of comparative advantage, was diminished by the Heckscher–Ohlin (H–O) theory which centered on resource endowments as the main factor explaining international trade patterns, the theory re-emerged. Technological innovation bounced back to the forefront of research into trade with the development of the technology gap (Posner 1961) and the product cycle theories (Vernon 1966) among others. Whereas Posner's (1961), argues that trade is generated by differences in the rate and nature of innovation, Vernon (1966) places less emphasis on the comparative cost doctrine and more on the timing of innovation.

According Lachenmaier and Woessmann (2004) there are two broad strands of theoretical literature predicting a relationship between innovation and exports. The first one presents international trade models that stress product-cycle features in the production of goods over time. These trade models tend to take innovation as exogenous and predict that innovation influences exports. These models include Vernon (1966), Krugman (1979), and Dollar (1986), among others. They predict that developed countries export innovative goods, which are later imitated by developing countries as these goods become mature, so that finally developing countries will export these goods to the developed countries. This implies to keep ahead, developed countries must continually innovate and as they do that their export basket becomes even larger. The other models are endogenous growth models that recognize open-economy effects and endogenize the rate of innovation and predict dynamic effects of international trade on innovative activity. These include among others; Grossman and Helpman (1989; 1990, Segerstrom et al. (1990), and Young (1991).

To explain how technological innovation leads to increase in international trade, Cohen and Levinthal (1990) introduced the concept of absorptive capacity, which is the ability to recognize the value of new, external information, to assimilate it, and to apply it. They further look at two faces of technological innovation: creation and absorption. Therefore, they argue that some level of absorptive capacity is necessary to create, and the cost of adoption increases as absorptive capacity falls. It is Zahra and George (2002) who came up with four dimensions of absorptive capacity: acquisition, assimilation, transformation and exploitation capabilities that even shade more light on how technology innovation leads to increase in exports.

Innovations can be facilitated by regional integration initiatives such as COMESA. As observed by Matambalya *et al.* (2015) regional integration enhances the framework conditions for innovation and for economic actors to leverage the knowledge generated through research and development (R&D) and through routine learning and practice of economic activities. Innovation is a key element for increasing trade as it is positively linked to improved quality of goods and services. Regional integration brings competition in the domestic market and as argued by Porter (1998), it can create pressure for improvements through innovations in ways that upgrade the competitive advantages of nations.

2.2 Empirical Review

Empirical literature on innovations is largely concentrated on the link between innovations and trade. For instance, Santacreu (2015) constructs a multi country dynamic general equilibrium model in which imports and growth are connected by technological innovations and their international diffusion through trade. The model has two sources of embodied productivity growth. First, in the spirit of the new growth theory, countries accumulate domestic technologies when their firms invest in R&D and innovate and secondly, since technology is assumed to be embodied in intermediate goods, countries adopt foreign technologies embedded in the intermediate goods they import. The findings indicate that innovation and adoption through imports affect a country's productivity growth differently as a function of its position on the transition path. Therefore, countries at early stages of development, with low technological base, grow by adopting the new foreign technologies embedded in the intermediate goods they import. On the other hand, countries at later stages of development, with a high technological base, instead grow by developing new technologies through R&D.

Wakelin (1998) examines sectoral trade flows for 22 industries in nine Organization for Economic Cooperation and Development (OECD) countries by adopting an approach from the technology gap tradition and relating relative export flows to relative technology investments (R&D, patents, and *Science Policy Research Unit*[14] (SPRU) innovation rates in the United Kingdom. The study establishes a positive relationship between relative innovation and bilateral trade performance at an aggregate level, and for a number of manufacturing sectors. Furthermore, sectors are categorized as either net users or producers of innovations; where innovation appear to have more impact on trade performance for

14 *SPRU* is a research centre based at University of Sussex

the net producers of innovations than the net users of innovations. Although this result is sensitive to the use of different technology and innovation indicators, the results provide general support for a positive relationship between innovation and export flows,

Other works have also shown the existence of a non-linear relationship between technological innovation and international trade. For instance, Estrada *et al.* (2006) note that those companies with a high R&D intensity have a higher export probability than those with a medium R&D intensity. Márquez, & Martínez (2009) examines the effect of technological achievement on exports. Using the gravity model and technological achievement index (TAI) and confirmed the expected positive effect of technological innovation on export performance and the existence of non-linearities. Using a panel data set of 30 developed and 88 developing countries for the period 1980 -2000, Lebesmuehlbacher (2015) examines the degree to which international trade and factor movements facilitate technology diffusion within developed and developing countries, particularly focusing on the role of migration. Results show that trade and Foreign Direct Investment (FDI) do not significantly affect diffusion within either country group. In contrast, migration enhances technology diffusion, but only in developing countries.

Ali (2017) investigates the impact of technological progress on economic development by introducing a model in which the Human Development Index (HDI) is used as the dependent variable and the TAI and Gross Capital Formation (GCF) are used as independent variables. The HDI, TAI and GCF are used in this model as proxy variables for economic development, technological progress and capital respectively. The results demonstrates that long-term associations exist between technology progress and economic development with the impact of technology progress on economic development accounting for 13.2% while the impact is 4.3% higher in eight selected East South Asian countries, at 13.5%, than in eight selected highly developed countries (9.2%).

Desai *et al.* (2002 observes that all countries must adopt innovations to benefit from the opportunities of the network age. This results from the three main arguments on innovation identified as; higher-technology goods present important opportunities to developing countries; many high-technology sectors are among the most dynamic in the global economy; and upgrading the technology content of the manufacturing sector diversifies the economy and creates opportunities in new markets. This brings in the perspective of the services sector and how it can be linked to trade in both services and goods.

Cipollina *et al.* (2016) analyses the role that quality standards and innovation play on trade volume, using a gravity model. They argue that the net effect of quality standards on trade depends on the producers' ability to innovate and comply with market requirements. The analysis uses a sample of 60 exporting countries and 57 importing countries, for a wide range of 26 manufacturing industries over the period 1995-2000. They demonstrate that the most innovative sectors are more likely to enhance the overall quality of exports and then gain a competitive advantage. Moreover, this effect depends on the level of technology intensity at sector-level and on the level of economic development of exporting country.

ECA (2016) examines how to harness the linkages between regional integration, innovation and competitiveness within the framework of Africa's normative regional integration development model oriented to structural change. The results demonstrate that, in a virtuous circle, innovation is both a driver and beneficiary of competitiveness, endogenous growth, development and transformation. Moreover, the growth of innovative capacities among members of a bloc is likely to lead to more integration among themselves through investments and production (value chains), trade and knowledge mobility. However, evidence from 15 African countries for 1995 to 2010 shows that growth in most of these countries was through factor accumulation and not through major gains in input combinations associated with innovation ECA (2016). This could be because many of the world's innovations are generated in a few developed countries and then adopted globally. Therefore, technology diffusion across borders plays an important role in driving economic growth Lebesmuehlbacher (2015).

2.3 Overview of Literature

The COMESA region values innovations to promote trade. This is demonstrated by the 16th Summit of the COMESA Authority of Heads of State and Government which established the Innovation Council, an Annual Innovation Award and a Regional ICT Fund. This has been driven by the need to put mechanisms in place to harness and mobilise existing knowledge in a structured manner that benefits all member states (Nakazzi, 2012). The Council is composed of representatives from academia, private sector and government and advices the member states in relation to existing and new knowledge and innovations, and the best ways of applying the knowledge and innovations. The literature review demonstrates that innovation is critical to expansion of exports, especially those of manufactured products. It improves the quality of products, reduces costs of transport, enhances diffusion of technology, and leads to diversification of products for exports. Ultimately, innovation is central to growth and economic development. Although several studies have been done to investigate the link between innovations and trade as illustrated, several gaps remain especially on the influence of innovation and trade in the COMESA region. This paper seeks to partly address this gap by contributing to policy and to the empirical literature specifically by estimating the impact of innovation on trade and specifically intra-COMESA exports.

3.0 Methodology

3.1 The Gravity Model

We apply a gravity model to examine whether trade performance is partly attributed to the ability to innovate. In the literature, the model was developed by Tinbergen (1962) and Pöyhönen (1963). Gravity models are widely used in international trade literature and they are an application of the Newton's law of gravity. In its simplest form, the gravity equation for trade states that the trade flow from country *i* to country *j*, denoted by *Xij* , is proportional to the product of the two countries' GDPs, denoted by *Yi* and *Yj* , and inversely proportional to their distance, *Dij* , broadly construed to include all factors that might create trade resistance as specified in *equation 1*.

$$Xij = \alpha 0 Y_i^{\alpha 1}\, Y j^{\alpha 2}\, D\, ij^{\alpha 3}, \ldots\ldots\ldots\ldots\ldots 1$$

Where α0, α1, α2, and α3 are parameters to be estimated. This relationship in *equation 1* is log-linearized and parameters are estimated in its short form as in *equation 2*

$$\ln (Xij) = \ln(\alpha 0) + \alpha 1 \ln (Yi) + \alpha 2 \ln (Yj) + \alpha 3 \ln (Dij) + etij \ldots\ldots\ldots 2$$

Where *etij* is the error term.

According to Alemayehu and Idris, (2015) the gravity model has widely been used to identify determinants of bilateral trade, though they are often criticized for lacking a strong theoretical basis. In this vein Cernat (2001) noted that despite its use in many early studies of international trade, the model was considered suspect in that it could not easily be shown to be consistent with the dominant

Heckscher-Ohlin model explaining net trade flows in terms of differential factor endowments (ibid, 2001). However, this challenge has since been resolved after the works of other scholars demonstrated that there is strong theoretical basis of the application of the model (see for example Anderson, 1979); Bergstrand, 1985; Deardorff, 1998; and Feenstra *et al,* 1998).

The censored nature of regional bilateral trade implies that OLS estimates are biased. For that matter, we estimate the model using Pseudo Poisson Maximum Likelihood (PPML) method to address the problems associated with OLS (Silva and Tenreyro, 2006). The Pseudo Poisson Maximum Likelihood (PPML) approach has been used widely (see for example Liu, 2009; Westerlund and Wilhelmsson, 2011; Martinez-Zarzoso, 2013; Alemayehu and Edris, 2015) among others. The parameters of the econometric model are computed by finding the estimates that maximize the likelihood function in these formulations. Although other estimation techniques such as fixed-effect and random-effect model have been widely used (Herrera, 2011), they are prone to heteroscedasticity and therefore their estimates are not robust. For that matter we did not venture to estimate using these techniques.

The use of the PPML estimator was chosen and justified on several grounds. Firstly, the PPML estimator accounts for heteroscedasticity which characterizes international trade data (Santos Silva and Tenreyro, 2006). In the presence of heteroscedasticity, estimating gravity models with the OLS estimator results in biased and inconsistent estimates. Secondly, the PPML estimator can take advantage of the information contained in the zero values trade flows. A notable drawback of the OLS approach is that it does not consider the information contained in the zero values of bilateral trade flows. Thirdly, due to the additive property of the PPML estimator, the gravity fixed effects are kept identical to their corresponding structural terms (Arvis and Shepherd, 2013; Fally, 2015). Finally, the PPML estimator can also be used to calculate the general equilibrium effects of trade related policies (Anderson *et al.,* 2015). As a robustness check, in addition to the PMML estimation, alternative panel-based Tobit technique estimation was also made. Given that it produced similar results we present only the PPML estimation results.

This model is estimated using bilateral export panel data of COMESA Member States among themselves and 43 major export destinations outside the region (see Appendix A1). We then add our variables of interest in addition to the augmented specification to estimate the following augmented regression as shown in *equation 3*:

$$X_{ijt}=b_0+b_{1.}lnY_{it}+b_2 lnY_{jt}+b_{3.}lnDist_{ij}+b_{4.}Cont_{ij}+b_5 Lang_{ij}+b_{6.}llock_i+b_{7.}llock_j+b_{8.}comcol_{ij}$$

$$+ b_{9.}lnTariff_j+b_{10.}lnTraCost_i+b_{11.}lnTraCost_j+b_{12.}lnTec_i + b_{13.}lnTec_j+ e_{ijt} \ldots\ldots\ldots\ldots\ldots\ldots.3$$

Where, *i* indexes exporter country, *j* importer country and *t* time. The dependent variable X_{ijt} is the trade value between *i* and *j* at time *t*. Concerning explanatory variables, we include two groups of determinants of trade. The first includes standard gravity variables: Y_{it} and Y_{jt} to indicate, respectively, production of exporter and expenditure consumption of importer; $Dist_{ij}$ is the distance between country *i* and *j*; $Cont_{ij}$, $Lang_{ij}$, and $comcol_{ij}$ are dummy variables taking the value of 1 for pair of countries sharing, respectively, common border and common language, having a common colonizer and zero otherwise; $llock_i$ and $llock_j$, respectively whether the exporter and importer taking the value of 1are land locked and zero otherwise: and $Tariff_j$ is the bilateral applied tariffs in the importer country at time *t*. The second set of variables is included to test our main hypothesis that a higher level of innovation yields a higher increase in export. Therefore, we firstly include *TraCost*, which controls for technology innovation in trade facilitation aspects both in the exporting and importing countries. Then, we include *Tec* for technology innovation which is the main variable of interest.

3.2 The Global Innovation Index[15]

The variable of interest in this analysis is innovation and how it impacts international trade. There were two proxies (patents and the percentage of R&D in GDP) that could have served the purpose, however these had limitations that led to being discarded. The number of patents a country registers was the best option, however, it had significant data limitations especially for the COMESA Member States, which made it impossible to use. Although the proportion of the national budget that is allocated to R&D is equally a good proxy for innovation, many countries included in the analysis did not have updated data. The best option, beside these two, was the Global Innovation Index (GII) whose construction is scientific, and data was available for all the countries and the years of analysis.[16] The GII is an annual ranking of countries by their capacity for, and success in, innovation. It aims at capturing the multi-dimensional facets of innovation and provides the tools that can assist in tailoring policies to promote long-term output growth, improved productivity, and job growth. The GII helps to create an environment in which innovation factors are continually evaluated. The core of the GII consists of a ranking of world economies' innovation capabilities and results.

The GII is computed by taking a simple average of the scores in two sub-indices, the Innovation Input Index (III) and Innovation Output Index (IOI), which are composed of five and two pillars, respectively. The III sub-index gauges elements of the national economy which embody innovative activities grouped in five pillars: i) institutions, ii) human capital and research, iii) infrastructure, iv) market sophistication, and v) business sophistication. The IOI sub-index captures actual evidence of innovation results, divided in two pillars: vi) knowledge and technology outputs and vii) creative outputs. Each pillar is divided into sub-pillars and each sub-pillar is composed of individual indicators. Sub-pillar scores are calculated as the weighted average of individual indicators; pillar scores are calculated as the weighted average of sub-pillar scores. Details are in the appendix Table A4.

3.3 Data Sources

The study used export trade data from the COMTRADE and World Integrated Trade Solutions (WITS) database which covers 43 countries that trade with COMESA Member States. Data on distance which is defined as direct distance between the capital cities of a pair of trading partners without taking into consideration the actual routes by either form of transport was extracted from the distance calculator website.[17] World Bank World Development Indicators (WDI) formed a valuable source of the per capita income, GDP and manufactured exports data. The data on whether, a country is land locked or not, is an island or not, borders a trading partner or not and has the same official language or not were extracted from the Centre d'Etudesm Prospectiveset d'InformationsInternationales (CEPII)[18] gravity dataset. The Global Innovation Index data was extracted from the GII annual reports. The analysis is done for the period 2007 to 2018. Details of the sources and the data are in Appendix A2.

3.4 Estimation Procedure

In the panel estimation process, the study made a choice between a number of estimation techniques to obtain the best and most robust results. The OLS was immediately discarded for reasons discussed above regarding the choice of a model. The other options were the Random Effects - RE and Fixed Effects –FE models. Whereas the RE estimation is appropriate for estimating trade flows between randomly drawn samples of trading partners from a large population, the FE is most appropriate for estimating trade flows between *ex ante* predetermined selection of countries. These equally had their

15 www.globalinnovationindex.org.
16 The Global Innovation Index is co-published by Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO, a specialized agency of the United Nations
17 http://www.timeanddate.com/worldclock/distanceresult.html?p1=115&p2=17
18 CEPII make available a "square" gravity dataset for all world pairs of countries, for the period 1948 to 2006. This dataset was generated by Keith Head, Thierry Mayer and John Ries (2010)

limitations.

When FE models estimation is used and some variables do not change over time, the inherent transformation wipes out such variables. Therefore, FE models are best suited for estimating the impact of variables that vary over time. Given that most of the variables in the model are non-varying, the FE is not best suited and this one was discarded. Ideally we should have conducted a Hausman test to make a choice between the RE and FE techniques. The RE even when selected is likely to suffer from problem associated with heteroscedasticity – less precise coefficient estimates. We choose the PPML for its strength and ability to overcome the limitation associated with the OLS, FE and RE.

The continuous data were transformed into logarithms. The impact of the variables on manufactured exports is determined by the coefficients generated as elasticities after this transformation. The rationale for the transformation into elasticities was to enable establishment of the proportion of technology innovation that generates a given level or proportion of both extra and intra–COMESA exports. In this way policy makers can be guided to invest into technology innovation for increasing exports of the COMESA Member States.

3.5 Diagnostic Tests

The Levin et al., (2000) test of panel unit roots that assume that the autoregressive parameters are common across countries was conducted. Levin, Lin and Chu (LLC) used a null hypothesis of a unit root that states that the panels contain unit roots and the alternative that the panels are stationary. The test results indicate that all the variables are stationary at less than 1 percent (the null unit root is rejected) in which case the co-integration test is not required to estimate the model. Furthermore, simple correlation test was used to check multi-collinearity in the model between the explanatory variables. Results show that the values of the correlation coefficients between explanatory variables are lower than 0.80 and as argued by Studenmund (2001) that below such a threshold the model is fine, we concluded that there was no serious problem.

4.0 Estimation and Discussion of Results

4.1 Introduction

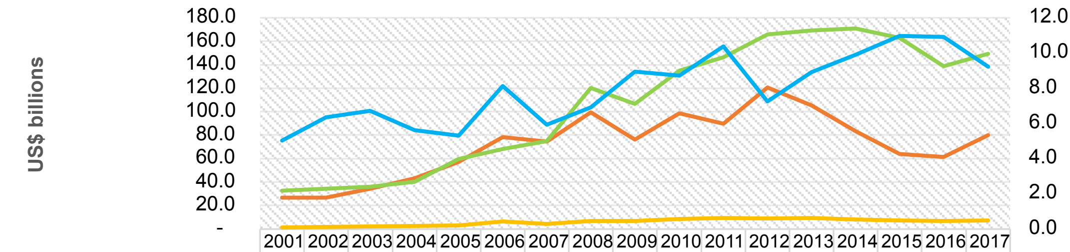
The chapter presents the study results. The results and discussion of trends in intra COMESA exports in comparison to the rest of the world are presented first..This is intended to gauge the intensity of technology that the products embody. This is followed by a presentation and discussion of the structure of products that COMESA Member States trade among themselves and the rest of the world; descriptive analysis of the variables used in the mode the results and discussion of the estimated model.

4.2 Intra-COMESA Exports in Comparison to the Rest of the World (RoW)

Figure 3 shows trade within the COMESA region and between the COMESA region and the RoW. Intra-COMESA exports are low (valued at US$ 1.7 billion in 2002, increasing to US$ 9.4 billion in 2013). This significantly reduced to US$ 7.4 billion by 2017. Exports to the world (COMESA inclusive) increased overtime, from US$ 26.8 billion in 2001 to US$ 120 billion by 2012 and then declining to US$ 80 billion in 2017. On the other hand, imports from the world are much higher, suggesting a trade deficit over the years.

From 2007, an increase in exports has corresponded with increased imports, probably for capital goods and to facilitate production. This trend however changed in 2014 when imports were registered at US$ 170 billion before declining. From this analysis, we assert that intra-COMESA trade (read on the right axis in percentage) is much lower compared to COMESA exports to the RoW and yet the region heavily imports from the RoW. Specifically, the share of intra-COMESA exports, which was 5 percent in 2001 and peaked at 11 percent in 2015 fluctuated between 6 to 10 percent over years. The statistics suggest that although the regional integration has contributed to increasing intra-COMESA trade, there is a long way to fully achieve this objective.

Figure 3: COMESA Import and Export Trade with the Region and the RoW



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Exports to COMESA	1.3	1.7	2.3	2.4	3.0	6.4	4.4	6.8	6.8	8.6	9.3	8.7	9.4	8.2	7.0	6.7	7.4
Exports to world	26.8	26.5	34.3	43.1	57.0	78.4	74.4	99.2	76.3	98.6	89.8	120.	105.	83.2	64.0	61.3	79.8
Imports from world	32.8	34.1	35.9	40.3	59.6	68.2	75.0	119.	106.	135.	146.	165.	169.	170.	162.	138.	149.
Intra-COMESA exports	5.0	6.3	6.7	5.6	5.3	8.1	5.9	6.9	8.9	8.7	10.4	7.2	8.9	9.9	11.0	10.9	9.2

3.3 The Structure of Intra-Trade Exports, Exports to and Imports from the RoW

Table 2 gives a summary of the intra- COMESA exports, exports to and imports from the RoW. It gives the total value of the top 20 products for the categories outlined above for the period 2007 to 2017. The intention is to infer the technology innovation input in these different categories of products. Whereas the intra-COMESA exports amounted to a total US$ 90 billion for the 11-year period, it was US$ 1.1 trillion for the exports to the RoW and US$ 1.7 trillion for the imports from the rest of the world. This suggests that there is more trade with the RoW than the bloc. Specifically, the region has high propensity to import from the RoW compared to the regional/ bloc imports.

It is evident that the exports originating from the COMESA region are not as technology intensive products as those imported in the region from the RoW. The region exports commodities and light manufactured products and imports high technology manufactured products demonstrating the low levels of technology innovation in the region. This suggests that the COMESA bloc market for high technology products is available for member states if regional technology innovation is tapped into.

The intra-regional exports largely constitute ores, coffee, tea, mineral fuels, cement, sugar and sugar confectionary, inorganic chemicals, iron and steel, tobacco, plastics, cereals, copper, animal and vegetable oils, paper boards, soap, beverages and spirits. This list is closely similar to COMESA exports to the RoW further strengthening the argument for exports of commodities and light manufactures. On the other hand the COMESA imports from the RoW constitute the following: Mineral fuels, machinery, electrical machinery, televisions, vehicles, cereals, iron and steel, plastics, pharmaceutical products, animal and vegetable oils, paper and paper products, optical, photographic and cinematographic products, fertilizers, organic chemicals, wood and wood articles, aircraft, spacecraft, and parts, and runner and rubber articles, sugars and confectionery. On a comparative basis although some of the products produced and exported by COMESA member stated are similar to those imported, the majority differ with a tendency for imports to be more technology intensive.

In summary the technology innovation inadequacies and deficiencies in the COMESA bloc partly explain the limited intra-regional trade and huge imports from outside the region. From a positive perspective, any serious leaps in technology innovation in the COMESA region is likely to generate and guarantee a huge intra-regional market.

Table 2: The structure of Intra-COMESA Exports, Exports to and Imports from the RoW in US$'000

Code	Intra COMESA Exports		Code	COMESA exports to the world		Code	COMESA imports from the world	
	Total 2007 to 2018	90,347,222		Total 2007 to 2018	1,118,296,097		Total 2007 to 2018	1,740,257,780
'26	Ores, slag and ash	10,393,388	'27	Mineral fuels, mineral	472,386,373	'27	Mineral fuels, mineral	253,150,233
'09	Coffee, tea, maté and spices	5,199,644	'74	Copper & articles thereof	98,202,757	'84	Machinery, mechanical applia,	180,471,119
'27	Mineral fuels, mineral	4,596,533	'71	Natural, precious stones, &metals,	48,468,240	'85	Electrical machinery & TV	131,224,600
'25	Salt; sulphur; earths & stone; & cement	4,300,925	'09	Coffee, tea, maté and spices	39,265,292	'87	Vehicles other than railway	127,935,137
'17	Sugars and sugar confectionery	4,136,684	'26	Ores, slag and ash	30,850,502	'10	Cereals	87,877,098
'28	Inorganic chemicals; precious metals,	3,905,646	'81	Other base metals; cermets;	13,702,375	'39	Iron and steel	77,562,950
'72	Iron and steel	3,228,563	'85	Electrical machinery &, TV	19,488,547	'72	Plastics and articles thereof	67,451,787
'24	Tobacco & manu. substitutes	3,201,180	'07	Edible vegetables & roots & tubers	20,288,224	'30	Articles of iron or steel	60,795,889
'39	Plastics and articles thereof	3,187,272	'62	Apparel and clothing	18,838,247	'73	Pharmaceutical products	50,923,533
'10	Cereals	2,852,233	'24	Tobacco & manu. substitutes	20,627,370	'15	Animal/ vegetable fats & oils	39,615,810
'74	Copper and articles thereof	2,687,792	'39	Plastics & articles thereof	17,760,647	'48	Paper and paperboard;	28,149,069
'15	Animal or vegetable fats and oils	2,555,600	'72	Iron and steel	16,874,243	'17	Optical, photographic, cinematographic,	23,539,231

'85	Electrical machinery and, television	2,307,067	'08	Edible fruit & nuts; citrus or melons	14,017,410	'38	Fertilisers	22,550,090
'34	Soap, organic surface-active agents,	2,197,794	'28	Inorganic chemicals; precious metals,	11,334,743	'90	Miscella-neous chemi-cal products	22,515,793
'84	Machinery, mechanical appliance,	2,084,287	'17	Sugars and sugar confec-tionery	15,347,692	'29	Rubber and articles thereof	22,436,492
'48	Paper and paperboard;	1,916,445	'33	Essential oils and perfumery, cosmetic	9,359,789	'26	Organic chemicals	22,026,084
'07	Edible vegetables & certain roots & tubers	1,854,058	'61	Apparel & clothing	15,439,183	'02	Wood and articles of wood;	21,423,849
'73	Articles of iron or steel	1,756,154	'31	Fertilisers	13,241,792	'40	Sugars & confectionery	20,521,278
'87	Vehicles other than railway	1,654,347	'06	Live trees and other plants;	11,037,889	'31	Air-craft,space-craft, &parts thereof	19,664,951
'22	Beverages, spirits	1,560,034	'12	Oil seeds and oleaginous fruits;	10,636,384	'28	Meat & edible meat offal	18,982,470

Source: Authors computations from Trade map data

4.4 Means of the Estimated Variables

Table 3 gives a summary of the means for the model estimation variables. The average Intra-COMESA export value for the 12 years of was US$ 22.3 billion and the other main 43 importers was US$ 113 billion suggesting the significant difference between intra-COMESA trade and trade with the RoW. On average, the transport costs per container are higher (US$ 3,315) for importing COMESA Member States (from both members and non-members) compared to exporting member states (US$ 2,626) to all destinations. This implies that for the COMESA region, it is more expensive to import than to export which is likely to impede intra-COMESA trade. Furthermore, the transport costs to import by the non-COMESA countries is even lower plausibly and partly explaining the differences in the volumes and values between the two groups. The average GDP of the COMESA Member States was only US$ 93 billion compared to the other importing countries at US$1.99 trillion). Whereas the average tariff in the COMESA region was 9.2, it was 4.2 for the importing countries suggesting that it was easier to export to them than the member states. Intuitively, the COMESA Member States have short distances between them compared to the other importers. The average technology index (Global Innovation Index) for the COMESA region (24) was significantly lower compared to the importers outside the region (41). This suggests that there is still limited innovation within the region compared to the other countries with which the region trades with. This negatively impacts on the region when it comes to export trade.

Table 3: The Mean Values of the Model Estimation Variables

Variable	COMESA	Other importers	All
COMESA Exports (billions)	22.3	113	84
Transport cost of exporters	2,626		
Transport cost of importers	3,315	1,453	2,044
GDP of importers (billions)	923	1,990	1,390
GDP of exporters (billions)	93		
Tariff by importers	9	4	56
Distance between cities	2,942	6,332	5,256
Technology innovation index for importers	24	41.2	36
Technology innovation index for exporters	24		25
Real Effective Exchange rate	119	106	110
Exporter is land locked	0.38		
Importer is land locked	0.43	0.43	0.43
Contiguity/bordering	0.12	0.02	0.05
Common language	0.56	0.29	0.38
Com colony	0.31	0.15	0.20

4.5 Estimation Results

This section provides the main results of the empirical analysis conducted on the total sample of 15,876 observations. Results of equation (3) are reported in Table 4 for the three categories adopted, namely; intra-COMESA exports, COMESA exports to top 43 partners and a combination of the two. Overall, the results show that the effects of the standard gravity variables are consistent with the theoretical gravity equation.

Import transport costs have a negative impact on COMESA export trade to non-COMESA import partners and this is the same when COMESA Member States are combined with other importers. Whereas a one percent increase in import transport costs leads to 0.06 percent decrease in COMESA export trade to non-COMESA partners, it leads to only 0.03 percent decrease for the combined set of importers. The results thus suggest that import transport costs are a significant impediment to COMESA export trade. The results agree with theory and empirical studies that argue that transport costs increase the cost of doing business and reduce the competitions of export firms (see for example Hummels (2007); Christ & Ferrantino (2009); & Behar & Venables (2010).

Results show that the GDP of both the exporting and importing countries play a significant role in determining the level of COMESA Member States exports at 1 percent level of significance. GDP of the COMESA Member States was a proxy for the production capacity and size of the economy. 1 percent increase in the GDP leads to 0.20 percent increase in exports for COMESA Member States. These results imply that member states should strive to grow their GDP as this significantly determines the level of exports within the bloc. On the side of the GDP of the importers, increasing it by 1 percent leads to 0.13 percent increase of export trade for the member states, 0.05 percent for the other trading partners and 0.07 percent for the combination of the two. The results are thus not only positive and significant at 1 percent and therefore in agreement with *a priori* expectation but revealing regarding the role of both exporter and importer size of the economy on trade.

The implication of tariff reduction in the COMESA region is pronounced in the results. Whereas tariffs are significant in reducing the level of exports at 1 percent of significance for other importing countries, this is not the case for the COMESA Member States importers as there is no significance. This result suggests that the process of tariff reduction within the bloc has been to a large extent successful. Increasing tariffs by 1 percent among the other importers leads to reduction in COMESA exports by 0.04 percent. The results thus call for continuing the liberalization process within the COMESA region to generate more intra-regional trade.

The distance between the trading countries has a strong bearing on the volumes of trade as these two exhibits an inverse relationship. The results for distance are significant at 1 percent and in agreement with *a priori* expectation. Increasing the distance by 1 percent leads to 0.4 percent decrease in trade for COMESA importing partners and 0.03 percent for non-COMESA importing partners and 0.11 percent for a combination of the two. In the COMESA region, connectivity remains a challenge as the level of infrastructure development is still low although recent efforts are likely to yield good results.

Table 4: Estimation Results

	Ppml Estimates		
Variable	**COMESA**	**Other importers**	**All**
in_trans_exp	0.00913	-	-
	(0.0198)	-	-
in_trans_imp	-0.00220	-0.0610***	-0.0323***
	(0.0208)	(0.00971)	(0.00917)
in_gdp_exp	0.209***	-	-
	(0.00721)	-	-
in_gdp_imp	0.133***	0.0469***	0.0729***
	(0.00792)	(0.00254)	(0.00259)
in_tariff	-0.0152	-0.0419***	-0.00923
	(0.0164)	(0.00644)	(0.00588)
in_dist	-0.412***	-0.0272***	-0.118***
	(0.0194)	(0.00663)	(0.00666)
in_tai_imp	0.409***	0.317***	0.431***
	(0.0416)	(0.0193)	(0.0188)
in_tai_exp	0.504***	-	-
	(0.0446)	-	-
in_reer	-0.0387	-0.277***	-0.183***
	(0.0342)	(0.0250)	(0.0197)
land_i	-0.0738*	-	-

	(0.0326)	-	-
land_j	-0.00545	-0.0954***	-0.0544***
	(0.0273)	(0.0102)	(0.0105)
contig	0.216***	0.391***	0.242***
	(0.0396)	(0.0195)	(0.0207)
comlang_off	0.110***	0.0588***	0.0645***
	(0.0224)	(0.00825)	(0.00821)
_cons	-5.703***	-0.765***	-2.342***
	(0.413)	(0.185)	(0.170)
sigma_u			
_cons			
sigma_e			
_cons			
r2	0.376	0.353	0.374
r2_o			
r2_b			
r2_w			

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The movements of the exchange rate play a significant role in partly determining the volume of trade between member states. Results show that the exchange rate in the other importing countries is significant at 1 percent level. Whereas a one percent appreciation in the exchange rate leads to 0.27 percent decline in imports among the other non-COMESA states this was 0.18 percent for all the importers combined, for the COMESA importers, the exchange rate coefficient was not significant.

From a regional integration perspective and as expected, countries bordering each other exert a positive and significant impact on COMESA Member States exports at 1 percent level of significance. Similarly, having a common language between exporters and importers increases the export trade of COMESA Member States. Not only does the exporter being land locked reduce exports among COMESA Member States, but it also reduces imports among them and the importing countries.

The variable of interest in the analysis is the technology innovation which in this study was proxied by the Global Innovation Index (GII). The analysis accounted for the index in both the exporter and importer countries. While in the exporter country it is expected to increase exports, in the importing countries it is expected to increase consumption hence imports. Both the coefficients of the GII for the exporters and importers are positive and significant at 1 percent. An increase in the GII index by 1 percent leads to an increase in COMESA Member States imports by 0.40 percent, non-COMESA importers by 0.32 percent and a combination of the two by 0.43 percent. On the other hand, increasing the GII by 1 percent leads to a 0.5 percent increase in the level and value of exports for the COMESA Member States.

These results suggest that intra-COMESA trade can and should be increased by targeting technology innovation in the region. Following from the literature, this can be achieved through two ways; endeavouring to innovate in the region and adopting technology from countries that have made significant advances in technology innovation. The results agree with Wakelin (1998); Estrada *et al* (2006) and Márquez, & Martínez (2009) who found a strong relationship between innovation and growth of export trade. Perhaps what this study has not addressed, an area for further research as proposed by Lebesmuehlbacher (2015) is technology diffusion and adaptation. The pathways should be established and more so contextualised to the COMESA region.

5.0 Conclusion and Policy Implications

The paper examined the role of technology innovation in determining the intra-COMESA exports and exports to 43 major importing countries. The aim was to estimate the impact of technology innovation on exports. The results suggest that indeed technology is a key element in increasing trade given that it is positively linked to improving the quality of goods and services. When countries innovate, they generate a body of knowledge that enables them to produce new products, improve existing ones and consequently improve on their levels of competitiveness. From the results, it is concluded that increasing technology innovation by 10 percent leads to increase in exports within the COMESA region by 5 percent.

Technology innovation is just one of the many areas to consider in increasing exports and they should not be neglected including trade facilitation to reduce costs of doing business and increase competitiveness among others. Regarding technology innovation, the study recommends that COMESA Member States :

- Establish a COMESA Innovation Fund and increase and target funding of R&D to generate innovative technologies to foster product improvement, development and diversification;
- Formulate innovation policies to address institutional linkages and collaboration, weak engineering and entrepreneurship capabilities and limited financial resources for technological innovation;
- Establish science and technology parks; artisanal and industrial clusters for purposes of incubation;
- Create a database of scientists and engineers that can be organized and networked to provide a critical mass of expertise to advance the STI program; and
- Provide legal and institutional frameworks to enhance technology diffusion, adaptation and harness knowledge from the rest of the world.

References

Alemayehu Geda, Edris Hussein Seid (2015) The potential for internal trade and regional integration in Africa, Journal of African Trade

Ali, Tariq. (2017). Technological Achievements and Economic Development: The Significance of Technological Achievement Gap in Selected East and South Asian Countries. STI Policy Review. 8. 133-156.

Anderson, J E (1979), 'A Theoretical Foundation for the Gravity Equation', *American Economic Review*, 69(1): 106-116.

Anderson, J., 1979. A theoretical foundation for the gravity equation. Am. Econ. Rev. 69 (1), 106–116.

Anderson, J., van Wincoop, E., 2003. Gravity with gravitas: a solution to the border puzzle. Am. Econ. Rev. 93 (1), 170–192.

Behar. A., and Venables., A (2010) Transport costs and International Trade: University of Oxford and CEPR. Paper written for Handbook of Transport Economics, eds André de Palma, Robin Lindsey, Emile Quinet & Roger Vickerman

Bergstrand, J., 1985. The generalized gravity equation, Monopolistic competition, and the factor-proportions theory in international trade. Rev. Econ. Stat. 67, 474–481.

Buxton, T., Mayes, D., & Murfin, A. (1991). UK trade performance and R&D. *Economics of Innovation and New Technology*, *1*(3), 243-256.

Cernat, L. (2001) "Assessing Regional Trade Arrangements: Are South-South RTAs More Trade Diverting?" Policy Issues in International Trade and Commodities Study Series No. 16 (New York: UNCTAD

Chen, M.X., Mattoo. A., 2004. Regionalism in Standards: Good or Bad for Trade, Policy Research Working Papers, No. 3458, World Bank, Washington, DC.

Chen, W. C. (2013). The extensive and intensive margins of exports: The role of innovation. *The World Economy*, *36*(5), 607-635.

Christ N., and Ferrantino.M, (2009) Land Transport for Exports: The Effects of Cost, Time, and Uncertainty in Sub-Saharan Africa Nannette International Trade Commission

Cipollina, M., Demaria, F., & Pietrovito, F. (2016). Determinants of trade: the role of innovation in presence of quality standards. *Journal of Industry, Competition and Trade*, *16*(4), 455-475.

Cohen W. M and Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. Administrative Science Quarterly 35(1), 128– 152

Grossman, Gene M., Elhanan Helpman (1990). Comparative Advantage and Long-Run Growth. American Economic Review 80 (4): 796-815

Deardorff, A. V. (1998),' Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?', in J. A. Frankel, ed., The regionalization of the world economy. Chicago: *University of Chicago Press*: 7-22.

Desai, M., Fukuda-Parr, S., Johansson, C., & Sagasti, F. (2002). Measuring the technology achievement of nations and the capacity to participate in the network age. *Journal of Human Development*, *3*(1), 95-122.

Dollar, David (1986). Technological Innovation, Capital Mobility, and the Product Cycle in North-South Trade. American Economic Review 76 (1): 177-190

Eaton, J., & Kortum, S. (2001). Technology, trade, and growth: A unified framework. *European economic review*, *45*(4-6), 742-755.

Eaton, J., Kortum, S., 2002. Technology, Geography, and Trade, *Econometrica*, 70 (5), pp. 1741-

ECA. (2016). Innovation, Competitiveness and Regional Integration. *Economic Commission for Africa, Addis Ababa, Ethiopia*. Economics, 146(2), pp 199-222

Estrada, S., Heijs, J., & Buesa, M. (2006). Innovation and international trade: a non-linear relationship. *Spanish commercial information*, *830*, 83-107.

Fagerberg, J. (1997), "Competitiveness, scale and R&D". En: Fagerberg, J., Hansson, P., Lundberg, L. y Melchior, A., eds., Technology and International Trade. Cheltenham, UK, Edward Elgar: 38-55.

Feenstra, Robert C., Markusen, James A., & Rose, Andrew K., 1998.Understanding the Home Market Effect and the Gravity Equation: The Role of Differentiating Goods. NBER Working Papers 6804. NationalBureau of Economic Research, Inc.

Grossman, G. M., & Helpman, E. (1989). Product development and international trade. *Journal of political economy*, *97*(6), 1261-1283.

Galbraith, J. K. (1967). The New Industrial State, Penguin, Harmondsworth, England.

Grossman, G. M., Helpman, E., 1989. Product Development and International Trade. *The Journal of Political Economy*, 97 (6), pp. 1261-83.

Grossman, G. M., Helpman, E., 1991a. Quality Ladders and Product Cycles. *The Quarterly Journal of Economics*, 106 (2), pp. 557-86.

Herrera Estrella Gomez (2011) Comparing alternative methods to estimate gravity models of bilateral trade, University of Granada, Campus de la Cartuja s/n, 18071 Granada, Spain

Hummels David (2007) Transportation Costs and International Trade in the Second Era of Globalization

Journal of Economic Perspectives—Volume 21, Number 3—Summer 2007—Pages 131–154

Krugman, Paul (1979). A Model of Innovation, Technology Transfer, and the World Distribution of Income. Journal of Political Economy 87 (2): 253-266. Kuznets

Lebesmuehlbacher, T. (2015). Understanding Technology Diffusion: The Role of International Trade and Factor Movements.

Leontief, W. Otros (1953). *Studies in the Structure of the American Economy. Theoretical and empirical explorations in input-output analysis, Nueva York: Oxford University Press*.

Márquez-Ramos, L., & Martínez-Zarzoso, I. (2009). The effect of technological innovation on international trade: a nonlinear approach. *Economics discussion paper*, (2009-24).

Matambalya, F., Yeboah, K., Nyadu-Addo, R. 2015. Exploring the Prospects for Tourism Innovation in Africa. Concept paper prepared Conference for Advancement of Business and Management Practices in Africa 2015. Leipzig (Germany).

Nakkazi, E. (2012). COMESA Council set up to promote science and technology. The EastAfrican, Aug. 12, 2012, available at, https://www.theeastafrican.co.ke/news/Comesa-council-set-up-to-promote-science-and-technology/2558-1639716-view-printVersion-nhpff1/index.html

Porter, M. E. (1998). *Clusters and the new economics of competition* (Vol. 76, No. 6, pp. 77-90). Boston:

Portugal-Perez, Alberto and John S. Wilson (2012) "Export Performance and Trade Facilitation Reform: Hard and Soft Infrastructure", World Development Vol 40, No.7 pp1295-1307, 2012

Posner, M.V (1961). International trade and technical change. Oxford Economic Papers 13, 323–341

Pöyhönen, P. (1963), 'A Tentative Model for the Volume of Trade Between Countries', *Weltwirtschaftliches Archive*, 90: 93-99.

Santacreu, A. M. (2015). Innovation, diffusion, and trade: Theory and measurement. *Journal of Monetary Economics*, *75*, 1-20.

Schumpeter, J. A. (1919). Imperialism and Social Classes, with an introduction by Bert Hoselitz, translated by Heinz Norden. *New York: Meridian Books*, *1927*(1955), 1890-1914.

Schumpeter, J.A. (1940). The Influence of Protective Tariffs on the Industrial Development of the United States. Proceedings of the Academy of Political Science, 2-7.

Schumpeter, J.A. (1942). Capitalism, Socialism and Democracy. George Allen and Unwin: New York. S

Segerstrom, Paul S., T.C.A. Anant, Elias Dinopoulos (1990). A Schumpeterian Model of the Product Life Cycle. American Economic Review 80 (5): 1077-1091.

Silva, Joao Santos, Tenreyro, Silvana, 2006. The log of gravity. Rev. Econ. Stat. 88 (4), 641–658.

Studenmund AH (2001) Using Econometrics – A Practical Guide, San Francisco, CA, Addision Wesley Longman

Tinbergen, J., 1962. Shaping the world economy. Suggestions for an international economic policy, The Twentieth Century Fund, New York.

Vernon, R (1966). International investment and international trade in the product cycle. Quarterly Journal of Economics 80, 190–207

Wakelin, K. (1998). The role of innovation in bilateral OECD trade performance. *Applied Economics*, *30*(10), 1335-1346.

Xiong, B., Beghin, J. C., 2012. Does European aflatoxin regulation hurt groundnut exporters from Africa? *European Review Agricultural*

Young, Alwyn (1991). Learning by Doing and the Dynamic Effects of International Trade. Quarterly Journal of Economics 106 (2): 369-405.

Zahra, S. and George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. Academy of Management Review 27 (2), 185–203.

Appendix:

Figure 1A: The strong relationship between the innovation and competitive indices

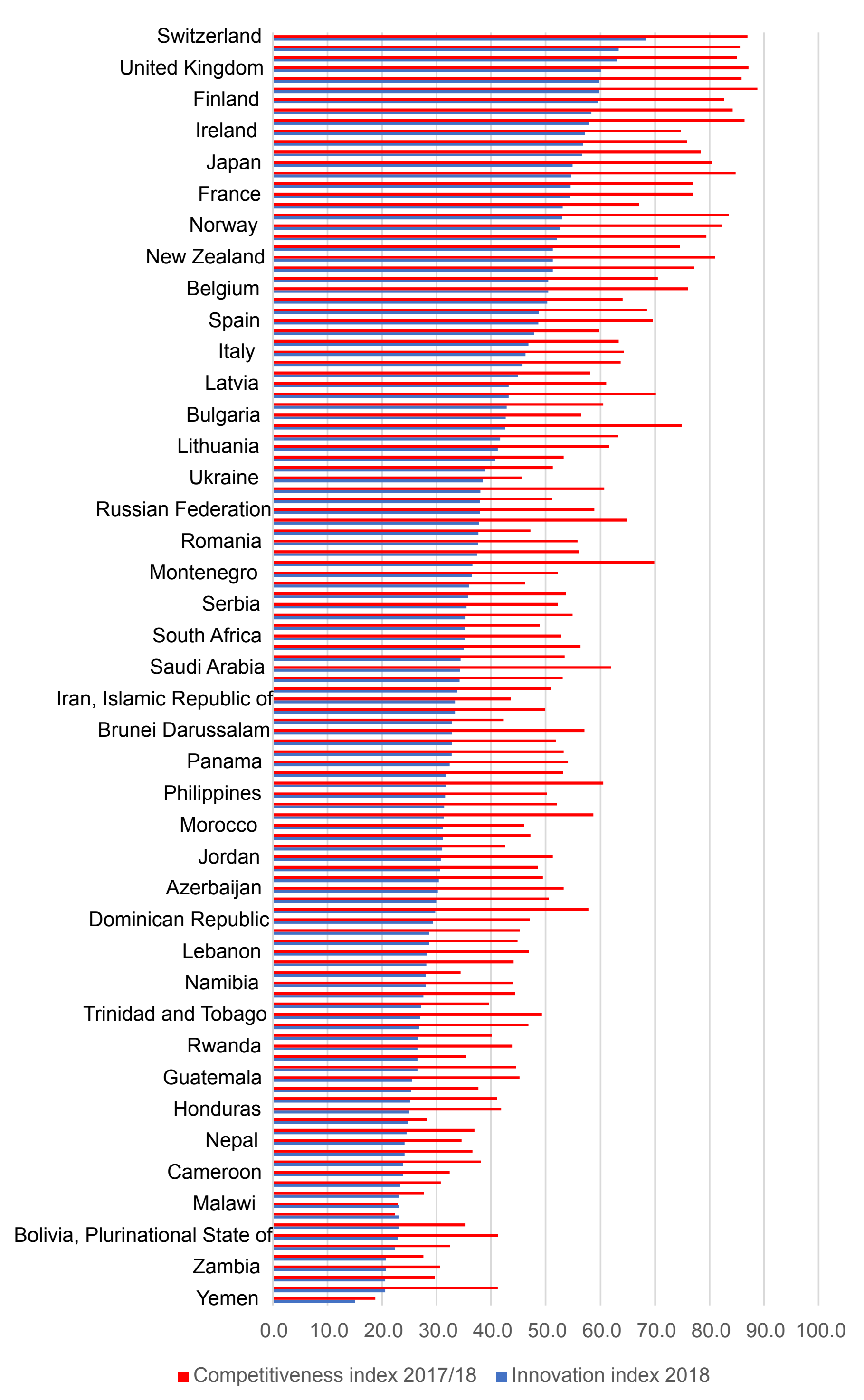


Table A1: The countries that constitute the trading partners in this research

	COMESA Member States		Other Main Importing Partners		
1	Burundi	1	Algeria	22	Malaysia
2	Comoros	2	Australia	23	Morocco
3	DR Congo	3	Austria	24	Mozambique
4	Djibouti	4	Belgium	25	Netherlands
5	Egypt	5	Brazil	26	Nigeria
6	Eritrea	6	Canada	27	Pakistan
7	Ethiopia	7	China	28	Portugal
8	Kenya	8	France	29	Russian
9	Libya	9	Germany	30	Saudi Arabia
10	Madagascar	10	Greece	31	Singapore
11	Malawi	11	Hong Kong	32	South Africa
12	Mauritius	12	India	33	Spain
13	Rwanda	13	Indonesia	34	Sweden
14	Seychelles	14	Iraq	35	Switzerland
15	Somalia	15	Ireland	36	Syria
16	Sudan	16	Italy	37	Tanzania
17	Sudan	17	Japan	38	Thailand
18	Swaziland	18	Jordan	39	Turkey
19	Tunisia	19	Korea	40	UAE
20	Uganda	20	Kuwait	41	UK
21	Zambia	21	Lebanon	42	USA
22	Zimbabwe			43	Yemen

Table A2: The variables used in this study their description and sources

Variable	Description	Source
in_exprts: Exports from i to j	Value of exports from the 21 COMESA countries to 21 COMESA and other 43 main importers, in thousands of US dollars	Trade map
in_trans_exp: Exporter's transport costs	Transport costs (US$ per container)	Doing Business
in_trans_imp: Importer's transport costs	Transport costs (US$ per container)	Doing Business
in_gdp_exp: Exporter's income	Exporter's GDP, PPP (current international $)	World Bank -Development Indicators
in_gdp_imp: Importer's income	Importer's GDP, PPP (current international $)	World Bank-Development Indicators
in_tariff: Tariffs	Tariffs levied in the importers country	WITS (World Bank)
in_dist: Distance	Great circle distances between the most important cities in trading partner	CEPII:http://www.cepii.fr/anglaisgraph/bdd/distances.htm
in_tai_imp: Innovation Index	Global Innovation Index	www.globalinnovationindex.org.
in_tai_exp	Global Innovation Index	www.globalinnovationindex.org.
in_reer: Exchange rate	Real effective exchange rate	World Bank -Development Indicators
land_i: Landlocked dummy	Dummy variable = 1 if the exporting country is landlocked, 0 otherwise.	CEPII:http://www.cepii.fr/anglaisgraph/bdd/distances.htm
land_j: Landlocked dummy	Dummy variable = 1 if the importing country is landlocked, 0 otherwise.	CEPII: http://www.cepii.fr/anglaisgraph/bdd/distances.htm
contig: share border	Dummy variable = 1 if the trading partners share a common border, 0 otherwise	CEPII:http: //www.cepii.fr/anglaisgraph/bdd/distances.htm
comlang_off: share a common language	Dummy variable = 1 if the trading partners share the same official language, 0 otherwise	CEPII :http://www.cepii.fr/anglaisgraph/bdd/distances.htm
Comcol: whether both had a common coloniser	Dummy variable = 1 if the trading partners have ever had a colonial link, 0 otherwise.	CEPII :http://www.cepii.fr/anglaisgraph/bdd/distances.htm

Table A3: Results of muli-collinearity for the independent variables

	tra_ cost _exp	tra_ cost _imp	gdp_ exp	gdp_ imp	tariff	dist	tai_ imp	tai_ exp	reer	land_i	land_j	contig	lang _off	comcol
tra_cost_exp	1.00													
tra_cost_imp	0.07	1.00												
gdp_exp	-0.20	-0.01	1.00											
gdp_imp	-0.02	-0.14	0.01	1.00										
tariff	0.05	0.39	-0.01	-0.14	1.00									
dist	-0.01	-0.35	-0.09	0.39	-0.38	1.00								
tai_imp	-0.04	-0.46	0.01	0.30	-0.69	0.58	1.00							
tai_exp	-0.13	-0.02	0.13	0.01	-0.02	0.06	0.05	1.00						
reer	-0.05	0.11	0.01	-0.03	0.36	-0.14	-0.30	-0.02	1.00					
land_i	-0.01	0.52	0.01	-0.17	0.06	-0.30	-0.14	-0.03	-0.05	1.00				
land_j	0.59	-0.01	-0.19	0.00	0.01	0.02	0.00	0.08	0.01	-0.02	1.00			
contig	0.10	0.22	0.00	-0.09	0.20	-0.30	-0.21	-0.07	0.05	0.10	0.08	1.00		
comlang_off	-0.05	0.10	-0.08	-0.08	0.12	-0.16	-0.11	0.08	0.03	0.11	0.00	0.11	1.00	
comcol	0.06	0.09	-0.11	-0.11	0.12	-0.21	-0.20	0.11	0.08	0.08	0.10	0.12	0.33	1.00

Table A4: The framework for different data used in constructing the Global Innovation index

Index	
1	**Institutions**
1.1.	Political environment
1.1.1.	Political stability and absence of violence/terrorism
1.1.2.	Government effectiveness
1.1.3.	Press freedom
1.2.	Regulatory environment
1.2.1.	Regulatory quality
1.2.2.	Rule of law
1.2.3.	Cost of redundancy dismissal
1.3.	Business environment
1.3.1.	Ease of starting a business
1.3.2.	Ease of resolving insolvency
1.3.3.	Ease of paying taxes
2	**Human capital and research**
2.1.	Education
2.1.1.	Expenditure on education
2.1.2.	Public expenditure on education per pupil
2.1.3.	School life expectancy
2.1.4.	Assessment in reading, mathematics, and science
2.1.5.	Pupil-teacher ratio, secondary
2.2.	Tertiary education
2.2.1.	Tertiary enrolment
2.2.2.	Graduates in science and engineering
2.2.3.	Tertiary inbound mobility
2.2.4.	Gross tertiary outbound enrolment
2.3.	Research and development (R&D)
2.3.1.	Researchers
2.3.2.	Gross expenditure on R&D (GERD)
2.3.3.	QS university ranking average score of top 3 universities
3	**Infrastructure**
3.1.	Information and communication technologies (ICTs)
3.1.1.	ICT access
3.1.2.	ICT use
3.1.3.	Government's online service
3.1.4.	Online e-participation
3.2.	General infrastructure
3.2.1.	Electricity output
3.2.2.	Electricity consumption
3.2.3.	Logistics performance

3.2.4.	Gross capital formation
3.3.	Ecological sustainability
3.3.1.	GDP per unit of energy use
3.3.2.	Environmental performance
3.3.3.	ISO 14001 environmental certificates
4	**Market sophistication**
4.1.	Credit
4.1.1.	Ease of getting credit
4.1.2.	Domestic credit to private sector
4.1.3.	Microfinance institutions' gross loan portfolio
4.2.	Investment
4.2.1.	Ease of protecting investors
4.2.2.	Market capitalization
4.2.3.	Total value of stocks traded
4.2.4.	Venture capital deals
4.3.	Trade and competition
4.3.1.	Applied tariff rate, weighted mean
4.3.2.	Market access for non-agricultural exports
4.3.3.	Intensity of local competition
5	**Business sophistication**
5.1.	Knowledge workers
5.1.1.	Employment in knowledge-intensive services
5.1.2.	Firms offering formal training
5.1.3.	GERD performed by business enterprise (% of GDP)
5.1.4.	GERD financed by business enterprise (% of GERD)
5.1.5.	GMAT mean score
5.1.6.	GMAT test takers
5.2.	Innovation linkages
5.2.1.	University/industry research collaboration
5.2.2.	State of cluster development
5.2.3.	GERD financed by abroad
5.2.4.	Joint venture/strategic alliance deals
5.2.5.	Patent families filed in at least three offices
5.3.	Knowledge absorption
5.3.1.	Royalties and license fees payments (% of service imports)
5.3.2.	High-tech imports
5.3.3.	Communications, computer and information services imports, %
5.3.4.	Foreign direct investment net inflows
6	**Knowledge and technology outputs**
6.1.	Knowledge creation
6.1.1.	National office resident patent applications

6.1.2.	Patent Cooperation Treaty resident applications
6.1.3.	National office resident utility model applications
6.1.4.	Scientific and technical publications
6.1.5.	Citable documents H index
6.2.	Knowledge impact
6.2.1.	Growth rate of GDP per person engaged
6.2.2.	New business density
6.2.3.	Total computer software spending
6.2.4.	ISO 9001 quality certificates
6.2.5.	High-tech and medium-high-tech output
6.3.	Knowledge diffusion
6.3.1.	Royalties and license fees receipts (% service exports)
6.3.2.	High-tech exports
6.3.3.	Communications, computer and information services exports, %
6.3.4.	Foreign direct investment net outflows
7	**Creative outputs**
7.1.	Intangible assets
7.1.1.	National office resident trademark registrations
7.1.2.	Madrid system trademark registrations by country of origin
7.1.3.	ICTs and business model creation
7.1.4.	ICTs and organizational models creation
7.2.	Creative goods and services
7.2.1.	Audiovisual and related services exports
7.2.2.	National feature films produced
7.2.3.	Daily newspapers circulation
7.2.4.	Printing and publishing output
7.2.5.	Creative goods exports
7.3.	Online creativity
7.3.1.	Generic top-level domains (gTLDs)
7.3.2.	Country-code top-level domains (ccTLDs)
7.3.3.	Wikipedia monthly edits
7.3.4.	Video uploads on YouTube

www.globalinnovationindex.org.

Does the Quality of Governance Matter in the Nexus between Innovation and Intra-Regional Exports? **The Case of COMESA.**

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Abstract

COMESA region has for a long time been struggling to raise its intra-exports to levels being enjoyed by other regions. Low innovation levels, as an impediment to competitiveness, is argued to be one of the major causes of low intra trade. Again, poor quality institutions/governance in COMESA Member States are also being debated to be the origin of low innovation leading to low trade. This study inquired on whether institutions have a role to play in the nexus between innovation and trade. The findings indicate that innovation is critical in stimulating intra-COMESA exports and that the impact of innovation on intra-COMESA exports increases with improvement in the quality of institutions. COMESA Member States are encouraged to improve on various facets of governance indicators in order to stimulate innovation led intra-COMESA exports.

Key words: Intra-Exports, Governance, Innovation and COMESA

1.0 Introduction

The agenda to increase intra-regional trade has seized COMESA for a long time with minimal success. Low innovation levels and its implications on competitiveness is argued to be one of the causes of low intra trade. The lower level of innovations in the COMESA region itself is reasoned to have its origins in poor quality institutions/governance existing within COMESA Member States. Therefore, this study intends to stimulate a COMESA focussed debate leading to clear policy discussions grounded on economic and institutional realities pointing out not only the role of governance in achieving innovation and the importance of innovation in trade competitiveness but also flagging out such public policy initiatives that would help the region achieve such goals. Thus, the specific objective of this study is to assess the role of governance/institutions in the relationship between innovation and intra-COMESA exports.

1.1 Background to the Study

While intra-African trade is just 15 percent of its trade with the world, the European Union (EU) trades 70 percent of its goods within itself and 51 percent of Asian trade and 19 percent of Latin-American trade are destined within their respective regions. This relative statistics show how Africa is remote to itself in terms of trade. COMESA pattern of trade is no different. It's remarkable that intra-COMESA exports increased from US$1.5 billion in 2000 to US$9 billion in 2015. However, the 2015 intra-exports constituted only 12.2 percent of the region's global exports, (Ahmed, 2017). COMESA's intra-exports averaged 12 percent of total regional trade between 2001 and 2017. This can be compared to the 50 percent and 19 percent of Southern African Development Community (SADC) and Community of Sahel-Saharan States (CENSAD) respectively, (Chidede and Sandrey, 2018). Intra-exports for COMESA even dropped to 10.2 percent in 2016, (African Trade Report, 2018), and in the same year East African Community (EAC), traded 20.3 percent within itself, the Association of Southeast Asian Nations (ASEAN) traded 24.2 percent, the SADC traded 20.6 percent, and EU traded 63.6 percent within its region. A further drop of 1.76 percent in intra-COMESA exports from the value recorded in 2016 was also noted in 2017, (African Trade Report, 2018). The fact that should be accepted is that intra-COMESA exports are low relative to other regions and this category of trade is on a declining trend which calls for urgent interventions. Innovation is one possible option that COMESA can embrace to save the situation. Innovation brings with it greater potential of introducing wholly new products, designs and industries that improves the region's competitiveness to foreign products.

Unfortunately, COMESA has not been recently performing well in the innovation front. Figure 1 shows the COMESA's output of innovation activities from the period 2008 to 2017 as reflected by number of patents filled with the European Patent Office[20]. Whilst the number of patents filed fluctuated over the period 2008 to 2017, the region registered its pick in 2015 with 102 patents filed. After 2015, the trend began to fall.

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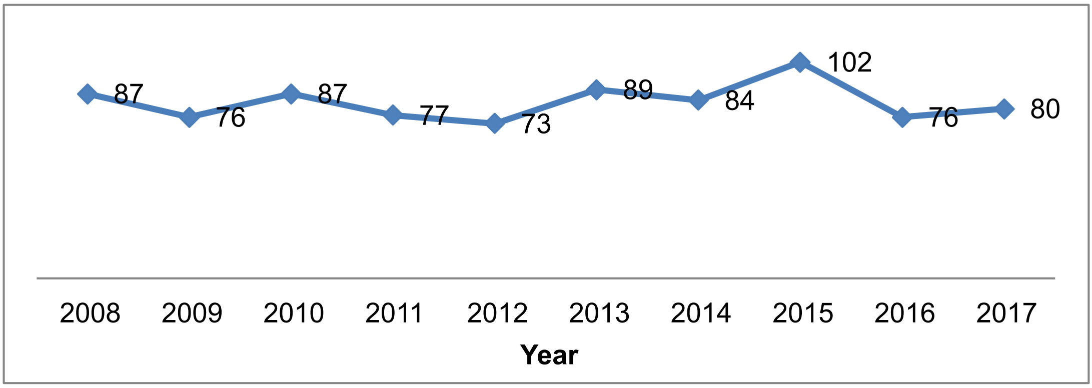
20 Other studies use data on patents filled at the US Patents Office, analysis of the two data sets show no much differences.

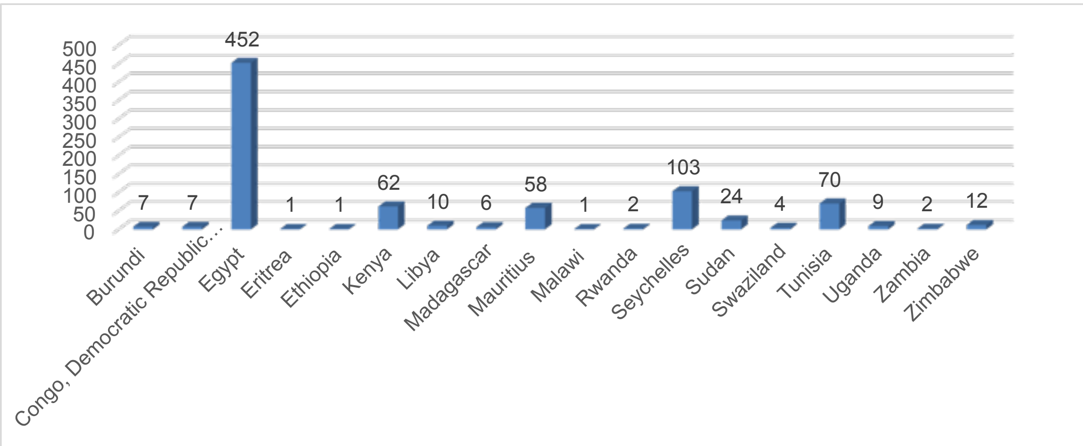
Figure 1: COMESA Patents Filings with the European Patent Office: 2008-2017



Source: Author compilation: Data accessed from EPO database

A closer look at individual COMESA Member States indicate that over the period 2008 to 2017, Egypt has been the leading innovating country followed by Seychelles with Tunisia, Kenya and Mauritius occupying the 3rd, 4th and 5th position respectively as shown in Figure 2.

Figure 2: European Patent Fillings by the Country of Origin: 2008-2017



Source: Author's compilation: Data accessed from EPO database

Economic theory has predicted that innovation can stimulate a country's exports, (Archibugil & Michie, 1998; Posner, 1961; and Krugman, 1979). Whilst the positive role of innovation in stimulating exports has been empirically validated by Piccardo, Bottasso, & Benfratello (2013); Blyde, Iberti, & Mussini (2015) and Sandu & Ciocanel (2014) among other researchers, the declining trend in innovative output in the COMESA region would mean that the exploitation of innovation to stimulate exports should begin with understanding the factors behind the region's falling innovativeness trends.

Institutional economic theories offer insights into factors determining technological innovation, (Easterly & Levine, 2001). Institutional economics emphasise that property rights, legal structure, regulatory structures, contract protection, corruption, good corporate governance and good economic policies are key determinants of technological progress, (Hall & Jones, 1999; Easterly & Levine, 2001; and Rodrik, Subramanian, & Trebbi, 2002). The highlighted institutional variables define the structure of incentives available that induce economic agents to mobilise resources so that they invest in knowledge generation activities. The relationship between innovation and institutions has also been empirically corroborated by Barasa, Knoben, Vermuelen, Kimunyu, & Kinyanjui (2017), Wang (2013), Tebaldi & Elmslie (2013), Rodríguez-Pose & Di-Cataldo (2013), Funda (2007) and Oluwatobi, Efobi, Isaiah, & Alege (2014) among others. With that background, COMESA Member States scored much lower on the six World Governance Indicators (WGI) for the period 2008 to 2016. In all the six WGI, COMESA Member States scored below -0.6 on average for the period 2008 to 2016. The WGI are measured on a scale ranging from -2.5 to 2.5 with 2.5 being the best perfoming and -2.5 the least performing.

Noting the presented trends in intra-exports, innovativeness and governance indicators for the COMESA region, coupled with the theoretically and empirically predicted linkages flowing from institutions through innovation to trade performance, it is therefore argued in this paper that the agenda to achieve innovation-led intra-COMESA export growth should be anchored on strong reforms targeted to stimulate innovation in the region and that governance plays a principal role in this effort. This paper seeks to validate this hypothesis.

The rest of the paper is organised as follows: section two is literature review; section three is methodology; presentation and discussion of results is in section four and section five is conclusion and policy implications.

2.0 Literature Review

2.1 Review of Theoretical Literature

Since the 1960s, economists developed models explaining the role of innovation in international trade competitiveness. Posner (1961) developed a technology gap trade theory in which innovation was a determinant of export market share. Process innovation reduces production costs and hence increases output per unit of input. This increase in productivity enables firms to enter and compete in international markets whilst less productive firms exit the market, (Melitz, 2003). Archibugil & Michie (1998) argued that innovation affects exports through three channels.

Firstly, process innovation reduces production costs resulting in low output prices making products more competitive in export markets. In bilateral trade, the landed price in the export market is a function of the factory-gate prices in the country of origin, which is marked up by bilateral transaction costs, (Larch & Yotov, 2016). Thus, the ideal conditions that favours exports from country of origin are efficient production yielding low factory-gate price and low transaction costs between the trading countries. This formulation is in line with the economic theory of demand which postulates that highly priced goods are less demanded and the vice versa, (Yotov, Piermartini, Monteiro, & Larch, n.d). Secondly, minor product innovations improve the quality of products making them attractive in foreign markets and finally, major product innovations create, for a limited time due to lag in imitations, a monopolistic position that help impose the products in the foreign market. It is also critical to observe that the entry point of innovation to have an effect on exports is through production by either process innovation or coming up with new products.

Whilst innovation can stimulate exports, the effect of a once off innovation on exports does not persist into the future due to replications in the export market. To explain the long run growth of exports resulting from innovation, Krugman (1979) developed a model of international trade in which the pattern of trade is dependent on a continuous process of innovation and technology transfer. He hypothesises a world of two countries, an innovating developed country and non-innovating developing country. Innovation takes place in the developed country in the form of producing new products that are exported to the non-innovating developing country. These new products are later produced in developing countries due to technological transfer. The lag in technological adoption by the developing country is what leads to trade taking place. Once a technology is adopted by developing country, the respective product becomes old and for trade to continue taking place, the developed country must develop yet another new product and export to developing countries. In short, for trade to take place in the Krugman model, innovation by developed countries and technological transfer to developing countries must be a continuous process.

The theoretical arguments motivated so far in this paper on the effect of innovation on exports can be summarised in a mathematical expression as follows:

$$X\_ijt=f(\delta\_it; \pi) \quad (3.1)$$

Where X_{ijt} are exports from country *i* to country *j* at time *t*, δ_{it} is a vector of innovation variables in the exporting country at time *t* and π is a vector of other variables that influence exports.

Equation 3.1 presents the argument that exports are a function of innovation and other variables. Should the impact of innovation on exports be validated by empirical analysis using data from COMESA Member States, the policy recommendation would be that COMESA Member States should consider scaling up innovation to stimulate exports. The policy questions that remain unanswered are how to scale up innovation and using which policy options? Relatively, COMESA has ranked low over the years in various indicators of innovations implying that the understanding of the impact of innovation on exports alone is not enough. Similarly, important is the exposition of the sources of innovation in the COMESA region.

An important point made in the Krugman's theory which is more relevant to this study is that technological transfer from developed countries is a source of innovation for developing countries through imitations. However, Krugman does not motivate the inspiration behind his model's assumption that innovation is not expected to originate from developing countries. The model implies that developing countries do not have conducive environment to breed new innovations and if there could be any technological innovations in developing countries, it should have been adopted from developed countries. Whilst Krugman categorically stated that his model only focuses on the effects of technological innovations on international trade and not the sources of innovation, the unidirectional flow of innovation from developed to developing countries predicted in his model speaks volumes on the likelihood of incidence of a raft of innovation barriers in developing countries. However, the predicted unidirectional flow of technological change has been seriously refuted by facts that there exist patents applications to protect innovations from developing countries.

Between 1985 and 1995, about 2,757 applications were made in Brazil, 1,545 in India, 5,549 in South Africa and 59,249 in South Korea, (Chen & Puttitanun, 2005). Though developing countries are innovating, developed countries are much more into innovation given that about 9,325 applications were made in Australia, 3,039 in Canada, 33,5061 in Japan and 127,476 in USA during the same period. This suggest there are certain stimulants to innovation in developed countries that are lacking in developing countries. Thus, the endeavour to stimulate intra-COMESA trade through innovation cannot be achieved by merely looking at various channels linking innovation to trade without consideration of whether there exists a conducive environment that incentivise technological innovation within COMESA Member States.

Literature on economic growth theories attempts to explain sources of innovation. Solow (1956) in a neoclassical framework of growth argued that technological change account for more than 50% of economic growth. However, he regarded technological innovation as exogenous defining it as a residual not explained by growth in labour and capital. The fact that little was known on the residual that accounted much of economic growth, Abramovitz (1956), posited that it is a measure of ignorance on the process of economic growth.

Further to the Solow model are endogenous growth theories which came in two categories. The first category considers technological innovation as an unintended result of investment by firms and individuals, (Romer, 1986; Lucas, 1988). They argue that knowledge gained by labour either through learning by doing or training from college is characterised by non-excludability. The spill over positive effects of this knowledge cannot be internalised by firms though the knowledge is gained as result of their investment. Thus, investment by one firm or individuals may result in increasing the stock of knowledge in the entire economy. The second category hypothesises that technological innovation arises due to deliberate actions by economic agents driven by financial incentives, (Romer, 1994). In this category, innovations are partially excludable because of instituted patent laws allowing generators a limited time period to earn a return on their investment. Partial excludability of innovations coupled with the non-rivalry nature of knowledge generation incentivise firms to invest in innovation whilst guaranteeing that at some point there will be positive spill-over effect that will increase the total stock of knowledge in the economy.

Institutional economic theory also appeared to explain what determines technological progress. Easterly & Levine (2001) argued that it is not factor accumulation but something else is responsible for explaining long run economic growth. They referred to the 'something else' to mean total factor productivity (TFP). They pointed out that national policy plays an important role in explaining technological progress as measured by TFP. Institutional economics emphasised that property rights, legal structure, regulatory structures, contract protection, corruption, good corporate governance and good economic policies are key determinants of technological progress, (Hall & Jones, 1999; Easterly & Levine, 2001; and Rodrik, Subramanian, & Trebbi, 2002). These variables define the structure of incentives available that induce economic agents to mobilise resources so that they invest in knowledge generation.

Integrating the views of institutional and endogenous growth theories, we observe that firms and individuals have resources that they can deploy to undertake innovative activities and that the decision to transform these resources into innovation is influenced by quality of institutions. Three key innovation inputs at firms' disposal include internal R&D resources, human capital resources and managerial experience. Institutions play a critical role to transform these resources into innovative outputs, (Barasa, Knoben, Vermuelen, Kimunyu, & Kinyanjui, 2017). In order to formulate adequate policy responses, it is important to understand the anatomy of how institutions moderate economic agents' decisions to transform resources at their disposal into innovative outputs.

When firms invest in R&D they increase their technical knowledge base which can be used to develop new cost cutting processes, new products or improve existing products enhancing their competitiveness in both domestic and international markets. This investment in R&D is done in expectation of monetary returns and institutions that guarantee such a return on investment through protecting knowledge from imitations induce more R&D investment by firms leading to an increase in innovative outputs, (Romer, 1994; Wang, 2013). It is argued that rule of law affects the investment propensity of innovative firms. Again, effective and impartial courts are essential determinants of innovation as they are able to enforce contracts and rules, and punish infringements, (Rodríguez-Pose & Di-Cataldo, 2013). Poor institutions do not protect intellectual property rights and thus discourage firms to invest in knowledge generation. Under corrupt environments, the permit and licensing requirement expose innovating firms to extortion by government officials. Barasa, Knoben, Vermuelen, Kimunyu, & Kinyanjui (2017) argued that corrupt environments reduces the likelihood and the magnitude of investment by firms in R&D.

Institutions influence the human capital absorptive capacity, a critical attribute determining the firms' ability to identify, assimilate and exploit knowledge from external environment and transform it into new business processes and new products. Education systems in countries with poor regulatory quality and high corruption levels would see people getting degrees fraudulently, mushrooming of privately owned unregistered and unregulated training institutions and enrolment systems based on privilege rather than achievements. Graduates produced under such institutional environment would lack critical skills required to transform other resources of firms into innovative outputs, (Wang, 2013).

Similarly, the tacit knowledge of experienced managers is critical in selecting most promising innovation projects. However, managers scan the internal and external environments in making such decisions. The external environment includes government requirements and corruption burden of deliberately delaying project approval or declining permits in a bid to extract rents. The external environment can persuade managers to decide on investing on R&D project or to stay such investments depending on the results of environmental scanning.

An elaborate role of institutions in promoting innovation performance of a country can be best seen in an innovation system context. An innovation system is a network or a group of firms, public research institutes, and several innovation facilitators working in interaction to promote innovation within a 'framework of institutions' that facilitate diffusion and application of the new innovative outputs, (Schrempf, Kaplan, & Schroeder, 2013). The framework of institutions refers to set rules and norms which are created to govern interaction of actors of the innovation system. As such institutions include laws, policies, rules, contracts, regulations, social conventions and traditions, (Schrempf, Kaplan, & Schroeder, 2013).

Institutions in the innovation system can be public or private. This paper is interested in the role of public institutions. Looking at elements on the innovation system reveals the importance of public institutions in stimulating innovation. An innovation system consists of five elements which are sources of innovation, institutions, interactive learning, interaction, and social capital, (Schrempf, Kaplan, & Schroeder, 2013). Sources of innovation include R&D, producer-consumer interaction, availability of equipment and training of workers. These sources show that innovation takes place in production, distribution and consumption. Institutions shape the interactions among the actors within the system, for example government set policies that influence the process of innovation, diffusion and application of the innovation output.

The innovation system emphasises a continuous interactive learning and this essentially links the system to firms human resources management, labour market laws/institutions, learning capabilities and absorptive capacity of firms and the economy at large. Government policies that promote university-public research institutes and industry collaboration becomes relevant. Government also play a central role in developing flexible and costs reducing labour laws, higher education and R&D policies that provide incentives for industry-universities linkages, (Schrempf, Kaplan, & Schroeder, 2013; Rodríguez-Pose & Di-Cataldo, 2013). Innovation takes place in an interactive environment of continuous knowledge production, diffusion and application. These interactions are coordinated by institutions and inefficient coordination leads to a complete failure of the whole system. Finally, social capital, trust, is argued to be high in innovation systems with high quality institutions. High trust positively influence innovation as it reduces the risk associated with innovation such as the risk of financing.

As opposed to the market failure view of neoclassical theory where institutions (patenting of intellectual property) only creates markets, the innovation systems give a broader role of institutions in innovation performance of a country. Governments through innovation policies set the direction of technological innovation, through specific policies and laws incentives financing of R&D by local banks and development partners, absorbs the financing risks, reduces transaction costs, promotes diffusion and adoption of the new knowledge when generated, (Stiglits, 2008; Rodríguez-Pose & Di-Cataldo, 2013).

Though the innovation system is more of an analytical tool, real applications that mimic the concept can be seen in Silicon Valley of USA, Midi-Pyrenees region of France, Steiermark of Australia, and the Baden – Wurttemberg in Germany, (Schrempf, Kaplan, & Schroeder, 2013). Export oriented medium and high-tech industrial parks developing in Ethiopia and the special economic zones concept being adopted by African countries that include Zimbabwe, reflect the innovation system where institutions play a central role.

2.2 Review of Empirical Literature

2.2.1 Innovation - Exports Nexus

Piccardo, Bottasso, & Benfratello (2013) assessed the role of innovation on firms export intensity using a cross sectional data for Italian manufacturing firms. They established that innovation as measured by expenditure on R&D positively affect export intensity.

In an analysis of the impact of innovation on exports using the 2009 cross sectional data for Chile firms, Blyde, Iberti, & Mussini (2015) established that innovation have a positive and significant impact on exports. They further found out that the effects of innovation on exports vary according to income level of the destination market. Innovation had greater impact on exports destined for high income country relative to a low-income country. They argued that firms innovate to sell to markets that reward innovation.

Sandu & Ciocanel (2014) evaluated the impact of innovation on exports of medium and high-tech products for 27 EU countries for the 2006-2010 period. Their results indicated that innovation influence high-tech exports of EU countries. However, the effects vary across various indicators of R&D expenditure. Private expenditure on R&D had a stronger impact on high-tech exports relative to the effects of public expenditure on R&D.

Ghanbari & Ahmadi (2017) investigated the nexus between innovation and exports of 3 medium high-tech industries using panel data spanning 2003-2012 for four countries, Iran, Japan, Korea and Australia. Their results have shown that innovation highly influences export performances of all industries.

The role of innovation in promoting exports is so apparent in the reviewed literature (Piccardo, Bottasso, & Benfratello, 2013; Sandu & Ciocanel, 2014; and Blyde, Iberti, & Mussini, 2015). However, there are also other strands of empirical literature advancing the feedback effect, that is, learning by exporting, (Lin & Tang, 2013). This suggests that when investigating the innovation-exports nexus empirically, one must consider controlling for endogeneity, (Piccardo, Bottasso, & Benfratello, 2013;

Blyde, Iberti, & Mussini, 2015). Palangkaraya (2012) using a panel data of 3000 Australian small and medium businesses established a positive relationship between innovation and exports. Regarding causality, he found out that there exists a bi-directional relationship between process innovation and exports of services only. For product innovation, there existed a one directional causal relationship running from innovation to exports. Similarly, Lin & Tang (2013) found out that, in China, though exporting firms have higher expenditure on R&D, exporting have a weak impact on innovation among exporting firms. According to Wagner (2012) as quoted in Piccardo, Bottasso, & Benfratello (2013), there is strong evidence that innovative firms self-select into exporting whilst the learning by exporting hypothesis is weakly supported.

2.2.2 Institutions-Innovation Nexus

This institution and innovation nexus has also been subject to many empirical analysis though this review could not find any study focussing on COMESA. The hypothesis that higher institutional quality stimulates innovation have been substantiated by a number of studies that include Barasa, Knoben, Vermuelen, Kimunyu, & Kinyanjui (2017), Wang (2013), Tebaldi & Elmslie (2013), Rodríguez-Pose & Di-Cataldo (2013), Funda (2007) and Oluwatobi, Efobi, Isaiah, & Alege (2014).

Barasa, Knoben, Vermuelen, Kimunyu, & Kinyanjui (2017) used the World Bank Enterprise Survey data covering 2010-2012 for Kenya, Tanzania and Uganda and employed the logistic regression model to assess the moderation role of institutions in transforming firm resources into innovative products. They first found out that internal R&D, level of education, labour experience and managerial experience are statistically significant determinants of firm level innovation. Secondly, they established that the effects of internal R&D, level of education and labour experience on innovation is depended on the quality of institutions.

Wang (2013) employed the OLS estimator to investigate the effects of institutions on R&D intensity using a sample of 162 countries for the period spanning 1996 to 2009. The study found out that institutions are important and statistically significant determinants of R&D intensity. Furthermore, the study established that the effects of institutions on R&D intensity are higher in countries which are financially more developed, and those with human capital development. Openness to international trade had a neutral influence on the institutional effects on R&D intensity.

Tebaldi & Elmslie (2013) interrogated the link between innovation and institutions using data spanning 1985 to 1995 and employed the instrumental variable. They established that corruption, market friendly policies, property rights protection and effective judiciary system are important and significant determinants of cross-country variation in innovation.

Rodríguez-Pose & Di-Cataldo (2013) employed the fixed effects (FE) model and the GMM Systems to analyse the causal linkage between governance and innovative capacity of European Union regions using data spanning 1997-2009. Their results validated that controlling corruption, rule of law, government effectiveness and government accountability are critical variables that explains variability in innovative capacity among regions of the European Union.

Funda (2007) validates the proposition that governance quality influences innovation performance. The conclusion arose from the study investigating the linkage of the two variables for EU countries using 1996 and 2005 data. The study was purely exploratory with OLS being the key data analysis technique employed.

Oluwatobi, Efobi, Isaiah, & Alege (2014) using a sample of 40 African countries, they employed the

Systems Generalised Methods of Moments technique to assess whether institutions enable innovation. The study used panel data for the 1996 – 2012 period and established that government effectiveness, regulatory quality and control of corruption are all positively related to innovation. The association is statistically significant. Their results indicate that government effectiveness and regulatory quality have the highest impact on innovation.

2.3 Framework of Analysis

There are two key facts established in the literature reviewed in this paper that are critical in the modelling of the role of institution in the export and innovation nexus for COMESA Member States. The first is that exports are a function of innovation. The second fact is that innovation is a function of institutional quality. Together, these facts imply that the effects of innovation on exports are affected by the quality of institutions. High quality institutions stimulate more innovation which in turn result in more exports. Contrariwise, low institutional quality retards innovation leading to low exports. The link between exports and innovation is expressed mathematically in equation (3.1). The link between innovation and institutions can be expressed as follows:

$$\delta_{it} = g(G_{it}; \theta_{it}) \qquad (3.2)$$

Where δ_{it} is the innovation variable, G_{it} represents governance or institutional variables and θ_{it} represents other factors that stimulates innovation.

Therefore, the combined effect of innovation and institutions on exports can be expressed as follows:

$$X_{ijt} = f(\delta_{it}(G_{it}); \pi) \qquad (3.3)$$

Equation (3.3) indicates that the quality of institutions in a country affects its exports via the innovation channel.

3.0 Methodology

The methodology adopted in this paper seeks to achieve the objective set in section one, which is to demonstrate the role of governance/institutions in the innovation and exports nexus. The modelling strategy adopted in this paper is to empirically investigate the exports effect of the interaction between innovation and institutions given in equation (3.3). This approach provides the answers to the question whether institutions reinforce the impact of innovation on intra-exports of COMESA Member States.

3.1 Empirical Model

To assess whether institutions reinforce the impact of innovation on intra-exports of COMESA Member States, this paper followed equation (3.3) and specified a cross-sectional model applied by Piccardo, Bottasso, & Benfratello (2013) as follows:

$$X_{ij} = \beta_0 + \beta_1 P_i + \beta_2 \pi_i + \varepsilon_i \qquad (4.1)$$

Where X_{ij} are intra-COMESA exports, P_i is the measure of innovation, π_i is a vector of other exports determinants and is the error term.

Equation (4.1) is further modified to include the interaction variable postulated in equation (3.3) and specify other exports determinants according to economic theory. The following specification follows a gravity model of trade that account for transaction costs as determinants of bilateral trade costs.

$$X_{ij} = \exp(\beta_0 + \beta_1 GDP_i + \beta_2 GDP_j + \beta_3 P_i + \beta_4 P_i * G_i + \beta_5 Dist_{ij} + \beta_6 Cointg_{ij} + \beta_7 ComL_{ij} + \beta_8 LL_{ij} + \beta_9 \Delta Rate_i) + \varepsilon_i \quad (4.2)$$

Where P_i*G_i is the interaction variable between innovation and institutions. This interaction variable captures the reinforcing effect of institutions on the relationship between exports and innovation in the COMESA region. $Dist_{ij}$ is the distance between the capitals of the trading countries, $Cointg_{ij}$ is a dummy variable that captures whether countries share a common border or not, $ComL_{it}$ is a binary variable taking the value of 1 if trading partners share common official language, LL_{ij} stands for landlocked and $\Delta Rate_i$ is the exchange rate. Distance, common border, land locked, and common language capture the effects of bilateral trade costs on exports. All other variables are as previously defined. Equation (4.2) was estimated using the Poisson Pseudo Maximum Likelihood (PPML) estimator, (Silva & Tenreyro, 2006).

3.2 Estimation Approach

The choice to use PPML estimator to estimate equation (4.2) was based on the need to address the problem of zero trade flows. Fixed effects were used to control for unobserved heterogeneity in equation (4.2). Since it is a fact that countries are not homogenous, it was not necessary to employ the Hausman test.

3.3 Data

Equation (4.2) was estimated using cross sectional data for 15 COMESA countries[21]. Exports data was accessed from ITC. Data for patents was extracted from filling by COMESA Member States at the European Patents Office. GDP per capita data was accessed from World Development Indicators. Institutional variables were accessed from World Governance Indicators. Six governance indicators were used in this study and these are government effectiveness, control of corruption, regulatory quality, rule of law, voice and accountability and political stability. Data on distance, common border, common official language and being landlocked were accessed from CEPII. Exchange rate data was accessed from the African Trade Report 2018 produced by the African Export-Import Bank (AFREXIMBANK).

4.0 Presentation and Discussion of Results

4.1 Descriptive Analysis

Table 1 presents the descriptive analysis. On average each COMESA Member State filled 17 patents with the European Patents Office in the year 2016. However, there is great variability in innovativeness among member states as reflected by a standard deviation from the mean of 37 patents, minimum of 1 and maximum of 151 patents filed. Furthermore, COMESA countries scored much lower on the governance/institutional indicators with all the six governance indicators scoring below -0.5. Governance indicators are measured on a scale ranging from -2.5 to 2.5 with 2.5 being the best performing and -2.5 the least performing.

21 These countries are Burundi, DRC, Egypt, Eswatini, Kenya, Libya, Madagascar, Mauritius, Rwanda, Seychelles, Sudan, Tunisia, Uganda, Zambia and Zimbabwe

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev	Min	Max
X_{ij}	24754.32	82138.58	0	581759
GDP_i	3230.576	3758.81	219.2066	13598.34
GDP_j	3230.576	3758.81	219.2066	13598.34
$Dist_{ij}$	3302.671	1821.511	180.006	8053.869
LL_{ij}	.6602871	.4747488	0	1
$Cointg_{ij}$	.1428571	.3507633	0	1
$ComL_{ij}$	.4952381	.501172	0	1
$\Delta Rate_i$	713.9287	1189.413	1	3602
P_i	17.46667	36.73338	1	151
Ge_i	-.6713727	.750965	-1.891474	.9582058
Cor_i	-.6415381	.7514859	-1.614042	.7934772
Ps_i	-.8618835	1.043588	-2.380922	1.047535
Rq_i	-.6942769	.7742277	-2.274259	1.02964
Rl_i	-.5979264	.7282748	-1.868774	.802415
Va_i	-.7418569	.7715779	-1.79709	.8641729

4.2 Correlation Analysis

Correlation analysis results are presented in Table 2. Preliminary analysis of correlation between exports, innovation and governance indicates that innovation is positively related to intra COMESA exports. Governance indicators that include government effectiveness, control of corruption, regulatory quality, rule of law, voice and accountability are positively correlated with intra-COMESA exports save for political stability whose coefficient is negative.

It is also interesting to note that governance indicators that include government effectiveness, control of corruption and rule of law are positively related to innovation. This sheds light, though little, to the assertion that governance reinforce the role of innovation in influencing exports. Correlation analysis also show that governance indicators are highly correlated among themselves. This result is a pre-cursor to the possibility of multicollinierityshould these variables used in one regression together. The estimation of equation (4.2) took necessary caution to avoid the multicollinearity problem.

Table 2: Correlation Analysis

Variable	X_{ij}	GDP_i	GDP_j	$Dist_{ij}$	LL_{ij}	$Cointg_{ij}$	$ComL_{ij}$	$\Delta Rate_i$	P_i	Ge_i	Cor_i	Ps_i	Rq_i	Rl_i	Va_i
X_{ij}	1.0000														
GDP_i	-0.0587	1.0000													
GDP_j	-0.0422	-0.0697	1.0000												
$Dist_{ij}$	-0.2689	0.2414	0.2374	1.0000											
LL_{ij}	-0.1281	-0.2424	-0.2341	-0.2515	1.0000										
$Cointg_{ij}$	0.4025	-0.1685	-0.1661	-0.4159	-0.0521	1.0000									
$ComL_{ij}$	0.1675	0.1640	0.1701	-0.3182	-0.0135	0.1384	1.0000								
$\Delta Rate_i$	-0.0129	-0.4309	0.0324	-0.1821	0.1211	0.0502	-0.0189	1.0000							
P_i	0.3497	0.0761	-0.0061	0.1399	-0.1962	-0.0226	-0.1154	-0.2350	1.0000						
Ge_i	0.0841	0.5663	-0.0420	0.0334	-0.0191	-0.1713	0.3145	-0.1990	0.1245	1.0000					
Cor_i	0.0134	0.5771	-0.0402	0.0568	0.0169	-0.1820	0.3169	-0.2211	0.0873	0.8880	1.0000				
Ps_i	-0.0248	0.5183	-0.0356	0.0015	0.1052	-0.2310	0.2981	-0.0407	-0.0970	0.8235	0.8135	1.0000			
Rq_i	0.0702	0.3062	-0.0235	-0.0630	0.0508	-0.1376	0.2927	0.1178	-0.0014	0.9007	0.7656	0.7448	1.0000		
Rl_i	0.1133	0.4694	-0.0338	0.0525	0.0092	-0.1754	0.2813	-0.0762	0.1665	0.9584	0.8607	0.8303	0.9128	1.0000	
Va_i	0.0491	0.5402	-0.0410	0.1371	-0.1861	-0.2012	0.2507	-0.0399	-0.0245	0.7387	0.5969	0.7144	0.6860	0.7315	1.0000

4.3 The Gravity Model Results

Table 3 presents the results of estimating the gravity model which is equation (4.2). Column 1 shows that innovation is statistically significant and positively related to intra-COMESA exports as predicted by theory. Column 2 to 7 separately included the interaction variable between innovation and institutional variables. The results show that all interaction variables are positive and highly significant at 1% level.

Table 3: Gravity Model Results: Reinforcing role of governance on the effects of innovation on intra-COMESA exports

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	X_{ij}	X_{ij}	X_{ij}	X_{ij}	X_{ij}	X_{ij}	X_{ij}
GDP_i	2.30e-06	-0.000367***	-0.000636***	-0.000611***	-9.65e-05**	-0.000169**	-0.000139***
	(5.26e-05)	(6.60e-05)	(0.000157)	(0.000190)	(4.62e-05)	(7.99e-05)	(4.74e-05)
GDP_j	-2.61e-05	-2.61e-05	-2.61e-05	-2.61e-05	-2.61e-05	-2.61e-05	-2.61e-05
	(4.81e-05)	(4.81e-05)	(4.81e-05)	(4.81e-05)	(4.81e-05)	(4.81e-05)	(4.81e-05)
$Dist_{ij}$	-0.000829***	-0.000829***	-0.000829***	-0.000829***	-0.000829***	-0.000829***	-0.000829***
	(0.000189)	(0.000189)	(0.000189)	(0.000189)	(0.000189)	(0.000189)	(0.000189)
LL_{ij}	-0.0188	-0.0188	-0.0188	-0.0188	-0.0188	-0.0188	-0.0188
	(0.489)	(0.489)	(0.489)	(0.489)	(0.489)	(0.489)	(0.489)
$Cointg_{ij}$	1.671***	1.671***	1.671***	1.671***	1.671***	1.671***	1.671***
	(0.358)	(0.358)	(0.358)	(0.358)	(0.358)	(0.358)	(0.358)
$ComL_{ij}$	-0.430	-0.430	-0.430	-0.430	-0.430	-0.430	-0.430
	(0.380)	(0.380)	(0.380)	(0.380)	(0.380)	(0.380)	(0.380)
$\Delta Rate_i$	0.000190	0.000317**	0.000185	0.000143	0.000476***	0.000315*	0.000635***
	(0.000119)	(0.000129)	(0.000189)	(0.000125)	(0.000140)	(0.000181)	(0.000155)
P_i	0.0240***	0.184***	0.185***	0.278***	0.200***	0.123***	0.175***
	(0.00332)	(0.0256)	(0.0310)	(0.0672)	(0.0280)	(0.0189)	(0.0242)
$Ge_{it}*P_i$		0.230***					
		(0.0361)					
$Cor_{it}*P_i$			0.246***				
			(0.0484)				
$Ps_{it}*P_i$				0.171***			
				(0.0464)			
$Rq_{it}* P_i$					0.178***		
					(0.0278)		
$Rl_{it}*P_i$						0.225***	
						(0.0443)	
$Va_{it}*P_i$							0.112***
							(0.0175)
Constant	9.282***	8.956***	10.13***	9.339***	7.766***	8.772***	7.489***
	(0.964)	(0.773)	(0.954)	(0.970)	(0.844)	(0.892)	(0.865)
Observations	195	195	195	195	195	195	195
R-squared	0.882	0.882	0.882	0.882	0.882	0.882	0.882

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Column 2 shows that the coefficient of the interaction between innovation and government effectiveness is positive and significant at 1% level. It is observable that the coefficient of innovation in Column 2 is larger relative to that in Column 1. Jointly, this means that improvement in government effectiveness and innovation leads to an increase in intra-COMESA exports and increases in the magnitude of the innovation impact on intra-exports. Government effectiveness captures the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. COMESA Member States need to work on these areas in order to promote innovation and therefore ignite more intra-COMESA exports.

Column 3 show a positive and statistically significant coefficient of the interaction between control of corruption and innovation. Again, the coefficient of innovation in Column 3 is greater compared to that in Column 1. Thus, the interaction of control of corruption and innovation is associated with an increase in the magnitude of impact of innovation on intra-COMESA exports. The control of corruption variable captures the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. Improvement in this area is critical to stimulate innovation led intra-COMESA exports.

In Column 4, the coefficient of the interaction between political stability and innovation is positive and statistically significant at 1% level. The relatively larger coefficient of innovation in Column 4 to that of Column 1 is suggestive of the role of political stability in reinforcing the impact of innovation on intra-COMESA exports. Political stability measures the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism. This study infers that managing these perceptions to reasonable stable levels stimulates innovation, hence, leading to more intra-COMESA exports.

The coefficient of the interaction between regulatory quality and innovation in Column 5 is also positive and statistically significant at 1% level. Thus, innovation in the presence of good regulatory quality stimulates exports. Also, the larger coefficient of innovation in Column 5 relative to that in Column 1 is suggestive of the reinforcing role of regulatory quality. The regulatory quality variable captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. COMESA Member States need to note that the creation of an environment that allows and encourage private sector development increases innovation and stimulates intra-COMESA exports.

Column 6 shows a positive and significant at 1% level coefficient of the interaction of the rule of law and innovation. The magnitude of the innovation coefficient in this Column is also suggestive of the reinforcing role of the rule of law when compared to the magnitude given in Column 1. The critical components captured by the rule of law variable to which COMESA Member States need to consider improving includes perceptions confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

The coefficient of the interaction of voice and accountability and innovation in Column 7 is positive and significant at 1% level. Again, in this Column the magnitude of the innovation variable in comparison of that in Column 1 is suggestive of the reinforcing role of voice and accountability. This voice and accountability variable reflect the perceptions of the extent to which a country's citizens are able to participate in selecting their government as well as measures on freedom of association, freedom of expression and a free media. COMESA Member States are encouraged to improve in the various facets of the voice and accountability variable in order to stimulate innovation and hence increase intra-COMESA exports.

Overall, whenever the interaction between innovation and institutional variable is added to the model estimated in column 1, the coefficient of innovation increases in magnitude. Together, these results confirm that institutions reinforce the impact of innovation on intra-exports of COMESA Member States. High quality institutions stimulate more innovation which in turn leads to more exports. Several scholars corroborate the quantitative findings of this study and these include Blyde, Iberti, & Mussini (2015), Piccardo, Bottasso, & Benfratello (2013), Sandu & Ciocanel (2014), Tebaldi & Elmslie (2013), Funda (2007) and Oluwatobi, Efobi, Isaiah, & Alege (2014).

5.0 Conclusion and Policy Implications

The study inquired on whether institutions have a role to play in the nexus between innovation and trade. The findings indicate that innovation is critical in stimulating intra-COMESA exports. Innovation itself is reinforced by improving the quality of institutions. Hence COMESA Member States are encouraged to improve on various facets of governance indicators in order to stimulate innovation led intra-COMESA exports.

References

Abramovitz, M. (1956). Resources and output trends in the United States since 1870. *American Economic Review, Papers and Proceedings, 46*(2), 5-23.

Archibugil, D., & Michie, J. (1998). Technical Change, Growth and Trade: New Departures in Institutional Economics. *Journal of Economic Surveys, 12*(3), 1-20.

Barasa, L., Knoben, J., Vermuelen, P., Kimunyu, P., & Kinyanjui, B. (2017). Institutions, Resources, and Innovation in East Africa: A Firm level approach. *Research Policy, 46*, 280-291.

Blyde, J., Iberti, G., & Mussini, M. (2015). When does Innovation Matter for Exporting? *Munich Personal RePEc Archive Paper*(61574). Retrieved from http://mpra.ub.uni-muenchen.de/61574/

Chen, Y., & Puttitanun, T. (2005). Intellectual Property Rights and Innovation in developing countries. *Journal of Development Economics, 78*, 474-493.

Easterly, W., & Levine, R. (2001). What have we learned from a decade of empirical research? It's not factor accumulation: Stylized facts and growth models. *The World Bank Economic Review, 15*(2), 177-219.

Funda, C. E. (2007). *The Link Between Innovation Performance and Governance: JRC Scientific and Technical Report.* European Commission Joint Research Centre .

Ghanbari, A., & Ahmadi, M. (2017). The Effect of Innovation on International Trade: Selected Medium-High-Technology Industries, Evidence on Iran+3. *Iran. Econ. Rev, 21*(1), 21-44.

Hall, R. E., & Jones, C. I. (1999). Why some countries produce so much more output per worker than others? . *The Quarterly Journal of Economics*, 83-116.

Krugman, P. (1979, April). A Model of Innovation, Technology Transfer, and the World Distribution of Income. *The Journal of Political Economy, 87*(2), 253-266. Retrieved from http://links.jstor.org/sici?sici=0022-3808%28197904%2987%3A2%3C253%3AAMOITT%3E2.0.CO%3B2-6

Larch, M., & Yotov, Y. V. (2016). General equilibrium trade policy analysis with structural gravity. *WTO Staff Working Paper,*(ERSD-2016-08).

Lin, F., & Tang, H. C. (2013). Exporting and Innovation: Theory and Firm-Level Evidence from the People's Republic of China. *International Journal of Applied Economics, 10*(2), 52-76.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics, 22*(1), 3-42.

Melitz, J. M. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica, 71*(6), 1695-1725. Retrieved from http://links.jstor.org/sici?sici=0012-9682%28200311%2971%3A6%3C1695%3ATIOTOI%3E2.0.CO%3B2-Y

Oluwatobi, S., Efobi, U., Isaiah, O., & Alege, P. (2014). *Innovation in Africa: Why Institutions Matter.* Retrieved from http://ssrn.com/abstract=2460959

Palangkaraya, A. (2012). *The Link between Innovation and Export: Evidence from Australia's Small and Medium Enterprises.* Economic Research Institute of ASEAN and East Asia.

Piccardo, C., Bottasso, A., & Benfratello, L. (2013). *Innovative capacity and export performance: Exploring heterogeneity along the export intensity distribution.*

Posner, M. V. (1961). International Trade and Technological Change. *Oxford Economic Papers, 13*, 323-341.

Rodríguez-Pose, A., & Di-Cataldo, M. (2013). Quality of government and innovative performance in the regions of Europe. *Papers in Evolutionary Economic Geography, 14*, 1-47. Retrieved from http://econ.geog.uu.nl/peeg/peeg.html

Rodrik, D., Subramanian, A., & Trebbi, F. (2002). Institutions rule: The primacy of institutions over geography and integration in economic development. *Center for International development (CID) working paper, 97*.

Romer, P. M. (1986). Increasing returns and long run growth. *Journal of Political Economy, 94*(5), 1002-1037.

Romer, P. M. (1994). The origins of endogenous growth. *Journal of Economic Perspectives, 8*(1), 3-22.

Sandu, S., & Ciocanel, B. (2014). Impact of R&D and Innovation on high - tech export . *Procedia Economics and Finance, 15*, 80-90.

Schrempf, B., Kaplan, D., & Schroeder, D. (2013). *National, Regional, and Sectoral Systems of Innovation – An overview, Report for FP7 Project "Progress"* . Uropean Commission.

Solow, R. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics, 70*, 65-94.

Stiglits, E. J. (2008). Economic Foundations of Intellectual Property Rights. *Duke Law Journal, 54*, 1693-1724.

Tebaldi, E., & Elmslie, B. (2013). *Does Institutional Quality Impact Innovation? Evidence from Cross-Country Patent Grant Data* . ResearchGate.

Tuhin, R. (2016). *Modelling the relationship between innovation and exporting: Evidence from Australian SMEs.* Commonwealth of Australia .

Wang, C. (2013). Can Institutions explain cross country differences in Innovative Activity? *Monash University, Department of Economics, Discussion Paper, 35*.

Yotov, V. Y., Piermartini, R., Monteiro, J.-A., & Larch, M. (n.d). *An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model.* WTO Publications.

Innovation and the Architecture of Intellectual Property Rights Regimes: **Evidence from COMESA Countries**

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Abstract

The broad objective of the study is to investigate the role played by intellectual property rights (IPRs) in promoting or discouraging innovation. The research employed a novel panel data set of the Common Market for Eastern and Southern African (COMESA) countries which are all developing countries for the period covering 2012 to 2017. In doing so it contributes to the innovation literature by looking at the determinants of innovation in developing countries, and takes into account the cumulative nature of innovation by using panel estimation methods. The study employed panel data econometrics and found that manufacturing activities, gross domestic product (GDP) per capita and a stable political environment are important factors explaining innovating activities. IPR have been found to have a negative impact on innovative activities in the region, and this is supported by the view that strong IPR may harm research which leads to innovation in developing countries. Thus, COMESA countries and policy makers are encouraged to be cautious in developing regulations which emphasize stringent IPR.

Keywords: Intellectual property rights, innovation, COMESA countries, patents, *JEL Classifications Codes*: O31, O34, O57

1 Introduction

In the contemporary world which is governed by the dictates of globalization and compounded by, among other things, free trade, foreign direct investment (FDI), and international exchange of knowledge, any given country's technological progress is dependent not only on local research and development (R&D) capital but also on foreign R&D capital (Coe and Helpman, 1995). Baker, et al (2017) contends that the 'weightless economy', that is, the economy of ideas, knowledge and information, will become an increasingly important fraction of economic output and ever more important for economic growth and development, both in developed and developing economies in the 21st Century. At the same time, Bechtold and de Rassenfosse (2019) argues that a patent policy (which is a form of an intellectual property right (IPR)) is a key component of innovation policy, which is concerned with the set of government interventions that help economic actors create, develop, transfer, and commercialize innovations.

Through globalization, countries from the South (i.e., developing countries) have the opportunity of promoting their technological capability through learning and assimilating foreign knowledge especially from the North (i.e., developed countries) rather than in-house R&D. The extent to which knowledge generated through R&D and further improved into innovative products, services and processes can be transferred depends on the architecture of the intellectual property rights (IPRs) regime in a given country, or sector. The World Intellectual Property Organization (WIPO) defines "Intellectual Property (IP) as creations of the mind, such as inventions, literary and artistic works, designs and symbols, names and images used in commerce." According to WIPO, IP is needed in any setup for the following reasons: Firstly, the progress and well-being of humanity rest on its capacity to create and invent new works in the areas of technology and culture. Secondly, the legal protection of new creations encourages the commitment of additional resources for further innovation. Lastly, the promotion and protection of intellectual property spurs economic growth, creates new jobs and industries, and enhances the quality and enjoyment of life[22].

In characterising innovation, Economic Commission for Africa (ECA, 2016) indicates that innovative ideas are the point of departure, although they must in practice be developed and turned into concrete solutions, like new goods or services, processes, or business models. Furthermore, innovations are considered as multidimensional with one or more simultaneous manifestations. Likewise, innovations are multidisciplinary, often involving dynamic interplay. Table 1 provides a summary of basic characteristics of innovation. The focus of this study is (tangible) product innovation.

Table 1: Basic Characterizations of Innovation

By type	
Innovation	**Possible practical manifestations**
(Tangible) product or service innovation	Introducing new or better tangible products, or new or better services to the market. The improvement could be in functional characteristics, technical abilities, ease of use or any other dimension
Process innovation	Introducing new ways (technological or organizational) of producing goods or services

22 http://www.wipo.int/edocs/pubdocs/en/intproperty/450/wipo_pub_450.

Organizational innovation (also: social innovation)	▪ Creating new organizations ▪ Introducing new business practices (including new business models) ▪ Introducing new ways of running organizations (essentially, new management processes) ▪ Introducing new organizational behaviour
Marketing innovation	Developing new marketing methods that are improved in several dimensions related to the product (design, packaging, promotion, pricing and so on)
By other criteria	
Innovation	**Description**
Degree of newness	Innovations can range from incremental (improvement)[a] to radical (also basic or fundamental)[b].
Form of innovation	Continuous and iterative process or discontinuous (and radical) process
Content of innovations	Different combinations of knowledge, expertise and technology
Source of thrust-driving innovation	▪ User-driven innovation ▪ Employee-driven innovation

Source: ECA (2016:49)

Key: a = This involves improving existing goods, services, processes, business models and so on.

b = This involves developing goods, services, processes and so on that did not exist previously.

Léger (2006) posits that in the case of industrialized or developed countries, intellectual property rights (IPR) are part of the infrastructure supporting investments in research and development (R&D) leading to innovation. According to Baker, et al (2017), the justification for creating patent and copyright monopolies, as well as other forms of intellectual property, is that without the ability to appropriate the returns to their innovative activities granted by these monopolies, the market would undersupply research, innovation, and creative work or at least that would be the case without some form of direct support from the government. While the initial investment to generate the "idea" in these areas is costly, reproducing it (e.g. by copying or backward engineering) is generally inexpensive. This means that the innovator or creator will not be able to recover the cost of their investment if their output is sold in a competitive market. Thus, through appropriate existence of optimal IPR framework, the granting of temporary exclusive rights on inventions allow right-holders to price their products above marginal cost, and hence recoup their initial research investment. These exclusive rights will motivate and incentivize the conduct of R&D. However, critics argue that by granting monopoly rights on an invention, IPR impede its dissemination. The resulting under provision of protected goods and monopoly distortions are usually considered acceptable costs for the creation of new knowledge and the increase in social welfare that it entails.

The debate on how IPR provides a breeding ground for innovation activities which leads to trade of innovated products, services and processes has two sides on the continuum. In general, IPR are perceived as catalyst for the promotion of technological innovation and to the transfer and dissemination of technology, in a manner conducive to social and economic welfare (World Trade Organisation, Agreement on Trade-Related Aspects of Intellectual Property Rights (WTO-TRIPs) Article. 7). The proponents of IPRs base their arguments on the positive role of IPRs (Rothschild and Newman. (2002); and these includes (i) incentivization of people to be creative, (ii) rewarding of individuals for their creative efforts, (iii) afford of legal rights to people for their creative efforts, (iv) fulfilling the principle of moral rights, (v) encouraging of public disclosure of inventions, (vi) facilitation of technology transfer, (vii) promotion of growth in innovation investments, and (viii) provision of guidance towards the industrial policy and strategy of the nation.

Other scholars who supports existence of IPRs such as (Davis, 2006) provides other benefits for patents. Firstly, after investing considerable human and relationship capital and incurring significant R&D expenditures to get to the invention stage and transform it into a useful innovation that satisfies the customer/consumer needs, a given firm needs IPRs to protect such inventions and innovations against imitations. Furthermore, inventors need to have time to recover their costs and reap benefits for their efforts through superior products/services, thereby affording them to charge premium prices, and be able to invest in newer inventions. At the same time, scholars such as Bertin and Wyatt (1988); Hanel (2006); Mansfield et al. (1981); Oppenlander (1977) among others, argue that innovators and firms could use IPRs defensively and offensively. Secondly, patents present a possible alternative source of revenue to firms through licensing or sale, in non-competing applications. Thirdly, according to Grindley and Teece (1997); Hall and Ziedonis (2001)), patents may also strengthen a firm's position in negotiations. Thus, patents establish the legal basis for cooperation. Finally, IPRs could enhance the market capitalization of the firm, acting as strategic signal of the strengths of the firm (Rivette and Kline 2000a, b). IPRs may also help the firm to attract more capital from investors and shareholders. Thus, patents may serve as indicators of firm's value.

The antagonists of IPRs strongly believe that IPRs actually hinder innovation and contribute to negative effects. (Deardorff 1992) shows that IPR protection is not a reliable mantra for promoting either innovation or wellbeing of all the people in the world. According to Hamilton (1996) and Gollin (2008) some of the negative consequences of IPRs include the fact that they: prevent the public from being able to fully access the details of innovation due to exclusive rights; raises the costs to consumers; creates unhealthy monopolies; misdirects innovation efforts to just profitable areas and not to what is important to public; creates unnecessary competition rather than cooperation; are expensive to obtain and maintain that they stay out of reach of poor and unsophisticated individuals/organizations; necessitate highly bureaucratic organizations and elaborate rules of governance, and creates conflicts between legality, morality, and ethics.

In the context of least developing countries (LDCs), Léger (2006) argues that a growing number of scholars or experts argue that IPR "do little to stimulate innovation in developing countries" (CIPR, 2002: 1). For instance, IPR may provide an incentive for innovation but there is limited local capacity in LDCs to make use of it. At the same time, even if stronger IP protection supports an increase in technology transfer, limited local absorptive capability may constrain the potential to use it. Lastly, the environment in which IPR exist, for example the quality of the legal system and the importance of transaction costs, might severely constrain the incentive effect. In most LDCs, the balance between dynamic benefits and static costs might not be positive.

1.1 Problem Statement

The COMESA policy of IPRs allude to the fact that economic growth and national development as well as the richness of a country used to be determined by factors of production, namely raw materials such as copper, minerals, oil, timber, sea food, water, plantations coffee, tea, cotton, and sisal, and vast land; and labour. With passage of time, the knowledge-driven economy, has however changed this notion in that countries which are now posting huge economic growth and development are countries which have taken steps to invest in IP as well as the necessary human capital required to create IPRs. Thus, in a 'knowledge-based and innovation-driven economy' the generation, creation, innovation and management of knowledge through IP play a crucial role in wealth creation and national development. The COMESA policy on IPRs contends that in a 'knowledge based economy' IP has become the major determinant between those countries that are industrialized and culturally advanced, on one hand, and those which are least developed and culturally backward, on the other hand. Evidence so far shows that though the latter countries are endowed with rich resources, they rely on the IP (machinery, equipment, including manpower) developed by the former countries. Currently, developing countries, including COMESA Member States, are net importers and consumers of IPRs and culture created from music, book, and films from the developed world.

The debate in the introduction section shows two opposing views on IPRs which brings back the central question: "Do IPRs promote innovations?" Proponents claim, "Absolutely, Yes," while opponents declare, "Certainly, Not." According to this study, the truth lies somewhere between these two extreme viewpoints, and the correct answer may be, "It Depends." Within the complexity of this debate, the divergence on the effects of strengthening IPRs on innovations between North (developed/rich) countries and South (developing/poor) countries seems to have widened in recent years. On one hand, developed countries often contend that stronger IPRs protection is good even for developing countries, because it can attract more foreign direct investment (FDI) and technology transfer and thus contributes to host countries' technological capability and stimulates more domestic innovations (Maskus, 2000). On the other hand, developing countries argue that an extension of international IPRs harms their technological progress and as such these countries prefer to establish weaker IPRs regimes favouring technological diffusion through imitation and acquisition from abroad[23]. Forero-Pineda (2006) provides a longitudinal debate on IPRs and concludes that the negative effects of the trend toward stronger IPRs of the less advanced and developing countries have become more apparent and understandable in some cases. Given that no scholastic research has been done on the impact of IPR on innovations in COMESA region, this study provides contextualized evidence from which Member States and policy makers can learn and be guided in terms of policy making on this particular issue.

This research empirically investigates the role of IPRs protection in innovations across countries from the global South using COMESA countries as the case study, thus attempting to further the literature in the subject area in three ways. First, most existing studies that examine the relationship between IPRs and innovations focus on a single country, such as Japan, while few studies provide cross-country evidence. This COMESA cross-country study provides new evidence and lends implications to international economic policies, such as TRIPs. Second, this paper uses a panel dataset of 12 COMESA countries for which data was available[24] covering the period 2012 to 2017. Crucially, to obtain robust estimates, this study adopts various measures of IPRs protection indices. Third and most crucially, whilst IPRs have become an important determinant in the extent to which a country attracts FDI into its territory, analysis of the link between IPRs, innovation in the context of developing countries becomes paramount in the development agenda of such countries.

1.2 Study Objectives

The broad objective of the study is to investigate the role played by intellectual property rights (IPRs) in promoting or discouraging innovation. Specifically, the research:

23 Forero-Pineda (2006) identifies some e□ects of the global trend towards stronger protection of intellectual property rights on developing countries, and traces related debates.

24 These countries are: Egypt, Eswatini (Formally Swaziland), Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Seychelles, Tunisia, Uganda, Zambia and Zimbabwe.

i. Investigates the impact of IPRs on innovation
ii. Analyse other factors that impact on innovation

1.3 Intellectual Property Rights in COMESA Region

COMESA is one of the eight Regional Economic Communities (RECs) recognized under the African Union (AU), made up of 21 Member States, namely; Burundi, Comoros, DR Congo, Djibouti, Egypt, Eritrea, Eswatini, Ethiopia, Kenya, Libya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Somalia, Tunisia, Sudan, Uganda, Zambia and Zimbabwe. With a population of 482 million people (2017), a GDP value of US$718 billion (2016), and a focus on trade and investment, COMESA is one of the largest economic organisations in Africa. Whilst there are some big companies in COMESA Member States, majority of firms in the region are mostly small and medium enterprises as well as informal entities, who do not participate in innovation activities. These firms mostly are consumers or users of innovated products from other regions mostly the developed countries. In actual fact, most regional countries can be considered as what COMESA Policy on intellectual property rights (hence after the Policy) say in that "Countries or firms which are unable to create IP remain to be net importers and consumers of the IPRs produced in those countries which create assets in IPRs and have incorporated IP as their competitive and growth strategy". According to the "Policy, COMESA Member States are net importer of IPRs developed and created from developed economies, as their IP bases are still in infancy or undeveloped".

Thus, large part of IPRs implemented in COMESA member countries are influenced by multinational companies (MNCs) operating these countries with the aim of ensuring that these IPRs benefits such MNCs. According to ECA (2016) the WTO, TRIPS Agreement, universalized standards of intellectual property protection that would benefit certain industrial sectors where firms from developed countries are dominant.

COMESA Member States recognize the importance of science, technology and innovation (STI) in socio-economic and cultural development and have agreed to cooperate in various fields as stated in the decision of the 2010 COMESA Summit on Science and Technology Development. In June 2012 the first COMESA Ministerial Committee met and underscored the critical importance of implementing the decisions on STI, at the national level by each Member State, and in this regard recalled the following decisions adopted by the COMESA Summit in 2010 where the countries as a region and as individual member states were encouraged and mandated to establish and create various aspects within the spectrum of STI for the development of the region and member countries.

Given that COMESA region is composed of developing countries, the debate on the efficacy of strengthening IPRs on promoting national innovations becomes a necessary debate which needs rigorous analysis. The question of whether stronger IPRs induce more innovations, depending on the degree of economic development becomes paramount in the context of the region. Analysis of the extent to which IPRs encourages innovation which leads to trade across borders becomes necessary given that empirical studies examining the influence of strengthening IPRs protection on innovations across countries remain rare. In particular, there are few studies from the developing world let alone COMESA exploring this issue using data for the post- Trade-Related Intellectual Property Rights (TRIPS) Agreement period[25], given the topical debate on IPRs across countries. It inspires the main purpose of this paper that investigates the role IPR protection in fostering innovations across countries in the post-TRIPs period. To the best knowledge of the authors, such an analysis has not been done on COMESA countries.

25 The Agreement of Trade-Related Intellectual Property Rights (TRIPS), administered by the World Trade Organization (WTO), was established in 1995 to set minimum standards of intellectual property rights (hereafter, IPRs) protection for each WTO member.

2.0 Literature Review

2.1 Theoretical Literature

2.1.1 Nature and Determinants of Innovation

Léger (2006) argues that the outcome of any meaningful innovation process is a new product (or process) as well as new information, which has public good characteristics, i.e., non-rivalry and non-excludability. These two features result in possible free-rider problem, the theory under which this study is premised. These two features of information make the gains from innovation uncertain and difficult to appropriate, which implies that R&D opportunities that would be socially profitable are not exploited because they are privately unprofitable. In any society, innovation is a function of incentives and these vary from government funding, to policies and government joint ventures. Among these incentives, IPR is suggested as one possible government intervention to correct this market failure[26].

There are broadly three main reasons that encourage innovation to take place in any setup. First, investments in innovative activities are motivated by the possibility of increased profits and market share, secured by IPR or other mechanisms (e.g. first-mover advantage, secrecy, etc). Second, innovation is a function of "demand-pull" factors (Schmookler, 1966), i.e., the perceived demand for new products and processes, makes innovation react. Lastly, "technology-push" factors that are related to advancements in technology and science provide another dimension of motivation to innovators (Cohen and Klepper, 1996).

Firms' innovative performances are a function of the environment in which a firm operates in. Within a given country, economic and political stability (Lall, 1992) provides an environment that can either support or discourage innovation activities of firms. The extent to which a given country is competitive internationally and the extent to which its openness to trade also affect incentives to innovate, as does the structure of the economy. However, these impacts are theoretically not clear (Grossman and Helpman, 1991). At individual firm level, given that R&D is an expensive endeavour, the cost of, and access to capital are some of the major determining factors of innovation activities. Finally, existence of qualified scientists, researchers and workers are indispensable inputs into the innovation process, thus the level of human capital in the country is another important factor (Crespo et al, 2004).

2.1.2 Theoretical Model

The study follows Yang et al (2014), Pakes and Griliches (1980) and Léger (2006) by adopting the knowledge production function where a country's patent production is assumed to be a function of its R&D expenditure, R&D researchers, and other determinants as shown in Equation (1):

$$P_{it} = AR_{it}^{\alpha} L_{it}^{\beta} e^{e} \qquad (1)$$

The model is expanded to include other variables that may influence patenting P (proxy for innovation). The multiplier A is the efficiency of knowledge production due to internal and external factors, especially the degree of IPRs protection and the difference in patenting due to countries' specific characteristics.

Taking the logs of both sides of Equation (1) yields the following log-linear equation

$$\ln P_{it} = \alpha \ln R_{it} + \beta \ln L_{it} + \sum_{c} \alpha_c \ln X_{it} + \theta \ln IPR_{it} + \varepsilon_{it} \qquad (2)$$

where R_{it} is the country's R&D expenditure, L_{it} is the number of R&D researchers in a country, *Xs* are vectors of country-specific characteristics, the term IPR is a measure of the strength of IPRs, and ε is

26 Others can include tax breaks on the performance of R&D, contests, R&D, or public performance of R&D.

an error term. Combining the factors, the empirical specification used in this study is presented under methodology section.

2.2 Empirical Literature

Few studies examine the link between IP protection and innovation in a panel of countries setup let alone for developing countries and more so for regional grouping like COMESA. The study by Yang et al (2014) examined the role of IPRs protection on stimulating innovations across developing and developed countries. In their attempt to consider the possible difference in the relationship between IPRs and innovations for countries of various development degrees, the study employed the technique of panel threshold model to proceed with empirical estimates. Using a panel dataset of 42 countries over the 1997-2006 periods, the paper found that stronger IPRs protections enhance innovations using conventional panel data model. However, after considering the threshold effects, IPRs protection remained a significantly positive influence on innovations for high-income countries, but it was found to have no effect on fostering innovations for non-high-income countries

In a study analysing innovation, intellectual property, and development, Baker, et al (2017) found that IPRs are becoming increasingly badly configured in the developed world, leading to a stifling of innovation, distortions in the direction of innovation, and a reduction in the benefits which accrue from any innovation that occurs. According to the authors, many of these failures arise because there is, especially under currently prevalent IPR regimes, no clear relationship between the social returns to innovation and the private returns. The study contends that the proliferation of me-too drugs, the increase in patent hold-ups and similar excesses buttress the argument that the IPR system in the developed world is poorly configured.

Léger (2006) investigated IPRs and innovation in a panel dataset comprising 24 industrialized and 44 developing countries, using average annual data for six 5-year sub-periods covering the period 1970 to 1995. The study employed panel data econometrics. The study found that past R&D investments had a positive and significant impact on current innovation, demand-pull factors were also important in all country groups, and the structure of the economy had a negative (positive) impact in developing (industrialized) countries. Intellectual property protection was only significant (at a low level) for developing countries.

Pakes and Griliches (1980) investigated inventive activities of U.S. firms using panel data econometrics. The research analysed and reported the relationship between patents applied for and R&D expenditures based on data for 121 large corporations covering the period 1968 to 1975. The study found that there was a statistically significant relationship between a firm's R&D expenditures and the number of patents it applied for and receives. This relationship was found to be very strong in the cross-sectional dimension, while it was found to be weaker in the within-firm time-series dimension

The paper by McCalman (1999) extends analysis of the General Agreement on Tariffs and Trade (GATT) Uruguay Round by quantifying the impact of international patent harmonization as implied by the Trade Related Aspects of Intellectual Property Rights (TRIPs) agreement. The research employed a sample of 29 countries consisting of both developing and industrialized countries. The two dependent variables were patenting and labour productivity. The sample mixture provided 841 bi-lateral patenting observations and 28 relative labour productivity observations. The study found that patent protection was an important method for appropriating the rents of an invention. Accordingly the study pointed out that patent harmonization had the capacity to generate large transfers of income between countries, the US being the major beneficiary. While developing countries were found to be major contributors to these transfers, Canada, UK and Japan also made sizable contributions. The study findings with regards to developing countries was that any move toward stronger IPRs would work against national economic interest, transferring rents to multinational corporate patent holders headquartered in the world's most advanced countries.

The study by Alfranca and Huffman (2003) employed a panel of European Union (EU) countries to estimate the effects of economic incentives and institutions on private innovation in agriculture, and found the level of IPR protection, institutional quality, economic openness and the lagged value of agricultural production to be positive and significant factors. On the other hand, interest rate and the lagged value of crop production had (significant) negative impacts.

Kanwar and Evenson (2003) analysed the determinants of innovation and technological change, proxied by total R&D investments as a proportion of gross national product (GNP). The study by Kanwar and Evenson (2003) obtained similar results: IPR protection, credit availability, demand-pull factors, trade openness and human capital positively affected innovation, while political instability and interest rates were found to negatively affect innovation. The research however did not consider the impact of past innovative activity, as was done by Lederman and Maloney (2003), who employed a dynamic general methods of moments (GMM) estimator. They found that interest rate and risk negatively affected aggregate private and public R&D investments, while past R&D investments, credit market depth, IPR protection, complementary institutions and the quality of research institutions are positive and significant explanatory factors. However, GMM estimators rely on asymptotic properties, hence estimates can be biased for small samples like they used. Furthermore, they do not control explicitly the level of development of the countries. The research by (Schneider, 2005) investigates the role of trade, foreign direct investment (FDI) and IPR in explaining innovation. The study found that whilst IPR played a significant and positive role in developed countries, it was negative and not significant for developing countries, and was positive and significant for the whole sample.

Drawing from the above discussions, limited empirical cross-country studies suggest the need of new evidence. Whilst this study is similar to existing literature, it contributes to this line of research by dealing with the unsolved drawbacks in previous studies. First the study provides empirical evidence of the relation between IPR and innovation in case of COMESA countries, a contribution which has not yet been done. Second, as various innovation measures are constructed by focusing on the coverage of innovation laws or the enforcement strength, suggesting individual index has its advantages and disadvantages. This study adopts various measures of innovation to implement empirical estimations, in order to obtain reliable and robust results. Thus, it is generally known that the impact of IPR on innovation in developing countries is theoretically not clear, and the empirical evidence available indicates that it might be different for industrialized and developing countries. This paper hence tests the propositions that: IPR protection is a significant factor affecting innovation. It does so by using a dataset of COMESA countries.

3.0 Methodology

3.1 Empirical Model Specification, Methodology and Data

The empirical model used in this study builds upon the theoretical model presented under sub-section 2.1.2 and it borrows from Yang et al (2014), Pakes and Griliches (1980) and Léger (2006). Equation 3 has been used for the econometric modelling.

$$\ln PAT_{it} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln Open_{it} + \beta_3 RI_{it} + \beta_4 \ln IPR_{it} + \beta_5 Manf_{it} + \beta_6 Pol_{it} + \beta_7 R\&D_{it} + \varepsilon_{it} \quad (3)$$

Following Yang *et al*. (2014), the dependent variable PAT is the number of patent applications from COMESA country *i* in the U.S. In the empirical literatures of innovation and IPRs, resident patenting and US patent application are both conventional proxy of innovation activity (Park, 2008). Owing to the differences in requirement of novelty across countries, using national patents suffers the problem of "home-country-advantage-effect", leading to distorted information regarding innovations[27]. Therefore, we use the number of US patent applications as the indicator of innovations. However, given the potential limitations which may be associated with PAT in that some COMESA countries may not have the adequate muscle to meet the requirements of registering their respective patents with U.S. due to level of rigor required in the process, the study also employed other two dependent variables. One of these other two is contained in the Global Competitiveness Report of the World Economic Forum and the variable is *trademark applications per million populations*. The second other variable is *Charges for the use of intellectual property, receipts* and is contained in the World Banks Development Indicators.

OPEN denotes the degree of openness, which is measured as the ratio of trade (i.e., exports plus imports) to GDP. It is a policy variable that captures the effect of international spill overs in the domestic economy through trade (Varsakelis, 2001). Moreover, Furman et al. (2002) treat openness as one of policy choices that particularly affects the environment for innovative activity, because openness enforces a country to face the international competition. Therefore, openness is expected to have a positive influence on innovations.

Research and Development (R&D) expenditure as a percentage of GDP is the key input in the patent or innovation production function. This study uses the contemporaneous level of R&D spending in the model, following Hall and Ziedonis's (2001) specification. The intension of human capital on R&D is also a critical variable of innovation output, higher expenditure on R&D is expected to be associated with development of new ideas, processes, goods and services which can be commercialized, and enhances the productive process in any production setup.

Term *Manf* is the output ratio of the manufacturing sector to GDP. Qian (2007) suggested that the effect of IPRs would be different depending on technological fields. As patents are generally granted to "functions" and "products" which are used and produced by the manufacturing sector, we thus adopt this variable to control the variations of industry structures across countries. The variable *Pol* measures the political environment in which a given company operates. As alluded to by Lall (1992), political stability provides an environment supportive of innovation.

The most important variable we are concerned with is the degree of intellectual property rights protection (IPR). How does one measure the national difference in IPRs protection? Unlike most previous studies that adopt the IPRs index developed by Ginarte and Park (1997) which unfortunately

27 For example, the utility model and design patents (more than 90% of patents granted in China) do not require substantive examination in order to be granted in China.

is not available for each year during this period, this study takes alternative measure. IPR employed in this study is in the form of intellectual property protection. With regards to real interest (RI), they are expected to be negatively related to innovation. Given that any innovation requires funding, most funding is borrowed from banks (as opposed to using retained profits), and as such, higher interest rates will demotivate borrowing from banks, thus limiting activities with innovation.

3.2 Data Sources

The study used diverse sources of data and from various institutions. Table 2 provides description of the variables used in the study as well as their sources.

Table 2: Description of variables

Variable	Definition	Expected sign	Data source
	Dependent variable(s)		
PAT	Number of patent applications with U.S.A		USA Office+
TM	Trademark applications applications/million pop.		GCR-WEF
CIPR	Charges for the use of intellectual property, receipts		GCR-WEF
	Explanatory variables		
GDPc	Gross domestic product (US$) per capita	+	WDI
R&D	R&D as % of GDP	+	GCR-WEF
Pol	Political stability		Freedom House
Open	Openness to trade	+	WDI
IPR	Intellectual property protection	+	GCR-WEF
Manf	Value-added in manufacturing as % of GDP	+	WDI
RI	Real interest rate	-	WDI

Source: Author compilation

Key: WDI = World Bank Development Indicators (WDI) World Bank 2019

: GCR-WEF = Global Competitiveness Report, World Economic Forum

: + Calendar Year Patent Statistics, USA Patent and Trademark Office

4.0 Empirical Analysis[28]

The analysis treats all countries as the same in the group and employs the conventional panel regression model to implement the empirical estimation. This approach assumes a linear relation between IPRs and innovation across countries. Whilst the research conducted Hausman tests, the outcome of the tests showed no significant different between pooled model versus fixed (FE) or random effect (RE) models, and as such, Table 3 presents the pooled results.

28 The estimations were done using twelve COMESA Member States for which complete data was available across the various variables. These countries are: Egypt, Eswatini (Formally Swaziland), Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Seychelles, Tunisia, Uganda, Zambia and Zimbabwe

To improve results reliability and robustness check, the study used three different dependent variables. The first dependent used is *US patents* and the use of this dependent variable serve as the benchmark model and can be compared with findings in the previous studies. Secondly, the study used *Charges for the use of intellectual property, receipts (BoP, current US$)* as a dependent variable. This variable indirectly shows the innovation activities in any given country as revealed by receipts (exports) of innovated products (i.e., goods, services, processes etc) a given country produces or develops and/or commercialize every year. The number of *Trademark applications per million populations* is the third dependent variable that has been employed in this study.

Table 3: Regression Results on Determinants of Innovation in COMESA Countries

	Dependent: PAT		Dependent: CIPR		Dependent: TM	
Variable	**Model I**	**Model II**	**Model I**	**Model II**	**Model I**	**Model II**
Constant	-16.5 (-0.8)	------	-3.4 (-0.7)	------	-0.2 (-0.1)	----
R&D	1.7 (0.2)	-0.7 (-0.1)	-0.2 (-0.1)	-0.7 (-0.3)	-0.9 (-1.5)	-1.0 (-1.6)
IPR	-7.8 (-1.7)*	-9.5 (-2.4)**	-3.9 (-3.8)***	-4.2 (-4.8)***	-0.3 (-1.2)	-0.3 (-1.5)
RI	-0.3 (-1.7)*	-0.3 (-2.4)**	0.04 (1.4)	0.03 (1.2)	0.03 (3.3)***	0.03 (3.6)***
Manf	6.4 (1.9)*	5.3 (1.7)*	0.9 (1.2)	0.7 (0.96)	-1.4 (-7.1)***	-1.4 (-7.9)***
GDPc	3.1 (1.7)*	2.6 (1.5)	2.9 (7.2)***	2.8 (7.6)***	0.9 (8.7)***	0.9 (9.5)***
Open	-11.8 (-2.9)**	-10 (3.0)***	-6.6 (-7.3)***	-6.2 (-8.5)***	0.8 (3.2)***	0.8 (4.1)***
Pol	3.2 (1.1)	3.4 (1.1)	2.0 (3.0)***	2.1 (3.0)***	-0.3 (-1.7)	-0.3 (0.6)
R^2	0.26	0.26	0.63	0.63	0.72	0.72
Adjusted R^2	0.18	0.19	0.59	0.60	0.69	0.70
F-Statistic	3.3***	---	15.9***	---	23.6***	---
Obs	72	72	72	72	72	72

Key: t-statistics in parenthesis

: [***], [**], [*] means statistically significant at 1%, 5% and 10%, respectively.

As R&D expenditure is the key input of patent production, the coefficient is however not significant in the case of COMESA countries. The finding of this study is different from the conclusion of Yang et al (2014) whose estimates found a significant elasticity of R&D of around 0.9. In the case of COMESA, the statistically insignificant role of R&D means that it (R&D) does not play an important role in fostering innovation. This is in sharp contrast to other studies where R&D was found to be an important determinant of innovation. One of the possible explanations of this anomaly finding maybe the fact that there is no serious R&D (in terms of absolute dollars spent) which has resulted in innovations which resulted in life products or services that significantly enhance lives or business operations that have been done in COMESA Member States. Actually, R&D conducted in most COMESA countries are more on how best to assimilate or adapt new innovations and/or technologies which have been done in other continents.

Focusing on the main variable of concern, the IPR variable, the estimated coefficients across all the models shows that the coefficients are negative and generally significant, though at different statistical levels. This result demonstrates that stronger IPRs protection overall discourages or negatively impact on innovations. For the case of COMESA this finding provides evidence to the fact that IPR discourages innovation, and the finding is not unusual given the dichotomy in the literature. This study's finding is consistent with previous studies, Deardorff (1992) whose findings concluded that stronger IPR hurt developing countries. Presenting a case of the negative impact of IPR on innovation, McCalman (1999) found that the move toward stronger IPRs in developing countries may work against national economic interest, transferring rents to multinational corporate patent holders headquartered in the world's most advanced countries.

The positive and significant coefficients on GDP per capita and manufacturing variables reveal that robust economic activities and manufacturing production are an important channel which stimulates innovation in any given economic setup. The finding on GDP per capita is in line with Leger (2006) that a vibrant economic activity implies profitability, thus encouraging innovation activities by firms. A politically stable country is associated with innovation as firms can easily engage in R&D which yields new ideas, products and processes even in the long run without fear of possible expropriation or loss due to potential risks emanating from political challenges.

The coefficient on real interest rate has been found to be both significantly positive and negative depending on the dependent variable. When the dependent variable is PAT (Number of patent applications with U.S), the coefficient is significant and negative. In this case, the fact that innovation requires funding, most funding is borrowed from banks (as opposed to using retained profits), and as such, higher interest rates will demotivate borrowing from banks, thus limiting activities with innovation. The coefficient is however positive and statistically significant when the dependent variable is TM (Trademark applications applications/million pop). One possible explanation is that, when compared to patents application, trademark applications are by far less costly. With patents, before you apply one should have done R&D which has resulted in new and innovative product (or service) and that R&D by nature requires sizeable funding, which implies borrowing. On the other hand, given that they are simple marks to differentiate a product, trademark application requires less funding, such that a company can apply using internal or retained earnings, and not seek credit. The coefficient is not significant when the dependent variable is CIPR (Charges for the use of intellectual property, receipts).

The coefficient on OPEN follows same trend as was found in the case of interest rate in that it is negative and statistically significant when the dependent variable is PAT, and positive and statistically significant when the dependent variable is trademark (TM). With regards to significant positive coefficient, trade openness here is considered as one of the policy choices that particularly affect the environment for innovative activity, because openness enforces a country to face the international competition. Therefore, openness has a positive influence on innovations. The negative impact of openness on innovation in the context of COMESA countries may stem from the fact that, with trade openness, it means more innovative products will easily enter the region, thus chocking off any possible innovation in similar products by firms and enterprises from COMESA region.

5.0 Conclusion and Policy Implications

The study identified determinants of innovation using a panel of COMESA countries. Manufacturing activities, GDP per capita and a stable political environment were found to be important factors explaining innovating activities. IPRs have a negative impact on innovative activities in the region, and this is supported by the view that strong IPR may harm research which leads to innovation in developing countries.

The main policy implication of the study's findings is that COMESA countries and policy makers are encouraged to be cautious when instituting regulations which emphasize stringent IPR. At this juncture and given the level of development across the Member States, the regional countries and policy makers should consider relaxed, as opposed to stringent IPR regulations in the spirit of encouraging innovation activities in COMESA region.

References

Alfranca, O. and W. E. Huffman. (2003). Aggregate Private R&D Investments in Agriculture: The Role of Incentives, Public Policies, and Institutions. Economic Development and Cultural Change 52(1): 1-22.

Baker, D., Jayadev, A and Stiglitz, J (2017). Innovation, Intellectual Property, and Development: A better set of approaches for the 21st Century. Shuttleworth Foundation.

Bechtold, S and de Rassenfosse, G (2019). Intellectual Property Protection and Innovation in Switzerland. Study elaborated as part of the report "Research and Innovation in Switzerland 2020" Part C, Study 6

Bertin, G and S. Wyatt. (1988). Multinationals and industrial property, the control of the world'

technology. Harvester-Wheatsheaf/Humanities Press International, Hemel Hempstead/Atlantic

Highlands

Coe, D.T. and E. Helpman (1995), "International R&D Spillovers," *European Economic Review* 39, pp.859-887

Cohen, W.M. and S. Klepper. 1996. Firm size and the nature of innovation within industries: The case of process and product R&D. *Review of Economics and Statistics*, 78(2): 232-243

Davis, J. (2006). 'The Value of Trade Marks: Economic Assets and Cultural Icons' in Y. Gendreau (ed.) *Intellectual Property: Bridging Aesthetics and Economics* Themis, University of Montreal, 2006 pp. 97-123

Deardorff, A.V. 1992. Welfare effects of global patent protection. *Economica* 59(233): 35-51.

Economic Commission for Africa (ECA) (2016). Assessing Regional Integration in Africa (ARIA VII): Innovation, Competitiveness and Regional Integration. Economic Commission for Africa, African Union and African Development Bank Group. Addis Ababa, Ethiopia

Forero-Pineda, C. (2006), "The Impact of Stronger Intellectual Property Rights on Science and Technology in Developing Countries," Research Policy 35, pp.808-824

Furman, J.L., Porter, M.E. and S. Stern. (2002). The Determinants of National Innovative Capability, *Research Policy* 31, pp.899 – 933.

Furukawa, Y. (2010), "Intellectual Property Protection and Innovation: An Inverted-U Relationship," *Economics Letters* 109, pp.99-101.

Gangopadhyay, K. and D. Mondal (2012), "Does Stronger Protection of Intellectual Property Stimulate Innovation?," *Economics Letters* 116, pp.80-82.

Ginarte, J.C. and W.G. Park (1997), "Determinants of Patent Rights: A Cross-National Study," *Research Policy* 26: 283-301.

Gollin, M.A. (2008). *Driving innovation: intellectual property strategies for a dynamic world*. Cambridge University Press, New York

Grindley, P.C and D.J. Teece. (1997). Managing intellectual capital: licensing and cross-licensing in semiconductors and electronics. *California Management Review* 39(2):8–41

Grossman, G. M. and E. Helpman. (1991). Innovation and Growth in the Global Economy. Cambridge, MA, MIT Press.

Hall, B and H. Ziedonis. (2001). The patent paradox revisited: an empirical study of patenting in the US semiconductor industry. *The Rand Journal of Economics* 32(2):101–128

Hamilton, M.A. (1996). The TRIPS agreement imperialistic, outdated and overprotective.

Vanderbilt Journal of Transitional Law 29:613

Hanel, P. (2006). Technovation. 26:895–931

Hausman, J. A., Hall, B.H. and Z. Griliches (1984). Econometric Models for Count Data with an Application of the Patents-R&D Relationship, Econometrica, 52: 909 – 938.

Kanwar, S. and R.E. Evenson 2003. Does Intellectual Property Protection Spur Technological Change? *Oxford Economic Papers* 55(2): 235-264.

Kiviet, J.F. 1995. On bias, inconsistency, and efficiency of various estimators in dynamic panel data models. *Journal of Econometrics*, 68(1): 53-78.

Lall, S. 1992. Technological capabilities and industrialization. *World Development* 20(2): 165-186.

Lederman, D. and W. F. Maloney. (2003). R&D and Development. World Bank Policy Research Working Paper 3024, Washington, DC.

Léger, A. (2006). Intellectual Property Rights and Innovation in Developing Countries: Evidence from Panel Data. Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Long Beach, California, July 23-26, 2006.

Léger, A. (2005). Intellectual Property Rights in Developing Countries: Do They Play a Role? World Development, 33(11): 1865-1880.

Maskus, K.E. (2000), *Intellectual Property Rights in the Global Economy*, Washington, DC: Institute for International Economics.

McCalman, P. (1999), "Reaping What You Show: An Empirical Analysis of International Patent Harmonization," *Journal of International Economics* 55: 161-186.

Oppenlander KH (1977) Patent policies and technical progress in the Federal Republic of

Germany. *IIC 8(2):*97–122

Pakes, A. and Z. Griliches (1980). Patents and R&D at the Firm Level: A First Report, *Economics Letters* 5: 377–381.

Park, W.G. (2008), International Patent Protection: 1960-2005, *Research Policy*, 37: 761 – 766.

Qian, Y. (2007), "Do Additional National Patent Laws Stimulate Domestic Innovation in a Global Patenting Environment: A Cross-Country Analysis of Pharmaceutical Patent Protection: 1978-1999," *Review of Economics and Statistics* 89. :436-453.

Rivette, K.G and D. Kline. (2000a) Discovering new value in intellectual property. *Harvard Business Review* 2000:54–66

Rothschild , M. F and S. Newman. (2002) . *Intellectual Property Rights in Animal Breeding and Genetics* . New York : CABI Publishing.

Schneider, P. H. (2005),"International trade, economic growth and intellectual property rights: A panel data study of developed and developing countries", *Journal of Development Economics*, Vol. 78 No. 2: 529-547.

Teitel, S. (1994), "Patents, R&D Expenditures, Country Size, and Per Capita Income: An International Comparison," *Scientometrics* 29: 137-159.

Varsakelis, N.C. (2001), "The Impact of Patent Protection, Economy Openness and National Culture on R&D Investment: A Cross-Country Empirical Investigation," Research Policy 30: 1059-1068.

Yang, C., Huang, Y., and H. Lin. (2014). Do stronger intellectual property rights induce more innovations? a cross-country analysis. *Hitotsubashi Journal of Economics,* 55: 167-188.

https://www.kauffman.org/wp-content/uploads/2019/12/IP_PolicyDigest_040715.pdf

The Role of Intellectual Property Rights Protection on Intra-COMESA Trade: **The Case of Trademarks**

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Abstract

The relationship between trade and intellectual property rights is inconclusive. This paper, therefore, examines the effects of intellectual property rights, mainly trademarks, on intra- COMESA trade using the pseudo poisson maximum likelihood estimation technique. A panel data of 10 products, classified using the Standard International Trade Classification (SITC) Revision 3 for five selected COMESA countries and for the period 2000 to 2017 was used. At the aggregate level, the study could not establish the market power and market expansion effects of trademarks on imports. However, using disaggregated sectoral import data, the study confirms a positive link between trademark-related tobacco product imports and a negative relationship between trademark-related rubber and clothing product imports. Thus, the study concludes that strengthening of trademarks has a market expansion effect for tobacco products and market power effect for clothing, footwear and rubber products. The selected COMESA countries are therefore urged to strengthen intellectual property rights for tobacco products as this promotes intra-COMESA trade while a laxed approach may be advocated for the promotion of trade in clothing, footwear and rubber products within the region.

***Key Words*: I**ntellectual Property Rights, Trademark, TRIPS Agreement, PPML, COMESA

1.0 Study Background

The raging debate on the effects of strengthening intellectual property rights (IPRs) protection stems from theoretical, empirical and policy realms. According to WIPO (2012), IPRs refer to the creations of the mind such as literary and artistic works, designs, symbols names and images used in commerce which is protected by law. These include patents (inventions), copyrights, trademarks and geographical indications that enable their creators to earn recognition or financial benefit from what they create.

In the policy arena, the status of IPRs as a deterrent to trade became profound following the enactment of a special provision in the United States Act of 1988 which linked the American foreign policy to the prevailing IPR regimes in bilateral trading partner regimes (Maskus & Penubarti, 1995). Furthermore, IPRs became an important issue as increased national disputes over IPRs led to the multilateral World Trade organization (WTO) on Trade-Related Aspects of Intellectual Property rights (TRIPS) in 1994 (Awokuse & Yin, 2010).

In the empirical realm, empirical studies confirm ambiguities on the relationship between IPRs and international trade (Awokuse & Yin, 2010). One group of authors believe that strengthening intellectual property rights is anti-competitive and tend to reduce the flow of goods across borders (Campi & Dueñas, 2019; Shin, Lee & Park, 2016) while another group contends that intellectual property rights are fundamental for promoting foreign trade and investment leading to economic development (Maskus & Penubartib, 1995; Awokuse & Yin, 2010). Intellectual property rights, including protection and enforcement is a key factor in promoting foreign trade and investment as well as boosting economic development. However, some trade economists however believe that trade agreements that include intellectual property rights creates a system of imbalance which can retard international trade (Curtis, 2012).

The effects of IPRs are also shadowed by social objective considerations. Strengthening IPRs have the implication of reducing access to much need drugs in the pharmaceutical sector negatively affecting social development. Thus the discussion of the relationship between trade and IPRs is cross-cutting as it includes many variables such as cultural, social, humanitarian and political considerations (Curtis, 2012).

The TRIPS agreement places obligations on all World Trade Organization (WTO) members to offer specified minimum standards of IP in a wide range of sectors. The agreement gives developing countries a certain amount of flexibility in how they fulfill their obligations. This allows countries to tailor their IPRs regimes to their own specific circumstances. With the signing of the TRIPS agreement, countries are bound to adopt or modify their IP related legislation in accordance to certain minimum standards. The Common Market for Eastern and Southern Africa (COMESA) comprises of average users of intellectual property rights (see *Table 1*). In Africa, counterfeiting is a major problem which has the potential of affecting investment and trade (Strategic Marketing Africa, 2016). Counterfeiting is an increasing problem of intellectual property rights particularly trademarks. Given that African countries are major users of marks when compared to other rights, they are likely to suffer from counterfeiting thereby reducing trade. How then has intellectual trade mark protection affected trade among COMESA Member States. In 2017, intra-COMESA exports declined by 1.76% while intra- COMESA imports surged by 1.33% (Trade Mark East Africa, 2018). The decline in exports was partly due to a decline in oil prices and commodity prices since 2014. The major players in the regional grouping are Egypt, Uganda, Kenya, Zambia and Sudan (ibid). The poor intra-COMESA exports were compounded by a drought which affected many eastern Africa countries in the year 2016 (ibid).

In the contemporary global economy, trademarks play an important role in a wide array of industries and sectors and shape the competitive landscape of many diverse markets. The importance of trademarks evolves with structural changes and economic development of countries. This is as apparent in developed countries as it is in developing countries. The importance of trade marks cannot be understated. Trademark filings have expanded rapidly in recent decades. WIPO (2012) indicate that the total trademark applications world-wide has more than doubled between 1995-2011 with more than 4.2 million applications filed.

Recognizing the importance of IP rights in international trade and economic growth, COMESA developed an IPRs policy document which member countries "facilitate the increase in regional trade in IP-intensive products and the flow of IPRs using all the flexibilities in international and regional instruments on IPRs". Further the policy document asserts that member countries shall "develop an effective IP promotion and protection system so as to create incentives for innovation and creativity as well as foreign direct investment" (COMESA, n.d.).

COMESA was formed in December 1994 replacing a Preferential Trade Area that had existed since 1981. It has a current membership of 21 countries which are: Burundi, Comoros, Democratic Republic of Congo, Djibouti, Egypt, Eritrea, Ethiopia, Kenya, Kingdom of Eswatini (formerly Swaziland), Libya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Sudan, Tunisia, Uganda, Zambia, Zimbabwe. Like other regional economic communities, COMESA has an intellectual property framework which is dichotomous. One part of the framework, Part A which is entitled 'COMESA Policy on IPRs' emphasizes the link between promoting intellectual property rights and economic development in developing countries. it also considers the relationships between intellectual property and trade (a relationship that this study tries to explain), the cultural industries, traditional knowledge and expressions of folklore and information communications technologies. The other, Part B is entitled 'COMESA Policy on Copyright and Copyright-related Industries' focus on the need to encourage and promote copyright protection for socio-economic development. The objective of Part B includes increasing capacity to commercialize copyright works, 'creating public awareness on the importance of copyright protection' and encouraging research on copyright and socio-economic development. Part B also stresses the need to curb piracy and copyright infringement and mentions the need to promote a balanced copyright system that facilitates access to knowledge and learning materials which contributes immensely to the quality of people's lives.

In light of the above, this study seeks to examine the role of intellectual property rights in promoting intra-COMESA trade. Particularly, the study seeks to establish whether the strengthening of IPRs in COMESA has promoted the movement of intellectual property intensive products between member countries. Africa has 9 regional economic communities (REC) (e.g. EAC, ECOWAS, IGAD, SADC among others)[30] and COMESA is one of the largest RECs in terms of membership. In addition, the REC has high income (Egypt), middle-income (Kenya) and low-income (Madagascar) members. This is important in ascertaining whether the effect of IPRs on trade is also sensitive to the level of development.

This paper makes two important contributions to the literature, first by examining the effects of intellectual property rights particularly trademarks on intra-COMESA trade flows. Secondly, the study contributes by providing the much-needed empirical evidence to help shape the debate on intellectual property reforms in Africa. This study differs from previous studies in several ways. First, it is the first study to empirically examine the effects of intellectual property rights, particularly trademarks on intra-COMESA trade. Secondly, it provides a sectoral dimension on the effects of trademarks on trade

30 EAC – East African Community, ECOWAS – Economic Community of West African States, IGAD – intergovernmental Authority on Development, SADC – Southern Africa Development Community. The other regional economic communities include the Arab Maghreb Union (AMU/UMA), the Economic community of central African States (ECCA), the Community of Sahel-Saharan States (CENSAD) and the recent African Continental Free Trade Area (AFCFTA)

in the COMESA region. Most of the studies were conducted from developed and other non-African developing countries. This study emphasizes trade flows between countries in a similar geographical region. In addition, the study uses panel data for selected COMESA countries for the period 2000 to 2017. The period helps to examine the dynamic effects of trademarks IPRs, particularly, trademarks, on trade flows.

1.1 Study Objectives

The main objective of this study is to examine the effect of intellectual property rights on intra-COMESA trade. In particular, the study seeks to:

(i). Examine the effects of trademarks on intra-COMESA trade volumes; and
(ii). Determine which product sector is highly affected in the COMESA region by trademark protection.

To answer the above objectives, the following research questions will be pursued:

(i). What are the effects of trademark protection on Intra COMESA trade?
(ii). Which product sectors are affected most by trademark protection in intra-COMESA trade?

The rest of the paper is organized as follows: section 1.2 provides an overview of IPRs in COMESA. Section 2 provides a review of both theoretical and empirical literature which is followed by section 3 on methodology, section 4 provides the findings and discussion of results. Finally, section 5 provides conclusion and policy implications.

1.2 Overview: Intellectual Property Rights Landscape in Selected COMESA Countries

This section discusses the intellectual property rights landscape in COMESA. Table 1 shows intellectual property performance measures for selected COMESA countries. As indicated in the Table 1, Rwanda, Mauritius and Kenya are rated highly in terms of intellectual property rights as measured by the intellectual property protection index while the Democratic Republic of Congo is considered the weakest. In terms of competitiveness index (global competitiveness index (GCI)), Seychelles is the best performer with the least being Burundi.

Table 1: Intellectual Property Rights Performance measures for selected COMESA Countries (2018)[31]

Countries	Patents	Trademarks	property rights	IP Protection	GCI Rank/140
Burundi	0.00	0.00	3.00	3.20	136
Congo, Dem Repub	0.00	0.00	3.10	3.00	135
Egypt	0.21	147.69	4.60	3.30	94
Ethiopia	0.01	0.00	4.20	3.80	122
Kenya	0.16	87.52	4.70	4.40	93
Malawi	0.00	24.53	4.20	3.40	129
Mauritius	0.81	29.26	5.10	4.50	49

31 Countries in the sample were chosen basing on data availability.

Rwanda	0.01	17.70	4.80	4.70	108
Seychelles	8.06	20.35	4.60	4.10	74
Eswatini	0.15	0.00	4.30	3.40	120
Uganda	0.01	32.54	4.00	3.40	117
Zambia	0.02	32.93	4.20	3.70	118
Zimbabwe	0.04	19.26	2.60	3.40	128
Average	**0.73**	**31.68**	**4.11**	**3.72**	

Source: Author Compilation from WIPO Database

An interesting observation from Table 1 is that COMESA countries are major users of trademarks when compared to patents. This shows that in terms of inventions COMESA countries are not good performers with an outlier being Seychelles which has the highest applications of patents in relation to its COMESA counterparts. Patents and trademarks indicate the number of applications for a million persons in the population. Burundi, Democratic Republic of Congo and Eswatini did not register any trademark application in the year 2018, whereas Egypt, registered the highest trademark applications of 147 per million population. Generally, COMESA countries have registered trademark applications of 31.68 per million population compare to that of 0.73 for patents.

As can be deducted from Table 1, some COMESA countries did not even have single patent application and these include Malawi, Burundi and Democratic Republic of Congo. Overall, the average number of patent application in the selected countries was 0.73 per million population, which an insignificant number. The variable property rights is an index ranging from 0-7 with seven being the strongest. As indicated in Table 1, most of the countries are above average users of property rights except for Zimbabwe where intellectual property rights are considered to be weaker. The global competitiveness index ranks most of the COMESA countries as weak in terms of providing a competitive environment. Most of the countries are positioned above 100 except for Mauritius, Seychelles, Egypt and Kenya.

2.0 Literature Review

This section discusses theoretical and empirical literature on the role of intellectual property rights with emphasis on trademarks, on international trade. It begins with the presentation of the theoretical literature which is subsequently followed with a review of related studies.

2.1 Theoretical Literature

The theoretical literature on the relationship between IPRs and trade is not conclusive on whether strong IPRs protection promotes or discourages bilateral trade (Maskus and Penubartib, 1995; Curtis, 2012). According to Maskus and Penubartib, (1995) two theoretical expositions exists on the relationship between intellectual property rights and international trade. The two effects are: (a) market expansion and (b) market power effects. The market expansion effect occurs when strengthening of IPRs discourages domestic firms from imitating the technologies embodied in imported goods. This resultantly leads to an increase in supply of the products by firms with better technologies. The corresponding effect will be the increase in net demand of the firms' products. On the contrary, the absence of strong IPRs lead firms to reduce their exports to countries where their technologies are likely to be imitated. This is more pronounced in circumstances where the importers have the adequate resources to reproduce or imitate the technologies or products that embody the technologies. Strong IPRs increase exports to such markets by reducing the costs associated with preventing loss of the technologies. Such costs include foregone revenues from reduced exports and expenses incurred in making the technologies difficult to imitate.

The opposite market power explanation postulates that strong IPRs reduce trade by allowing a temporary monopolistic kind of behaviour where firms will take advantage of the increase in net demand by reducing supply of the product and increase prices. In this way, strengthening of IPRs generates market power effects, which reduce trade. Firms in strong trademark protected countries can exercise their market power by restricting the quantity of exports and increase their unit price in a bid to extract monopoly rents. Since the market power and market expansion effects are countervailing, the direction of the relationship between IPRs and trade from a theoretical perspective is indeterminate.

Trademarks as a form of IPRs, serve primarily to identify a source of goods and service. This function enables trademarks to both reduce consumer search costs and incentivizes producers to develop goodwill in their products or services. Trademark rights are determined by priority of use in commerce and trademark registration confers significant benefits to a mark owner. Trademark registration is a powerful tool for an entity interested in building a strong brand. Among other benefits, trademarks confer nationwide rights, serves as prima facie evidence of ownership of a particular mark and enables enhanced protections against counterfeits. This is expected to have the market expansion effect.

Trademarks seek to reduce consumer search costs by assuring consumers that they are buying the goods with the qualities they expect from a particular brand. Thus, it also incentives producers to invest time, money and energy into the quality of the goods presented to the public under a particular mark. Trademarks are the essence of competition because they make possible a choice between competing goods and services by asking the buyer to distinguish one from the other. Trademarks encourage the maintenance of quality by securing to the producer the benefit of the good reputation which excellence creates. To protect trademarks therefore is to protect the public from deceit, to foster fair competition and to secure to the business community the advantage of reputation and goodwill by preventing their diversion from those who have created them to those who have not.

Depending on the effect the trademark, it can be concluded that the effect of IPRs strengthening becomes an empirical issue as theoretically, the different views suggest ambiguity. Further, it is also argued (Curtis, 2012) that weak or non-existent intellectual property rights reduces international trade through decreases in direct foreign investment, technology transfer, joint ventures or licensing agreements and demand. Thus, recommending non-existence is not a best option.

2.2 Empirical Literature

Vast empirical evidence has been provided on the nexus between intellectual property protection and international trade. However, the majority of the studies focuses on developed countries with few on developing countries. Most importantly, the empirical literature on the role of intellectual property rights protection is very limited in Africa.

Awokuse and Yin, (2010) using a gravity approach for China and 36 of its trading partners shows that strengthening of intellectual property patent rights protection stimulates China's imports particularly of knowledge-intensive products. This study confirms that strengthening IPs protections has more of a market expansion effect than a market power effect. However, the effect varies by different product sectors and is strongest in knowledge intensive products.

Similarly, Raizada and Dhillon, (2017) in a study based on Indian trade data, established a positive significant correlation between intellectual property rights and trade (imports and exports) in India for the period 1996-2014. Furthermore, Granger-Causality tests indicate that the direction of causality is unilateral: running from trade to intellectual property protection for patents and from intellectual property rights to trade for trademarks and copyrights.

More important to this study, Campi and Dueñas (2019) examined the effects of intellectual property rights in trade agreements on international trade. Considering trade agreements with and without intellectual property rights provisions, and using a panel of 110 countries for the period 1995-2013, the authors finds a positive relationship between trade agreements and trade but a stronger positive relationship for those trade agreements without intellectual chapters. Considering trade agreements with IP chapters, one hand, the study finds that Intellectual property tights chapter facilitates developed countries export of high IP products to both developed and developing countries while on the other do not foster developing countries exports. By intuition, this means that intellectual property rights IPRs provisions in the trade agreements drives trade through the market expansion effect. For developing countries, trade flows are enhanced by signing trade agreements with no IPRs chapters.

This finding of Campi and Dueñas (2019) is buttressed by Maskus and Ridley, (2016). This study finds a positive and significant effect of deeper regional trade agreements on trade flows of member countries. Though greater effect was observed for middle income countries high- and low-income countries also benefited in some particular sectors. Including IPR provisions deepens a trade agreement increasing the intensity of trade flows (Mattoo, Mulabdic & Ruta, 2017).

Maskus and Penubartib, (1995) states that there is little evidence about the effect of different level of intellectual property protection on trade flows. However, the authors established a positive relationship between patent protection and the volume of manufactured exports. The ambiguity on the effects of intellectual property rights was confirmed by Campi and Dueñas, (2016). Stronger IPRs have a negative on the intensive margin of trade though a positive impact is observed on the extensive margin.

Shin, Lee and Park, (2016) shows that IPRs may act as an export barrier to trade, discouraging exports from least developed countries (LDCs) that ae in the process of catching-up in terms of their levels of technology. Interestingly, the authors argue that despite the positive effects of IPRs reforms on global trade, exports of LDCs have not been significantly promoted. This creates distributional bias in favour of exporters from developed countries relative to those from the LDCs. In the same vein, COMESA countries are at different levels of development and this study further hypothesizes that countries that are on the higher level of income benefits from the strengthening of IPRs within the trade agreement at the expense of low-income countries. A summary of some empirical work on the relationship between IPRs and international trade are presented in *Table 2*.

Table 2: Selected Empirical Evidence on the effects of IPR Protection on Trade

Author(s)	IPR Measure	Methods	Findings
Prasetyo (2013)	IPR index (composite)	Ordinary least Squares	Negative effect on trade
Campi and Dueñas, (2019)	IPR Chapters in trade agreements	Gravity model (panel data fixed effects)	Negative effects on trade for trade agreements with IPRs Chapters
Maskus and Penubartib, (1995)	Patent index	Gravity model	Positive effects on manufactured imports
Campi and Dueñas, (2016)	IPR Index (composite)	Gravity model	Negative and uneven effects on agricultural trade
Raizada and Dhillon, (2017)	IPR indices for patents, copyrights and trademarks	Vector error correction model and Granger-Causality approaches	Positive effects on trade (imports and exports)
Awokuse and Yin, (2010)	Ginarte-Park IPR index (patent rights)	Gravity model (Hausman-Taylor IV technique)	IPR protection stimulates imports

3.0 Methodology

The study uses a gravity model to examine the effects of intellectual property protection on intra-COMESA trade. The gravity model has a long history in the empirical estimation of bilateral trade. A simplified version of the derivation of the Anderson and van Wincoop, (2003) gravity model as given by Baldwin and Taglioni, (2006) follows the following steps:

The first is the presentation of the demand equals supply equation and the specification of the expenditure share identity that includes the relevant prices. The expenditure share identity states that the value of trade flow from country i to j, $P_{ij}x_{ij}$ should equal the share country i has in expenditure of country j; i.e.

$$P_{ij}x_{ij} = s_{ij}E_j \qquad (1)$$

Where P_{ij} = import price from i to j, s_{ij} = share of i in 's expenditure E_j. s_{ij} is assumed to follow from the constant elasticity of substitution (CES) demand structure. This allows the derivation of an explicit expression for the imported goods share in E_j. Assuming all goods are traded, this share depends on the bilateral prices relative to the price index presented as follows:

$$s_{ij} = \left(\frac{P_{ij}}{P_j}\right)^{1-\sigma}, where; P_j = \left[\sum_{i=1,\dots,N}\left(n_i P_{ij}\right)^{1-\sigma}\right]^{1/1-\sigma} \qquad (2)$$

P_j = is the Dixit- Stiglitz constant elasticity of substitution consumer price index for country j. The parameter σ denotes the elasticity of substitution between varieties and is assumed to be greater than 1. N = number of countries and n denotes the distribution parameter of the utility function or the number of varieties supplied by country i. The number of varieties is defined symmetrically providing room for ignoring the varieties. Equation 2 is further improved by adding trade costs, which is a crucial element in the gravity model. Letting t_{ij} represents bilateral trade costs, the price in the market j equals:

$$P_{ij} = P_j t_{ij} \qquad (3)$$

P_i = the price of a variety in country i. Thus, adding transport, the price in market j becomes P_{ij}.

The gravity equation describes total trade between two countries and this implies aggregating across varieties to get:

$$T_{ij} = n_i s_{ij} E_j = n_i \left(P_i t_{ij}\right)^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}} \qquad (4)$$

Assuming that all goods are traded, the budget constraint states that total output of country i, Y_i equals the total sales to all destinations country j including country i itself;

$$Y_i = \sum_j T_{ij} = n_i P_j^{1-\sigma} \sum \left(t_{ij}^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}} \right) \qquad (5)$$

Rewriting equation 5 as:

$$n_i P_i^{1-\sigma} = \frac{Y_i}{\pi_i^{1-\sigma}}; where, \pi_i = \left(\sum \left(t_{ij}^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}} \right)^{\frac{1}{1-\sigma}} \right) \qquad (6)$$

The gravity equation can then be derived from inserting equation 6 into 4 to get;

$$T_{ij} = Y_i E_j \left(\frac{t_{ij}}{\pi_i P_j} \right)^{1-\sigma} \qquad (7)$$

Equation 7 represents the theoretical gravity equation that governs bilateral trade flows. This equation can be decomposed into two important terms: (1) the size term $Y_i E_j$[32] and the trade cost term $\left(\frac{t_{ij}}{\pi_i P_j} \right)^{1-\sigma}$. The size term measures the level of frictionless trade while the trade costs measures the effects of trade costs on the frictionless trade. Bilateral trade cost is mostly proxied by various geographical and trade policy variables such as bilateral distance, tariffs and other dummy variables to indicate common border, common language, membership to a preferential trade agreement and colonial ties. A number of issues (see van Bergeijk & Brakman, 2010:11; Yotov, Piermartini, Monteiro, & Larch, (2016) have been raised in the empirical estimation of gravity models. Among them are issues to do with multilateral resistance, zero trade flows, distance, the level of disaggregation, endogeneity and heteroscedasticity. These issues pose challenges to the estimation of a gravity model. Three alternatives have been provided to deal with the multilateral resistance issue. The approaches include fixed effects as an approximation to multilateral resistance, linearization and some analytical solution (op. cit.). Regarding zero trade flows, literature has suggested a number of measures which include dropping zero variables, adding some constant to all trade flows to enable logarithmic transformation. These two approaches are appropriate when the zero trade flows are normally distributed. When the zero trade flows are not normally distributed this leads to selection bias. The Hausman-Taylor two step estimator and the PPML estimator can be used to correct for this selection bias. The Hausman-Taylor two step estimator was used by Awokuse and Yin, (2010). Lastly, the gravity model can be estimated at both macro- and micro-levels. A more disaggregated analysis help capture the actual behaviour of micro-units.

32 The original Anderson and van Wincoop, (2003) uses income shares in the derivation of the structural gravity model

This study estimates a stochastic form of (7) modifying it to include gravity variables such as distance, common border, common language and intellectual property rights measures as proxies for bilateral trade costs. This model is given as follows:

$$\ln M_{ij,t} = (1-\sigma)\ln \tau_{j,t} + \ln Y_{i,t} + \ln E_{j,t} - (1-\sigma)\ln \pi_{i,t} - (1-\sigma)\ln P_j + \varepsilon_{ij,t} \quad (8)$$

However, for the purposes of this study, the estimated model is simplified to:

$$\ln M_{ij,t} = \alpha_0 + \alpha_1 \ln Y_{i,t} + \alpha_2 \ln Y_{j,t} + \alpha_3 \ln tmark + \delta_1 \ln Dist_{ij} + \delta_i \sum_{i=2}^{n} t_{ij} + \varepsilon_{ij,t} \quad (9)$$

M_{ij} is a measures imports, Y_i and Y_j are the gross domestic product of country **i** and **j** respectively. These variables are expected to have a positive effect on trade and as such we expect the coefficient of the estimated parameter α to be positive. The parameter t_{ij} comprise of other trade cost variables such as common border, common language. Distance is a proxy for transportation cost. The greater the distance the more resistance to trade. Distance is therefore expected to have a negative effect on imports. Common language and common border are expected to be directly proportional to trade between countries. Both theoretical and empirical literature instigates that the effect of IPRs on trade is ambiguous as either the market expansion effect or the market power effect will dominate.

A number of approaches have been used in the estimation of equation 8 ranging from ordinary least squares to maximum likelihood estimation technique. Each approach in estimation has its own strength and weakness. In the presence of heteroscedasticity and zero trade flows, ordinary least squares estimates may yield biased estimates (Hsiao; 2003). Further, in panel data, ordinary least squares are subject to unobservable heterogeneity bias.

A common remedy is to include country specific effects in the regression. The alternative model specifications are the fixed effects model and random effects model. The fixed effects model assumes that the independent variables are correlated with unobserved fixed individual effects while the random effects assumes that the unobserved are randomly distributed but uncorrelated with all regressors. The choice of the appropriate model between these two competing models is aided by the use of the Hausman test. The Hausman test is based on the null hypothesis of no correlation between unobserved characteristics and the explanatory variables. Under the null hypothesis, both the fixed effects model and the random effects model yield consistent estimates but the random effects models provide more efficient estimates. Rejecting the null hypothesis under the Hausman test indicates that the fixed effects model is preferred over the random effects model. The random effects model procedure allows for the inclusion of time-invariant independent variables e.g., distance. However, the common shortcoming of the random effects model is the potential for endogeneity problems such that some of the independent variables are correlated with the random unobserved individual effects.

Alternative methods to correct for endogeneity in a gravity model is to use instrumental variable estimator such as proposed by Hausman-Taylor. Alternatively, the Pseudo Poisson maximum likelihood (PPML) estimation technique can also be used. The PPML can be used even when trade data is mulled with zero trade flows (a common feature with trade data) and when there is heteroscedasticity (a common problem with panel data) (Baldwin & Taglioni, 2006)"mendeley":{"formattedCitation":"(Baldwin & Taglioni, 2006. In light of this, this study uses the PPML to examine the effects IPRs on intra-COMESA trade. An important issue in the estimation of the nexus between IPRs and trade flows is the problem of endogeneity, however for African countries this endogeneity can be questioned as the adoption of IPRs were not endogenous to domestic innovation (Delgado, Kyle & Macgahan, 2013).

The sample data comprise of 5 COMESA countries (Egypt, Ethiopia, Kenya, Mauritius and Zimbabwe) for the period 2000-2017. Kenya, Egypt are leaders in intra-COMESA trade. Data for imports is drawn from the World Integrated Trading System (WITS) whilst data for GDP was drawn from the World Development Indicators (2018). Distance, common border and common language date is drawn from the BACI database. Import data for the ten sectors are organized according to the 2-digit of the Standard International Trade Classification (SITC) nomenclature. The ten sectors are furniture, footwear, dairy, beverages, tobacco, paper, plastics, pharmaceutical products, clothing. Data on trademarks is drawn from the World Intellectual Property Organization (WIPO). The variable intellectual property trademark protection was measured as annual trademark applications by foreign residents or firms in each of the 5 COMESA countries. The number of trademark applications accounts for more variation across time and may be less susceptible to measurement errors (Awokuse & Yin, 2010).

4.0 Study Findings

The section first discusses the study findings, beginning with descriptive statistics, and lastly the results from the gravity model. Table 3 presence the descriptive statistics of the variables used in the model.

Table 3: Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
imports	4464	666.967	793.062	0	2426
lngdp_imp	4464	17.025	8.448	4.713	26.531
lngdp_exp	4464	20.648	6.246	4.713	26.531
lndistance	4464	7.693	.654	6.369	8.744
lntrademark	4464	4.274	2.248	0	9.102
contig	4464	.141	.348	0	1
language	4464	.742	.438	0	1
comcol	4446	.494	.5	0	1

Source: Author Computations

Table 3 shows the mean imports of the ten selected products averaged US$666.97 million between the period 2000 – 2017. The standard deviation of the distance is 0.654, implying that the countries are spatially close to each other. Approximately 74.2 percent of the countries in the sample speak the same language while 14.1 percent share the same border. Forty-nine percent of the countries have the same colonial history. Multicollinearity amongst the variables was tested using the zero order pairwise correlation. The results are presented in Table 4.

Table 4: Pairwise Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) imports	1.000							
(2) lngdp_imp	-0.038*	1.000						
(3) lngdp_exp	0.141*	-0.246*	1.000					
(4) lndistance	-0.036*	-0.171*	-0.132*	1.000				
(5) lntrademark	0.012	0.177*	-0.003	0.228*	1.000			
(6) contig	0.105*	0.073*	0.025	-0.623*	-0.127*	1.000		
(7) language	-0.103*	-0.197*	-0.182*	-0.498*	-0.232*	0.239*	1.000	
(8) comcol	0.011	0.307*	-0.006	-0.433*	0.154*	0.063*	0.578*	1.000
* shows significance at the 0.05 level								

The results from the zero order pairwise correlations suggest the non-existence of perfect multicollinearity. All the zero order pairwise coefficients are less than 0.8. As such all the variables were included in the regression model and results from the estimation are presented in Table 5.

Table 5 presents the results of intellectual property rights on intra-COMESA trade. The first column shows the effect of trademarks on international trade at an aggregate level. The coefficient corresponding to trademarks is negative and statistically insignificant. This illustrates that trademark strengthening has no significant effect on the import volumes of trademark related products. It shows the effects of including an IPRs chapter as well as trademarks on intra-COMESA trade. Subsequent columns display the results of IPRs on the 10 different products as IPRs are considered to have different effects at a highly disaggregated level.

Using the Poisson pseudo maximum likelihood (PPML) model, the results indicates that trademarks are mostly important in the trade of tobacco, rubber and clothing products. For tobacco products the strengthening and enforcement of trademark related intellectual property rights leads to an increase in the import of trademark related tobacco products while an opposite effect is observed for trademark related rubber and clothing products. In the context of trademarks, the strengthening of trademarks leads to an increase in the importation of trademark protected tobacco products. However, stronger trademark protection reduces the importation of trademark related rubber and clothing products. This can increase the supply of counterfeit products. These results suggest that it is trade promoting for countries to increases their IP protection for tobacco products while it is disadvantageous to countries exporting rubber, clothing and footwear products. In particular, the coefficient of trademarks is positive and statistically significant. The positive coefficient of 0.085 indicates as trademark applications increase by 1 percent, the volume of tobacco imports increases by 0.085 percent. Tobacco brand names are associated with quality, as such the protection of trademarks will be corresponded by an increase in imports of the same products. This result support the findings by Maskus & Penubarti, (1995) and Raizada & Dhillon, (2017). However, on the contrary, negative and statistically significant coefficients on rubber, clothing and footwear products creates market power effects which is corresponded by a decrease in the imports. This is usually the case if the trademark protection is corresponded by an increase in prices. These findings are supported by Campi & Dueñas, (2019).

The results suggest that a 1 percent increase in the number of trademark applications leads to a 0.081 percent increase in imports of tobacco products. At the same time, 1 percent increase in trademark applications lead to a 0.079 percent, 0.068 percent and 0.085 percent decreases in clothing, footwear and rubber imports respectively. As in the gravity model, countries that have the same colonial history trade more in trademark related products. However, for language, the results suggest that countries that have a common official language trade less on trademark related products. This may be due to the fact that the products originating from countries with similar languages may be having trademark names that maybe confusingly similar. Compared with those emanating from countries using different languages, consumers may find it easy to distinguish source and origin which may lead to more trade.

Table 5: Pseudo Poisson Maximum Likelihood Regression Results

	(all_ Products)	(Dairy)	(Bever-ages)	(Tobac-co)	(Phar-maceuti-cal)	(Plas-tics)	(Rubber)	(Paper)	(Furni-ture)	(Cloth-ing)	(Foot-wear)
	imports	imports	imports	imports	imports	imports	imports	imports	imports	imports	imports
lngdp_imp	-0.022***	-0.030***	-0.022	-0.007	-0.041***	-0.028*	-0.025***	-0.019	-0.051***	-0.028**	-0.003
	(0.008)	(0.010)	(0.018)	(0.032)	(0.012)	(0.015)	(0.009)	(0.015)	(0.010)	(0.013)	(0.020)
lngdp_exp	0.011	-0.008	-0.000	0.034**	-0.001	0.017	0.009	0.002	0.027	-0.001	0.015
	(0.011)	(0.038)	(0.031)	(0.016)	(0.016)	(0.024)	(0.017)	(0.021)	(0.019)	(0.018)	(0.025)
lndistance	0.037	-0.342**	0.328	0.041	-0.095	0.402	0.131	0.095	-0.157	0.046	-0.029
	(0.170)	(0.165)	(0.633)	(0.295)	(0.157)	(0.319)	(0.198)	(0.274)	(0.203)	(0.293)	(0.351)
lntrademark	-0.024	0.022	-0.026	0.081*	-0.009	-0.035	-0.085***	-0.035	0.002	-0.079**	-0.068**
	(0.019)	(0.023)	(0.033)	(0.047)	(0.030)	(0.046)	(0.029)	(0.036)	(0.033)	(0.034)	(0.034)
contig	0.584**	0.304	1.318	0.500	0.541***	0.807*	0.873**	0.601*	0.439*	0.670*	0.431
	(0.239)	(0.191)	(0.941)	(0.427)	(0.161)	(0.481)	(0.366)	(0.345)	(0.230)	(0.360)	(0.510)
language	-0.846***	-1.704***	-1.768***	-0.514	-0.788***	-0.678**	-1.110***	-0.979***	-0.642***	-0.989***	-0.764*
	(0.133)	(0.251)	(0.620)	(0.728)	(0.174)	(0.334)	(0.230)	(0.358)	(0.202)	(0.329)	(0.432)
comcol	0.612***	1.026***	1.450**	0.257	0.585***	0.959***	0.787**	0.782**	0.595**	0.854***	0.562
	(0.170)	(0.237)	(0.575)	(0.613)	(0.221)	(0.340)	(0.309)	(0.333)	(0.246)	(0.273)	(0.349)
_cons	6.667***	10.140***	4.406	5.412**	8.201***	3.602	6.263***	6.489**	8.074***	7.198***	6.880**
	(1.446)	(1.662)	(5.537)	(2.751)	(1.337)	(2.737)	(1.489)	(2.522)	(1.635)	(2.586)	(3.141)
Obs.	4446	306	360	450	522	360	486	486	504	612	360
R-squared	0.068	0.099	0.125	0.088	0.094	0.071	0.120	0.075	0.145	0.091	0.073
Standard errors are in parenthesis											
*** p<0.01, ** p<0.05, * p<0.1											

5.0 Conclusions and Policy Implications

The effects of strengthening intellectual property rights are inconclusive as contradictory results are expected. Despite several studies examining the role of intellectual property rights on international trade few have analyzed the impact of strengthening of intellectual property rights particularly trademarks in Africa. This paper investigated the effects of strengthening intellectual trademarks on intra-COMESA sectoral imports. Particularly, the study provides empirical evidence on the following key questions: What are the effects of strengthening intellectual trademarks on intra-COMESA imports? Are there any heterogeneous effects on product sub-sectors?

In an attempt to answer to these questions, the paper undertook an empirical analysis. The empirical evidence suggests that the enforcement and strengthening of trademarks is detrimental for the trade of tobacco products whilst it is important for the trade of rubber and clothing products. However, overall, the strengthening of IPR using trademark applications as a proxy, has no significant effects on imports in intra-COMESA trade. Notwithstanding, at a disaggregated level of products, results from the empirical analysis confirms the heterogeneous effects of IPRs strengthening on trade. Particularly, tobacco products are positively affected by the strengthening of IPRs while rubber, footwear and clothing products are negatively affected. In addition, at the sectoral level, the majority of the product subsectors are irresponsive to changing IPR regimes.

In conclusion, the findings of the study confirm neither the outright market power nor market expansion effects of strengthening trademarks on intra-COMESA trade. From the findings, it is therefore recommended that trademarks are enforced and strengthened for tobacco related products while a laxed approach should be contemplated for rubber, footwear and clothing products within the selected COMESA countries. The effects of strengthening trademarks are countervailing. Strengthening of trademarks can lead to a decrease in trade if it leads to unfair competition as in the case of rubber, clothing and footwear products. But if it necessitates competition as in the trade of tobacco products then strengthening of trademarks should be embraced. An important policy issue will be on the harmonization of intellectual property rights and competition laws.

An important caveat: data limitation on COMESA countries on intellectual property right nulls making definitive conclusions on the effects of IPR protection particularly trademarks, on international trade. Furthermore, trademarks are a subset of IPRs and the number of trademark application is a rough theoretical measure of intellectual protection. Thus, further studies could benefit by increasing the subset of IPRs and broadening the analysis thereof, towards a more conclusive exposition of the effects of IRPs in general on trade.

References

Anderson J. & van Wincoop E. (2003). Gravity with Gravitas : A Solution to the Border Puzzle. *American Economic Review*, *93*(1), 170–192.

Awokuse T. O. & Yin H. (2010). Does Stronger Intellectual Property Rights Protection Induce More Bilateral Trade ? Evidence from China ' s Imports. *World Development*, *38*(8), 1094–1104. https://doi.org/10.1016/j.worlddev.2009.12.016

Baldwin R. & Taglioni D. (2006). *Gravity for Dummies and Dummies for gravity equations* (No. NBER Working Paper, No. 12516).

Campi M. & Dueñas M. (2016). Intellectual Property Rights and International Trade of Agricultural Products. *World Development, Elsevier*, *80*, 1–18. https://doi.org/10.1016/j.worlddev.2015.11.014

Campi M. & Dueñas M. (2019). Intellectual property rights , trade agreements , and international trade. *Research Policy*, *48*(3), 531–545. https://doi.org/10.1016/j.respol.2018.09.011

COMESA POLICY ON INTELLECTUAL PROPERTY RIGHTS. (n.d.).

Curtis J. M. (2012). Intellectual Property Rights and International Trade: An Overview, (3).

Delgado M., Kyle M. & Macgahan A. M. (2013). Intellectual property protection and the geography of trade. *Journal of Industrial Economics*, *63*(3), 733–762.

Maskus K. E. & Penubarti M. (1995). How trade-related are intellectual property rights ? *Journal of International Economics*, *39*, 227–248.

Maskus K. E.& RidleyW. (2016). *Intellectual Property-Related Preferential Trade Agreements and the Composition of Trade* (No. No. 2016/35).

Mattoo A.Mulabdic A. & Ruta M. (2017). *Trade Creation and Trade Diversion in Deep Agreements* (No. No. 8206).

Raizada G. & Dhillon S. S. (2017). Impact of Intellectual Property Rights on International Trade : Evidence from India. *Journal of Intellectual Property Rights*, *22*(July), 200–210.

Shin W.Lee K. & Park W. G. (2016). When an importer's protection of IPR interacts with an exporter's level of technology: comparing the impact on the exports of the North and South. *World Economy*, *72*(1), 151–175.

Strategic Marketing Africa. (2016). Africa's brand owners battle the scourge of counterfeit goods. *International Journal of the African Marketing Confederation*, 10–14.

Trade Mark East Africa. (2018, July). Intra Comesa Exports Drop. *Growing Prosperity Through Trade*.

van Bergeijk P. A. G. & Brakman S. (2010). The comeback of the gravity model. In P. A. G. van Bergeijk & S. Brakman (Eds.), *The Gravity Model in International Trade* (1st Editio, pp. 1–29). Cambridge: Cambridge University Press.

Yotov Y. V., Piermartini R., Monteiro J. & Larch M. (2016). *An Advanced Guide to Trade Policy Analysis : The Structural Gravity Model*. United Nations and World Trade Organization.

Do Stronger **Intellectual Property Rights** Stimulate Intra-COMESA Exports?

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Abstract

The study estimated the impact of Intellectual Property Rights on intra-COMESA exports. Using a gravity model and panel data for 10 COMESA Member States, the study found that, a 1 point increase in Intellectual Property Rights Index (IPRI) score of the exporting country would increases intra-COMESA exports by 0.001%. A similar increase in IPRI score of the importing country would reduce intra-exports by 1.5%. The study further found that "if" all COMESA exporting countries scale up their index scores by 2, exports would increase by 6.3% while a similar increase by the importing countries would result in a 1.1% decrease in intra-COMESA exports. "If" all the COMESA importing countries increase their index scores by 4, intra-COMESA exports would increase by 0.5%. The optimal level of IPRs protection that ideally stimulates intra-COMESA exports is reached when all COMESA countries increase their index scores from the current level by 2 scores. COMESA Member States should focus on strengthening their legal and political environment, physical property rights and intellectual property rights. Maintaining the current IPRI scores or strengthening them by magnitude exceeding 2 index scores would lead to low intra-COMESA export flows.

1.0 Introduction

The global science and technology landscape is changing rapidly. The production and trade of knowledge-intensive or high-technology products are accounting for increasing shares of global output (Science and Engineering 2018). Knowledge-intensive or creative products in total world trade doubled between 1980 and 1994 from 12% to 24% (Fink and Braga 1999) and total exports and imports rose in value terms by 47 and 56 per cent in 2012 respectively. The global market for traded creative goods and services rose by more than 81 percent from 2003 to 2012, (UNCTAD Annual Report 2015).

Global exports of commercial Knowledge and Technology Intensive (KTI) goods and services accounted for 46% of all goods and services in 2016 and estimated at $7.5 trillion in value terms, consisting of $1.6 trillion of commercial knowledge-intensive services, $2.6 trillion of high-technology products, and $3.4 trillion of medium-high-technology products (Science and Engineering 2018). This heighted level of knowledge-intensive goods crossing national boundaries have, for the past two decades, placed issues of Intellectual Property Rights (IPRs) on a spotlight.

Economists are increasingly emphasizing the central role of IPRs on international trade. Despite such calls, theory oriented policy makers in developing countries, are resisting demands from multilateral agreements such as the Trade Related Intellectual Property Rights Agreements (TRIPs of 1994) to harmonize the global IPRs citing the ambiguous relationship between IPRs protection and development (Lee Branstetter, 2017). There is little empirical evidence, especially from developing economies, to convince policy makers in this subject matter compared to other areas of economics. More studies are needed to illuminate the area.

1.1 Background of the Study

The policy debate regarding the optimal IPRs regime involve a wide range of stakeholder interests. Traditionally, IPRs policy debates were involving developed countries only, as they were deemed to be the source of IPRs-related goods. Nowadays, developing economies are becoming innovation centers too and are critical in policy discussions on harmonisation of intellectual property rights laws (Congressional Research Services, 2019).

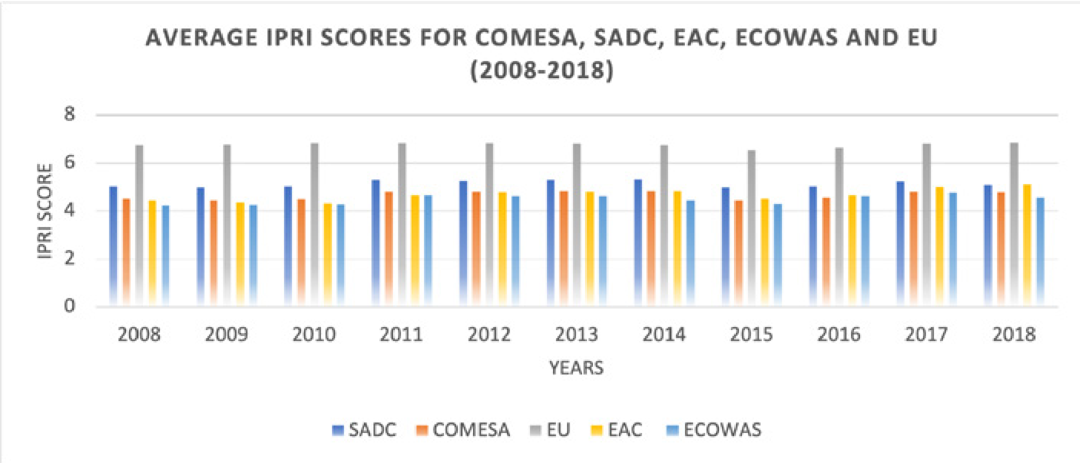
Developing countries have been conventionally known for resisting multilateral concessions seeking harmonisation of IPRs policies arguing that, premature imposition of strong IPRs on their economies was inappropriate (Lee Branstetter, 2017). Some scholars argue that stringent IPRs policies may limit economic growth in less advanced countries (Congressional Research Services, 2019). Such philosophies which are predominantly visible in developing economies, explain the existence of weak IPRs protection in developing economies relative to developed countries (International Property Rights Index 2018 Report).

African economies are characterised by weak intellectual property rights protection. COMESA, the biggest regional economic community (REC) in Africa in terms of membership, depicts weaker IPRs protection relative to other RECs in and outside Africa. A comparative analysis using the intellectual property rights index (IPRI) indicates weaker IPRs protection for RECs in Africa compared to those in developed countries. IPRI is a measure for property rights used to gauge and compare countries or jurisdictions (International Property Rights Index 2018). The IPRI is comprised of 10 items[35]grouped under Legal and Political Environment (LP), Physical Property Rights (PPP) and Intellectual Property Rights (IPR) components. The overall grading scale of the IPRI ranges from 0 to 10, with 10 representing the strongest level of property rights protection and 0 reflecting the non-existence of secure property

[35] Judicial independency, rule of law, political stability, control of corruption, protection of physical rights, registering property, ease of access to loans, protection of intellectual property rights, patent protection and copyright piracy.

rights in a country. Figure 1 shows the average IPRI scores for COMESA, SADC, EAC, ECOWAS and the EU.

Figure 1: Average IPRI scores for COMESA[36], SADC[37], EAC[38], ECOWAS[39] and EU[40]

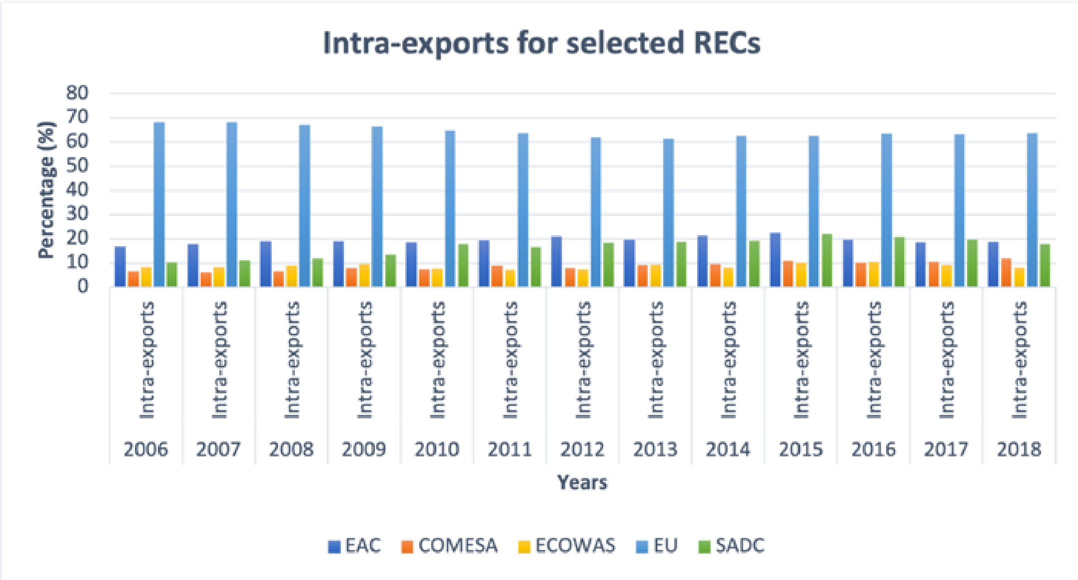


The graph shows that EU has the highest IPRI scores on average relative to other RECs[41] in Africa for the period 2008 to 2018. Of all the COMESA countries examined[42], only 31% of them scored slightly above 50% of the total maximum scores[43]. All the EU countries scored above 50% of the total scores where as half of the EAC countries[44] scored slightly above 50% of the total IPRI scores for the same period.

Whilst COMESA exhibit weak protection of IPRs, its performance in terms of intra-exports is low compared to regions with relatively strong IPRs protection. Figure 2 shows intra-regional export performances of COMESA, EAC, ECOWAS, SADC and the EU for the period 2006-2018.

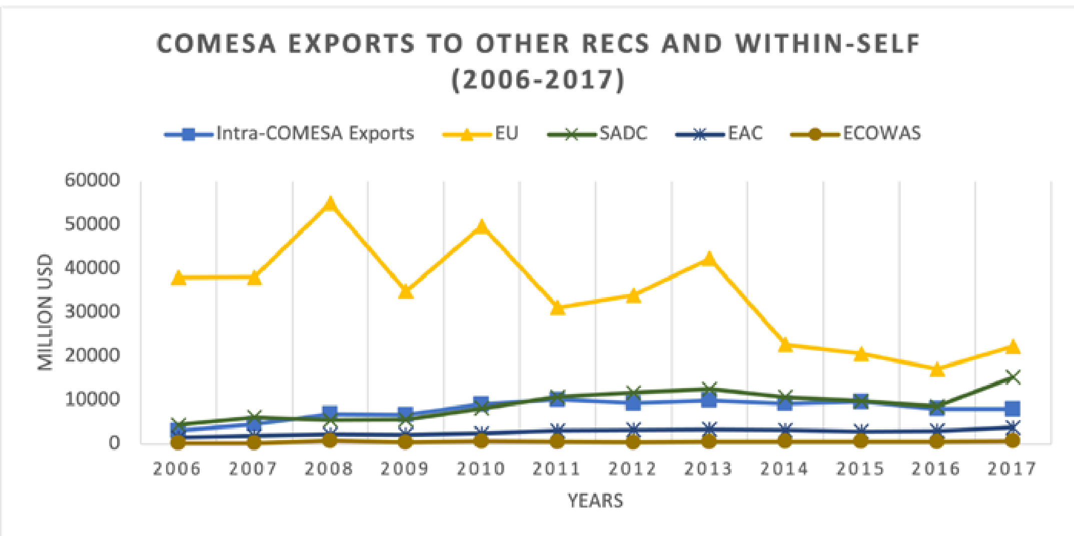
[36]Common Market for Southern and Eastern Africa: The region is made up of 21 member states
[37] Southern African Development Communities. The region is made up of 14 member states
[38]East African Community: The region is made up of 6 member states, some of which have multiple membership to the COMESA region
[39]Economic Communities for Western African States. The region is made up of 15 Member States
[40]European Union: The region is made up of 28 member state
[41] COMESA, SADC, EAC and ECOWAS
[42] COMESA Countries examined based on availability of IPRI scores for the period under study
[43]Mauritius, Tunisia, Egypt and Rwanda
[44]Tanzania, Rwanda and Egypt

Fig 2: Intra-exports for selected RECs



COMESA region export less within itself compared to other RECs. The region is outperformed by all other regions for the period 2006 to 2018 save for ECOWAS in 2017 and 2018 only. EU exports more than 60 percent within itself and less than 40 percent outside the region. Contrary, COMESA Member States exports less than 12 percent to each other and over 88 percent to the rest of the world (see Annexure A). It is surprising to note that COMESA exports more to regions with strong protection of IPRIs, Europe and SADC regions included, than to itself and other African RECs with weak protection of IPRIs. This depiction suggests that countries prefer to export goods to regions where their property rights are protected. As a result, regions with weak protection of IPRIs such as COMESA, exports more to regions with strong protection of property rights. Figure 3 shows COMESA intra-and-extra exports.

Fig 3: COMESA intra-and-extra Exports



The internal remoteness of COMESA is an increasing concern to the economics fraternity given that the situation puts the region at risk as world export prices normally respond to global shocks. Such evitable risks can be minimised by increasing intra-COMESA trade. COMESA has remarkably lowered tariffs as a response to low intra-exports, unfortunately, trade reacted marginally.

The present situation is undesirable. The region continues to export more to the Rest of the world (Row) than itself. Analysis indicates that COMESA trade more with regions that exhibits strong protection of intellectual rights. COMESA exports more to the EU, a region with strong protection of IPRs. It also exports more to SADC, again a region with strong IPRs than itself. What is driving exports outside the COMESA region? This question helps to understand what is attracting COMESA exports to Row.

Issues of intellectual property rights protection have been cited in theory as a key determinant factor of international trade. Despite whatever theoretical predictions, developing economies are persistently arguing that strong IPRs protection distorts natural trade patterns, (Nguyen Khanh Doanh and Yoon Heo, 2007). This reflection enlightens why policy makers in developing countries are resisting pressure to strengthen their Intellectual Property Rights (IPRs) systems arguing that untimely imposition of strong IPRs were not ideal for their economies, (Lee Branstetter, 2017).

Developed economies, on the other hand, hold the view that inadequate IPRs protection in developing countries are costly as they constitute an unfavourable trade environment that constrain firm's competitiveness. This view is in contrast to that of developing economies which argue that stronger IPRs protection only benefit developed countries (Nguyen Khanh Doanh and Yoon Heo, 2007). This matter has remained outstanding since 1980s and has led to numerous initiatives to harmonize and strengthen IPRs protection at national and international levels.

The study contributes to the existing literature and improves on previous studies in three respects. First, the study used a more comprehensive measure of intellectual property rights, the International Property Rights Index (IPRI), unlike previous studies that used the Ginarte and Park Index. The Ginarte and Park Index quantified the level of patent rights protection only, yet patent rights are one form of intellectual property protection, (Walter G. Park, 2001). The measure, thus, disregards other instruments of intellectual property protection such as copyright protection, trademark rights and geographical indications among others.

This paper argues that the use of a more complete picture of a nation's intellectual property regime such as the IPRI that incorporates other instruments of intellectual property protection would produce more accurate results. The IPRI is a new innovative gauge developed in 2007 which ranks countries according to their strengths and efforts to protect both physical and intellectual property. The index comprises a total of 10 variables, which are divided into the three main components: legal and political environment, physical property rights, and intellectual property rights. Despite a large number of property rights related variables, the final index score is itself the average of the component scores and focuses only on core factors that directly relate to the strength and protection of private property rights. The final ranking is very similar to the alternative previous rankings but is more preferred as it suffers less from the problems of dilution and remains parsimonious.

Previous studies (see Salim et al 2014) have used the Girnate and Park Index in conjunction with the IPRI. The two indexes have been constructed using different methodologies and have been published on different scales. The Girnate and Park has been published on 0-5 scale while the IPRI scores is on 0-10 scale. Although these studies converted the scales into a single index for conformity purposes and disregarded the effects of methodological differences without any valid reasons, their models failed to account for the measurement errors.

Second, it addresses the problem of zero export flows between countries using the Pseudo Poisson-Maximum Likelihood (PPML) estimator. Thirdly, this study provides new evidence on African experiences. Little evidence, if any, has ever been documented on the experiences of Africa and COMESA countries in particular.

1.2 Problem Statement

Intra-COMESA trade flows have been fairly low compared to other regional economic communities (RECs). While intra-COMESA exports account for 11.9% percent of the region's total exports, EAC, SADC, ECOWAS and EU recorded 18.7percent, 17.9 percent, 8.1 percent and 63.6 percent respectively (UNCTADSTAT, 2019). This implies that, COMESA countries are more remote to each other, than the external world, a situation that makes it susceptible to international shocks (Willie and Chikabwi 2017). To stimulate intra-exports, COMESA Member States had remarkably lowered tariffs, but unfortunately exports responded marginally (Otsuki, 2011; Azharia et al., 2011). Propelling the intra-trade agenda requires COMESA to give equal commitment, if not more, to non-tariff trade barriers. Theory proposed Intellectual Property Rights protection as a strong factor influencing international trade. In terms of IPRs protection, COMESA depicts weaker IPRs protection compared to other RECs. Would strengthening IPRs protection in the COMESA region stimulate trade flows? This paper seeks to investigate the impact of intellectual property rights on intra-COMESA export flows.

1.3 Objectives of the Study

The study seeks to investigate the impact of strengthening IPRs protection on COMESA intra-export flows. Specific objectives are to:

- Analyze the impact of existing IPRs protection on intra-COMESA export flows
- Analyze the impact of stronger IPRs protection on intra-COMESA export flows.

Findings from this study are critical in the COMESA region in finding policy solutions to low intra-COMESA export flows. Should strengthening IPRs protection found stimulating intra-COMESA exports, recommendations would target policies to strengthen IPRs protection from the existing levels.

1.4 Research Questions

(i) What are the impacts of the current IPRs protection on intra-COMESA export flows?
(ii) Do strengthening IPRs protection stimulate intra-COMESA exports?

2.0 Literature Review

2.1 Review of Theoretical Literature

The debate surrounding the multilateral protection of intellectual property rights is an evolving issue in developing economies. The matter has been fairly studied in developed economies, subsequent to philosophical arguments that developed countries are sources of innovation (Chin and Grossman 1991). Little researches have been done on developing economies since they were argued to be recipients and not creators of innovation. This is contrary to the present innovation circumstances. Developing economies are innovative too. They are involved in the production and trade of high-technology products (Yongmin Chen and Thitima Puttitanun, 2004). Recent innovation data indicates that South Africa recorded 728 patents applications filed by domestic innovators in 2018 which is 72 percent, 80 percent, 99 percent more than Bulgaria, Croatia and Cyprus (World Intellectual Property Indicators 2018).

Pioneers to probe the nexus between IPRs protection and international trade principally focused on developed economies, with little attention devoted to the developing world (Chin and Grossman, 1991, Diwan and Rodrik, 1991 and Deardorff, 1992, Chen and Puttitanun, 2004). Thus, huge literature has been developed thereto and models customised to suit the developed world context. These studies followed the North-South framework developed by Chin and Grossman in 1991 with the predominant view that production of knowledge intensive products occur in developed countries only.

Chin and Grossman (1991) developed a model suitable to examine the nexus between IPRs protection and trade flowing from developed to developing countries. The framework categorised the universe into two sections, the innovative and non-innovative. The innovative section was labelled the North segment and the non-innovative termed the South fragment. Grossman and Helpman (1991), capitalised on these insights and developed a model to explain the short-run costs and long-run benefits of harmonising IPRs protection by strengthening them.

The Grossman and Helpman stylised endogenous growth model proposed that developed countries are the engines of innovation that supply new and quality products to the less developed nations. In their model, they categorized developed countries as the North segment and less developing as the South segment. The North-South Grossman and Helpman framework has become the centre-piece in analysing the nexus between IPRs protection and international trade in economics. However, the model is appropriate in explaining trade in a developed-to-less developing country context.

The Grossman and Helpman endogenous growth model assumes that only firms in the North (developed countries) are innovative. However, with weak IPRs protection in the South (less developing), imitation takes place. Thus, harmonization of IPRs by strengthening IPRs protection in the South would benefit the North. Strong IPRs protection in the South stimulates innovation in the North leading to the production of new quality goods, new production methods and new product designs which enhances competitiveness and facilitates trade between the North and the South.

Weak IPRs protection, on the other hand, is conducive for Southern firms as they encourage accumulation of stock of local knowledge. Through imitation, weak IPRs protection in the South stimulates innovation-upon patents, an approach that reduces imports flow from the North to the South in the long run. Considering the innovation process in the Grossman and Helpman model, the effects of imitation-innovation trade depends on the efficiency of “catching up” by firms in the South.

The Grossman and Helpman model, in summary entails that policy reforms aimed at harmonizing IPRs through strengthening IPRs protection in the South, tend to bear two substantive effects on trade. These effects are commonly referred to as the market expansion effect and the market power effect.

The Market Expansion Effect

The market expansion effect defines a case in which strong IPRs protection in the South leads to the expansion of bilateral export markets for firms in the North, (Lee Branstetter, 2017). Trade flows may be enhanced in several ways. Firstly, improved IPRs protection reduces the risks of potential “pirates” which are strong factors that deter exporters to trade patented goods in countries with weak IPRs protection. Because imitative activities in South (less-developing countries) diminishes the profit margins of the exporting firms, exporters are reluctant to export to firms with weak IPRs protection while strong IPRs stimulates exports.

Secondly, strong IPRs protection warrants exporters exclusive rights to commercialize their intellectual assets without fear that they would be unable to recover their innovation costs, (Nguyen Khanh Doanh and Yoon Heo, 2007). They displace "pirating activities" and prevent the possible loss of exporters' technologies to firms in the destination country, (Salim et al 2014). Strong IPRs regime also dampens local firms' capacity to produce and compete with similar foreign patented products. As a result, local production decreases and the net demand and sales volume of foreign protected products increases, (Lee Branstetter, 2017).

The Market Power Effect

Strong IPRs protection may also influence the way Northern firms behave in a market. Exporters may react negatively to improved IPRs protection, taking advantage of reduced "pirates" and elasticity of demand in the importing country. They may also capitalise on increased imitation cost for local firms and start restricting supplies for pricing advantage. These circumstances may exist when exporters of patented goods took monopolistic advantage in the market for rent seeking reasons.

Alternatively, exporters may choose to serve the Southern market by Foreign Direct Investment (FDI) or by licensing its intellectual asset to a foreign firm (Ferrantino 1993, Lee & Mansfield 1996, Salim et al 2014, Lee Branstetter, 2017). Given that the exporter took improvements in IPRs protection as a market power instrument, international trade flows are expected to decrease, (Salim et al 2014).

While this study recognises the Grossman and Helpman model as the building block of the IPRs-trade analytical framework, the study challenges the philosophical thinking behind the model that only developed countries are innovative. This study regards the assumption that "only developed countries innovate" as a misrepresentation of facts. Whilst this paper acknowledges that most innovations originate from the North, the paper argues that developing countries are innovative too. This is demonstrated by a significant number of patents applications filed by domestic innovators in developing countries. Analysis of patent application statistics for the period 1885-1995 conducted by Yongmin Chen and Thitima Puttitanun, (2004) indicated that Brazil, India, South Africa and South Korea submitted 2,757; 1,545; 5,549 and 59,249 patent applications respectively compared to 9,325; 3,039; 335,061 and 127,476 for Australia, Canada, Japan and US respectively.

Of course, the Grossman and Helpman model should be treasured for providing an insightful foundation on IPRs protection and trade nexus at a multilateral level, however, the same framework cannot explain trade exhibited in developing economies. Yongmin Chen and Thitima Puttitanun, (2004), developed a model sufficient to explain a IPRs driven trade in a developing-developing country set-up. In their model, the duo challenged the Grossman and Helpman North-South philosophy. Chen and Puttitanun, established legitimate reasons for developing countries to protect their IPRs. They submitted that developing countries may still want to protect IPRs for domestic economic consideration. The model reasoned that domestic innovative activities are also present in developing countries that justifies stronger IPRs.

Chen and Puttitanun considered a framework similar to the Grossman and Helpman model but with substantial distinctions in context. While the Grossman and Helpman North-South framework was built to explain the developed-less developing countries' trade context, Chen and Puttitanun model focused in a purely less developed country perspective. This model is ideal in this paper which seeks to establish the effects of stronger IPRs protection in trade within developing countries with COMESA countries being the focused group.

Chen and Puttitanun's framework considered a model of a (small) developing country with two sectors, an import sector and a local sector. The import sector comprises of two unique firms, a (northern) foreign firm and a (southern) domestic firm. The northern firm is highly innovative and has a patented technology that allows it to produce products of higher quality compared to domestic firm. However, the Southern firm, through imitation, can raise its product quality, should IPRs levels permit. Thus, domestic firm can innovate-through imitation provided IPRs protection is weak. This type of invention is classified in this paper as "imitation-induced innovation". The local sector, like the import sector, comprises of two firms, both domestic. One of the firms (innovative firm) has the ability to produce patentable new technology for new products while the other firm (non-innovative firm) can imitate the technology.

Since non-innovative firms in both the importing and the local sector have high imitation capacities, strengthening IPRs protection reduces imitation possibilities in both sectors. Such a reform brings different implications. Strong IPRs protection means less imitation and lower product quality of the domestic firms. Such a scenario induces lower competition for domestic firm's products, which results in increased price of foreign products in the domestic market. Weak IPRs protection encourages imitation by reducing the cost to invent around existing patents, (Grossman and Helpman, 1991). Domestic firms are therefore in favour of this method as it allow them to accumulate knowledge stock. Thus, from this perspective, low IPRs protection result in innovation that is transmitted through imitation.

Strong IPRs protection in the local sector means more incentive for domestic innovative firm to invest in more rewarding technology (more innovation) which leads to more efficient investment. Due to low imitation risks and higher chances of recouping research and development (R&D) costs, innovative domestic firms are encouraged to, either improve production methods or devise new cost-saving production systems, develop new product designs and new quality products, all of which improve the competitiveness of innovative domestic firms and leads to trade. From this standpoint, strong IPRs protection induces domestic firm's innovativeness.

Summarizing Chen and Puttitanun's model, a conclusion that both strong and weak IPRs protection encourage innovation that ultimately induces trade can be made. Strong IPRs protection incentives domestic innovative firms to innovate more whereas weak IPRs protection encourages innovation through imitation tendencies. Since both levels (strong and weak IPRs protection) are associated with innovation driven trade, economies are urged to establish optimal levels of IPRs that balances a trade-off between facilitating imitation-led innovation and providing incentives for domestic innovation that stimulate trade.

The theoretical model of Chen and Puttitanun can be summarised in mathematical format as follows:

$$X_{ijt} = f[Inn_{it}(IPR_{it}), IPR_{jt,}\varphi] \qquad (2.\ 1)$$

Where X_{ijt} are exports from country i, to country j, at time t, $Inn_{it}(IPR_{it})$, is the level of IPRs in country i that stimulates innovation in country i, at time t. $IPR_{jt,}$ is the level of IPRs in country j that facilitates imitation in country j, at time t and φ is a vector of traditional gravity variables that include GDP per capita of the exporter and importer, common border, common official language, distance, land locked and common colonizer.

Equation (2.1) present the argument that exports are a function of IPRs-induced innovation in the exporting country i, and IPRs-induced imitation in the importing country j and other variables that determines trade. Should the levels of IPRs that induce innovation and immitation led trade in the exporting and importing country respectively be empirically established in this study using COMESA countries, policy recommendations would target to establish optimal level of IPRs regime that stimulates intra-COMESA exports.

2.2 Empirical Literature

The link between IPRs protection and trade flows is an empirical question. It cannot be answered by theoretical argument alone. Several studies that attempted to respond to IPRs protection and trade flow linkages (Fink and Braga 1999, Nguyen Khanh Doanh and Yoon Heo, 2007, Salim et al 2014, Lee Branstetter, 2017) failed to yield conclusive results. Further to that, empirical studies conducted in the African setting are very scarce.

Fink and Braga, (1999), used the conventional gravity model to estimate the effects of increased patent protection on bilateral trade flows for 89*88 countries. Using 1989 total non-fuel and high technology trade data, the study found that IPRs protection have a significantly positive impact on bilateral trade flows for both total non-fuel imports and exports. For high technology trade, the study found a significantly negative impact of both exports and imports on the probability that countries trade with each other.

The study by Fink and Braga suggested a market expansion effect on non-fuel products and a market power effect on knowledge-intensive products. Although both findings are theoretically correct, they are more significant in the trading of non-fuel products than knowledge-intensive goods. The findings are amazing as they are against the a priori expectation that the effects of IPRs protection are stronger for knowledge-intensive trade.

A similar study was conducted by Salim et al. (2014). The study focused on effects of IPRs and threat of imitation on Australia's export flows over the period 1995–2010. Using the augmented gravity model and unbalanced panel data from 223 countries that attracted positive imports from Australia, the study estimated 2 models, first without the imitation threat dummy and second with the imitation threat dummy. The regression done without imitation threat found out that, a one-point higher score of the importers in the IPRs scale of all countries leads to about 17 per cent increase in bilateral exports from Australia. However, regressed in the presence of imitation threat, the study obtained a statistically insignificant effect on Australia's bilateral exports.

The results by Salim et al (2014), was also confirmed by, Maskus and Penubarti, 1995, Braga and Fink, 1997, Kang and Park, 2006, Oh and Won, 2005, Jung 2007, and Nguyen Khanh Doanh and Yoon Heo, 2007. Maskus and Penubarti (1995), found out that a stronger protection of IPRs increases trade flows when all industries are pooled whereas Jang, (2007) found similar effects on total IT exports of Korea. Regarding the same Korean exports, Oh and Won, (2005) found out that Korea export more to countries where their patents are highly protected. Same results using similar models were long-established by Braga and Fink, (1997).

Kang and Park, (2006), analysed the impacts of foreign IPRs level on the export of Korea from 2001 to 2003 using the gravity model and found that foreign IPRs level has negative effects on Korea's total exports. However, regarding exports to developing and low-tech industries and export to developed and low-tech industries, the study produced interesting results. Strong IPRs were found to be negative when exporting to developing countries and low-tech industries, but positive in the high-tech industries exporting to developed countries.

Nguyen Khanh Doanh and Yoon Heo, (2007), studied the linkage between IPRs enforcement and trade flows between Asian and the Rest of the world (Row). Using categorized panel data for 1990, 1995 and 2000, and the gravity model, the study obtained three effects of strong IPRs protection in ASEAN exports destination countries. First, the study finds positive impact on ASEAN's exports to non-ASEAN countries, especially exports in the high-tech sectors such as chemicals, machinery and transport equipment. Second, negative effect on imports, with respect to ASEAN's imports from ROW with stronger effects found in the manufactured goods, beverage and tobacco industries. Lastly, ambiguous increase in bilateral trade between ASEAN and the Row, when both Row and ASEAN strengthen protection of IPRs.

The literature reviewed has indicated that IPRs protection affect export flows. It further indicated that weak IPRs protection can stimulate imitation led innovation that spur exports and at the same time, strong IPRs protection can induce innovation that, through competitiveness, can lead to exports. The literature further submit that empirical evidence on IPRs protection and export flows in the African set-up is relatively scarce.

2.3 Framework of Analysis

The reviewed literature established key facts that explain the nexus between intellectual property rights and international trade. In short, bilateral trade can be expressed as a function of the exporting country's level of IPRs protection that induce innovation in the exporting country, IPRs protection levels in the importing country and other trade variables. Theory established that IPRs level facilitates domestic innovation and imitation-focused innovation that improve competativeness and ultimately lead to trade. Imitation-led innovation occurs when IPRs are weak such that they facilitate imitation of patented technology whilst strong IPRs provide incentives for more innovation, that leads to domestic innovativeness that contributes to production of new products, use of new cost saving production techniques and new product designs which improves competativeness and leads to trade. Weak IPRs may lead to an increase or decrease in trade depending on the efficiency of "catch up" in imitation of the importing country.

The above theoretical perspective can be expressed mathematically as follows:

$$X_{ijt} = f[Inn_{it}(IPR_{it}), IPR_{jt,}\varphi] \qquad (2.2)$$

Where $\mathrm{X_{ijt}}$ are exports from country i, to country j, at time t, $\mathrm{Inn_{it}(IPR_{it})}$, is the level of IPRs in country i that facilitates innovation in country i, $\mathrm{IPR_{jt,}}$ is the level of IPRs in country j that influences exports from country i to country j and φ is a vector of other trade variables.

3.0 Methodology

To empirically estimate the impact of IPRs protection on bilateral export flows, the study adopted the gravity model approach. The model have been applied successfully as a standard tool used in the analysis of different types of international flows, such as trade, Foreign Direct Investment (FDI), migration and recreational traffic. Gravity models are also commonly used to analyse trade distortions associated with policy differences across countries. The empirical model used in this study follows Silva and Tenreyro (2006). The regression equation is specified as follows:

$$X_{ijt} = \exp\,[Inn_{it}(IPR_{it}) + \ IPR_{jt} \ \ + \varphi] + \mu_{it} \qquad (3.1)$$

Where $\mathrm{X_{ijt}}$ represents the bilateral export flows from country i to country j, at time t, $\mathrm{Inn_{it}(IPR_{it})}$, is the level of IPRs protection in country i that facilitates innovation in country i (IPRs level that induce innovation), $IPR_{jt,}$ is the level of IPRs in country j that influences exports from country i to country j, φ is a vector of other trade variables and μ_{it} is the white noise error term.

The regression used the PPML estimator to estimate equation (3.1) in a multiplicative form as given below:

$$X_{ijt} = exp(\alpha + \beta_1 Inn_{it}(IPR_{it}) + \beta_2 IPR_{jt} + \beta_3 GDP/cap_{it} + \beta_4 GDP/cap_{jt} + \beta_5 Dist_{ij} \beta_6 LL_{ij} + \beta_7 CL_{ij} + \beta_8 CB_{ij} + \beta_9 CC_{ij}) + \mu_{it} \quad (3.2)$$

Equation (3.2) was regressed on current level of IPRs protection and simulated IPRI scores, to establish the optimum IPRs level to stimulate intra-COMESA exports. The counterfactual simulation considers the impact to intra-exports "if" all COMESA countries strengthened their IPRs protection from the current status by 2 and 4 index scores.

3.1 Counterfactual Analysis

The counterfactual simulation considers a hypothetical scenario, a "what if situation" that seeks to solicit results given that the situation prevails. The paper seeks to establish the impact to export flows "if" all COMESA countries increase their index scores. Thus, countries are assumed to have strengthened their IPRs protection from the current status by 2 and 4 index scores. This implies strengthening of data elements included in the index. The final index is made up of the following components: Legal and Political Environment[45], Physical Property Rights and Intellectual Property Rights[46]. An increase in index scores shows an upturn in the nation's effectiveness in defending property rights. The indicator provides the most useful measure of how well a country protects property rights.

To construct the assumed scores, the paper added 2 and 4 scores to the country-specific IPRI scores obtained from the IPRI yearly reports. The simulated index scores are within the range attained by other countries especially in the developed world.

The study estimated three regression equations namely: (i) regression of bilateral exports flows from country on prevailing IPRs protection levels (ii) regression of bilateral exports on simulated IPRI scores of 2 (iii) regression of bilateral exports on simulated IPRI scores of 4.

3.2 Modelling and Econometric Issues

Trade data usually comprises of zero trade flows in some years. Of the exports data used in this study, 16% (134 out of 837 observations) contains zero trade flows. These zeros are commonly as a result of rounded trade flows or countries do not trade with each other (Fink and Braga 1999). Exclusion of these zeros is not recommended as this would lead to a potential sample selection bias. Cognizant of the zero trade flows problem the study used the PPML estimator which addresses the problem of zero trade flows.

Trade data are commonly plagued with heteroscedasticity (Santos Silva and Tenreyro, 2006). Besides, heteroskedasticity arises most often with cross-sectional data. Country specific attributes such as geography, differences in trade policies among others explains the existence of country heterogeneity. This paper addressed the heteroscedasticity problem and the issues of unobservable multilateral resistances using the importer-and–exporter time and pair fixed effects.

[45] This component provides an insight into the strength of the institutions of a country and the respect of the 'rules of the game' among citizens. The component has a significant impact on the development and protection of physical and intellectual property rights.

[46] Physical Property Rights and Intellectual Property Rights reflect two forms of property rights, which are crucial to the economic development of a country. The items included in these two categories account for both de jure rights and de facto outcomes of the countries considered.

3.3 Data Manipulation

Data adequacy especially in developing countries is a challenge. Information on Intellectual Property Rights Index (IPRI) and patent application were limited to only 10 COMESA countries for the period 2008 to 2017. Of these countries, data on IPRI scores and patent application were missing for 0.18%[47] and 7% of the total sample respectively. The missing data was however interpolated.

3.4 Econometric tests

3.4.1 Hausman Test

The Hausman test was performed to ensure the robustness of the results and appropriateness of using either the Fixed Effects or Random Effects model. The null hypothesis of the test is that the individual and time-effects are not correlated with the explanatory variables. If the null hypothesis is true, the fixed effects estimator is not efficient under the random effects specification, because it relies only on the within variation in the data. On the other hand, the random effects estimator is efficient under the null hypothesis but is biased and inconsistent when the effects are correlated with the explanatory variables (Carrere, 2004). The test results (see Annexure B) indicated that fixed effects is the most suitable model.

4.0 Results and Discussions

4.1 Descriptive Statistics

The intra-COMESA exports reached an average of 25928.73 thousand for the period 2008 to 2017. During the period, some countries recorded zero export flows and others reached maximum export flows of 657286.1 thousand for the same period.

The average IPRI scores for the destination COMESA countries are 4.6 scores. The variations in the level of IPRs protection is 0.8. Some countries recorded on average a minimum of 3.1 IPRI scores and a maximum of 6.3 IPRI scores for the same. The level of variability exhibit a small but fairly significant IPRs protection-gap across COMESA countries. Regarding IPRs-induced innovation, an average of 584.0 exports are induced by IPRs levels. The IPRs-induced innovation led exports account for a minimum of 3.2 thousand and a maximum of 4567.8 thousand export flows across COMESA countries.

[47] Data on IPRI were missing for Tunisia for 2013 and 2014.

Table 2: Descriptive Statistics

Variable	Mean	Std Dev	Min	Max
X_{ijt}	25928.73	71349.49	0	657286.1
IPR_j	4.59511	.82689	3.1	6.315
$Inn_i(IPR_j)$	584.0189	1089.35	3.214	4567.784
GDP/Capi	2082.2	2607.296	180	10130
GDP/Capj	2082.2	2607.296	180	10130
Distij	3108.441	2008.189	396.8041	8053.869
Landlocked	.7777778	.4159709	0	1
CommBorder	.0666667	.2495825	0	1
CommLangoff	.4888889	.5001545	0	1
Commcolony	.3555556	.4789475	0	1

4.2 Correlation Analysis

Analysis of correlation between exports and the interaction variable [], commonborder, commonofficial language and commoncolony are positively correlated whilst GDP for the importing and exporting countries has a theoretically contradicting negative coefficient of correlation. The correlation analysis also suggest the presence of a negative association between IPRs protection in the importing countries and exports.

Table 3: Correlation Analysis

Variable	exports	iprij	inniprsi	gdpcapi	gdpcapj	distij	landlord	cborder	comlan-goff	comcol-ony
exports	1.0000									
Iprij	-0.0068	1.0000								
inniprsi	0.1673	-0.0166	1.0000							
gdpcapi	-0.0259	-0.0808	0.2424	1.0000						
gdpcapj	-0.0510	0.7588	-0.0186	-0.1038	1.0000					
distij	-0.2446	0.2863	0.3158	0.3160	0.3160	1.0000				
landlo~d	-0.1120	-0.2520	-0.2733	-0.2826	-0.2826	-0.3560	1.0000			
cborder	0.5025	-0.0441	-0.1091	-0.1132	-0.1132	-0.3463	0.1429	1.0000		
comlangoff	0.1645	0.1756	-0.2187	0.1995	0.1995	-0.2405	-0.0119	0.2733	1.0000	
comcolony	0.1340	0.1040	-0.2471	0.0452	0.0452	-0.3357	0.1737	0.3598	0.7595	1.0000

4.3 Gravity Model Regression Results

Table 4 presents results of the gravity model regression with the prevailing situation (intra-exports with current index scores), counterfactual regression with index score of 2 and counterfactual regression with index score of 4.

Table 4: Gravity Model Results

Variables	Regression with the prevailing situation	Counterfactual regression with index score of 2	Counterfactual regression with index score of 4
$Inn_{ij}(IPR_{ij})$	0.000 (.0011168)***	0.000 (6.34e-07)***	0.112 (.0001819)
IPR_{ji}	0.004 (-1.541377)**	0.000 (-1.090712)***	0.078 (.4848618)*
GDP/Cap_{ij}	0.000 (.0004681)***	0.085 (.0002515)*	0.671 (.0000507)
GDP/Cap_{ji}	0.001 (.0003079)***	0.000 (.0004495)***	0.094 (.0001634)*
$Dist_{ij}$	0.000 (-.0008365)***	0.000 (-.0008365)***	0.000 (-.0008365)***
LL_{ij}	0.842 (.0409393)	0.842 (.0409393)	0.842 (.0409393)
CB_{ij}	0.000 (1.545672)***	0.000 (1.545672)***	0.000 (1.545672)***
CL_{ij}	0.000 (1.681466)***	0.000 (1.681466)***	0.000 (1.681466)***
CC_{ij}	0.000 (-3.228819)***	0.000 (-3.228819)***	0.000 (-3.228819)***
Constant	0.000 (14.43331)	0.000 (15.2505)	0.004 (6.387606)
Observation	837	837	837
R-squared	.93695794	.93695794	.93695794

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The results show that all other variables except for common colony and landlocked have expected signs and are strongly significant at 1% level, save for IPR_{ji}, which is significant at 5% level. Landlocked is insignificant in influencing intra-exports in COMESA. The interaction between IPRs and innovation $(Inn_{ij}(IPR_{ij})$ is positive, significant and consistent with the theoretical prediction.

4.3.1 Regression with the prevailing situation

The results indicate that a 1 point increase in index scores of the exporting COMESA countries would stimulate intra-exports by 0.001%. The results further indicate that, an increase in the importer's index scores by 1 point would lead to a 1.54% decrease in intra-COMESA exports.

A decrease in intra-COMESA exports as a result of an increase in IPRs protection by the importing countries may suggest dominance of the market power effect. Exporters may react negatively to improved IPRs protection, taking advantage of reduced "pirates" and elasticity of demand in the importing country. Because of increased imitation cost, exporting countries may start restricting supplies for pricing advantage. Alternatively, due to high transport costs, complexity of border posts in Africa, exporters may choose to serve foreign markets by FDI or by licensing its intellectual asset to foreign firms.

4.3.2 Counterfactual regression with index score of 2

Regressing equation (3.2) with an assumed increase in index score of 2 on all COMESA exporting and importing countries produced interesting results. The results indicated that, "if" all COMESA countries increase index score of the exporting countries by 2, the interaction between IPR-and-innovation ($(Inn_{ij}(IPR_{ij})$ in the exporting countries, would increase intra-COMESA exports by 6.3%. These results are consistent with the theoretical predictions. An increase in the index scores resulted in an increase of the coefficient of the interaction variable. The results further indicate a reduction in intra-COMESA exports by 1.1% upon increase in index scores of the importing COMESA countries by the same magnitude. The inverse relationship can be as a result of the market power effect.

4.3.3 Counterfactual regression with index score of 4

To motivate the COMESA region to strengthen IPRI protection, the paper regressed equation (3.2) with an assumed increase in index score of 4 on all COMESA exporting countries. Results indicate that strengthened IPRI protection by index score of 4 have insignificant effect on the role of IPRs-on-innovation $(Inn_{ij}(IPR_{ij})$ on intra-exports while a similar increase in the importing countries would increase intra-exports by 0.5%.

These results are consistent with the theory which states that strong IPRs by importing countries expand bilateral export markets due to reduced risks of potential "pirates" that warrantees exporters' exclusive rights to commercialize their intellectual assets without fear that they would be unable to recover their innovation costs. Strong IPRs by importing countries also dampens local firms' capacity to produce and compete with similar foreign patented products.

4.4 Comparison to Related Studies

There are several studies that estimated the impact of IPRs protection on bilateral trade flows. Nguyen KhanhDoanh and Yoon Heo, (2007) used a gravity model and categorized panel data to investigate the linkage between the enforcement of IPRs and trade flows in ASEAN countries. Using the IPRI scores developed by Park and Ginarte in 1997, the study found that, reinforced IPRs protection in the importing countries (non- ASEAN countries) has a positive impact on ASEAN's exports. Stronger effects were however found in the high-tech sectors such as chemicals, machinery and transport equipment.

Similar to this paper, the study further found that increased IPRs protection in the importing countries (ASEAN) has a positive effect on ASEAN exports. Stronger effects were found in the manufactured goods, beverage and tobacco industries. A regression of stronger IPRI scores in both ASEAN and Rest of the world (Row) produced a positive and statistically insignificant effect of IPRs protection on bilateral trade between ASEAN and the Row.

Fink and Bragaa, (1999) examined how stronger protection of intellectual property rights affects international trade flows. Using a gravity model of bilateral trade flows and the Park and Girnate index, the study suggests that, on average, higher levels of protection positively impact bilateral non-fuel trade. Estimating the same model on high technology goods, the study found that IPRs protection have statistically insignificant impact on high technology goods.

Comparing this study to Fink and Bragaa's, it should be noted that, Fink and Bragaa's study used disaggregated data and the Park and Girnate index whereas this paper used aggregated data and the newly developed IPRI. Despite such differences, the studies concur that stronger IPRs protection positively impacts trade flows.

5.0 Conclusion and Policy Implications

This paper investigated the impact of intellectual property rights on intra-COMESA exports. Key findings are that, the current level of intellectual property rights protection in COMESA exporting countries stimulate innovation-led intra-exports by 0.001%. The same level of IPRs protection in the importing countries are reducing exports by 1.5%. The net effect of the current level of IPRs protection is a reduction in intra-COMESA export flows. "If" all COMESA exporting countries scale up their index scores by 2, innovation-induced exports would increase by 6.3% while a similar concurrent increase in IPRs protection of the importing countries would result in a 1.1% decrease in intra-COMESA exports. The net effect is a 5.2% increase in intra-COMESA exports. "If" all the COMESA exporting countries increase their index scores by 4, intra-exports induced via innovation would have insignificant effect on intra-COMESA exports, whereas, similar increase by the importing COMESA countries would lead to a 0.5% increase in intra-COMESA exports.

The results are consistent with the theory. Theory suggest that an optimal level of IPRs protection that balances a trade-off between facilitating imitation-led innovation and providing incentives for domestic innovation that stimulate exports should be established to maximise intra-exports. Thus, the optimal level of protection is reached when all COMESA countries increase their IPRs protection scores by 2 scores. Weak and very strong protection have been found to spur low exports.

Policy initiatives should consider increasing index scores of all COMESA countries by 2 to stimulate intra-exports. COMESA Member States should focus on strengthening their Legal and Political Environment[48], Physical Property Rights[49] and Intellectual Property Rights[50]. Maintaining the current IPRI scores or making them stronger than the established level would lead to low intra-COMESA export flows. Future research should focus on the impact of IPRs on trade with particular emphasis on sectoral levels to inform sector- specific policy decisions

[48] Judicial independence, rule of law, political stability and control of corruption
[49] Protection of physical property rights and registering property
[50] Protection of intellectual property rights, patent protection and copyright piracy

References

Abdul Sattar and Tahir Mahmood, (2011) Intellectual Property Rights and Economic Growth: Evidences from High, Middle and Low Income Countries

Carrere, C. (2004) 'African Regional Economics: Impact on Trade with or without Currency Unions

Carsten Fink and Carlos A. Primo Braga (1999), How Stronger Protection of Intellectual Property Rights Affects International Trade Flows

Congressional Research Services, (2019) Intellectual Property Rights (IPR) and International Trade

Ferrantino, M. J., 1993, "The Effect of Intellectual Property Rights on International Trade and Investment," Weltwirtschaftliches Archive,

Grossman .G.M. AND Helpman E (1991), Innovation and Growth in the global economy

Jung, M-H., (2007), "The Effects of the Interaction of the Foreign Intellectual Property Rights and Imitation Ability on the Export Patterns of IT Industrial Sectors in Korea

Kang, H-J. and Park, K-Y., (2006), "The Effects of Foreign Intellectual Property Rights (IPRs) on the Export Volume of Korea

Lee Branstetter, (2017), Intellectual Property Rights, Innovation and Development: Is Asia Different?

Lee, J-E & Mansfield, E., 1996, "Intellectual property protection and U.S. foreign direct investment," Review of Economics and Statistics 78(2)

Maskus, K. E. and Penubarti, M., (1995), "How Trade-related Are Intellectual Property Rights?"

Nguyen Khanh Doanh and Yoon Heo, (2007), Impacts of Intellectual Property Rights on Trade Flows in ASEAN Countries

Oh, K-Y. and Won, J. I., (2005), "The Effects of Patent Rights on International Trade: Evidence of Korea

PRIMO BRAGA, C.A. AND C. FINK, (1997), "The Economic Justification for the Grant of Intellectual Property Rights: Patterns of Convergence and Conflict",

Rahul Salim, Nasser Al Mawali and Amirul Islam, (2014), Do the Intellectual Property Rights of Importers Matter for Promoting Australian Exports?

Science and Engineering Indicators 2018

United Nations Conference on Trade and Development Annual Report 2015

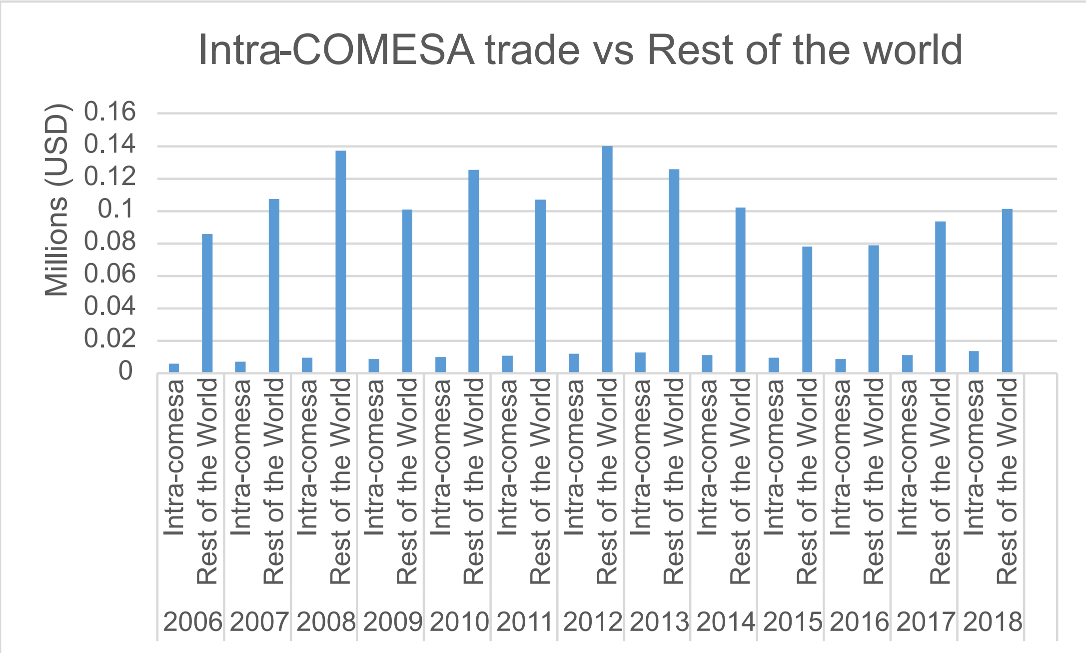
Walter G. Park, (2001),Intellectual Property and Patents Regimes

World Intellectual Property Indicators 2018

Yongmin Chen and Thitima Puttitanun, (2004), Intellectual Property Rights and Innovation in Developing Countries.

Annexures

Annexure A: Comparison of Intra-COMESA exports to the Rest of the world (Row)



Annexure B: Hausman Test Results

```
. hausman fe re

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
    gdpcapi  |    5.273933    -.5457551        5.819689        4.127294
    gdpcapj  |    -1.86711    -2.593024        .7259135        3.713684
   inniprsi  |    68.71536     60.42901         8.28635        2.090918
   innipri4  |   -79.20883    -40.90206       -38.30676        7.914244
   innipri2  |    .0607587     .0280168        .0327419        .0069403
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        25.46
                Prob>chi2 =       0.0001
                (V_b-V_B is not positive definite)
```

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