



UN-OHRLLS

SCIENCE, TECHNOLOGY AND INNOVATION FOR STRUCTURAL TRANSFORMATION OF LANDLOCKED DEVELOPING COUNTRIES

United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS)

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LIST OF ACRONYMS

AAAA	Addis Ababa Action Agenda
ACET	African Centre for Economic Transformation
APoA	Almaty Programme of Action
ASYCUDA	Automated System for Customs Data
ATM	Automated Teller Machine
BITC	Bhutan Innovation and Technology Centre
CoP	Conference of Parties
EASTECO	East African Science and Technology Commission
EIF	Enhanced Integrated Frameworks
EPZ	Export Processing Zone
ESCAP	Economic and Social Commission for Asia and the Pacific
EU	European Union
FAO	Food and Agricultural Organization
FDI	Foreign Direct Investment
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GFI	Global Forum Initiative
HDI	Human Development Index
IMF	International Monetary Fund
ICTs	Information and Communication Technologies
IFC	International Finance Corporation
ILO	International Labour Organization
ITC	International Trade Centre
ITU	International Telecommunication Union
KIC	Kigali Innovation City
KLab	Knowledge Lab
LLDCs	Landlocked Developing Countries
MDGs	Millennium Development Goals
NISER	Nigerian Institute of Social and Economic Research
NSI	National System of Innovation
OECD	Organisation for Economic Co-operation and Development
ODA	Official Development Assistance
PPP	Public-Private Partnership
R&D	Research and Development
R-HMIS	Rwanda Health Management Information System
S&T	Science and Technology
STI	Science, Technology and Innovation
SMEs	Small and Medium-sized Enterprises
SRMP	Smart Rwandan Master Plan
SSC	South-South Cooperation
SOEs	State-Owned Enterprises
SD	Sustainable Development
SDGs	Sustainable Development Goals
TFM	Technology Facilitation Mechanism

TfD3	Third International Conference on Financing for Development
TFA	Trade Facilitation Agreement
TVET	Technical and Vocational Education
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UN DESA	United Nations Department of Economic and Social Affairs
UNECA	United Nations Economic Commission for Africa
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
UIS-UNESCO	Institute for Statistics (UIS)
UNFCCC	United Nations Framework Convention on Climate Change
UNCSD	United Nations Conference on Sustainable Development
UNEP	United Nations Environment Programme
UN-OHRLLS	United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States
VPoA	Vienna Programme of Action
WDI	World Development Indicators
WIPO	World Intellectual Property Organization
WTO	World Trade Organizations
ZEEP	Zimbabwe Energy Efficiency Project

EXECUTIVE SUMMARY

Landlocked developing countries (LLDCs) are important cluster of countries that are highly disadvantaged in global trade because of geographical remoteness, lack of territorial access to the sea, high transport and transit costs, and sometimes political or security barriers in transit countries. The Vienna Programme of Action (VPoA) for LLDCs for the decade 2014-2024, adopted by the international community in November 2014, is aimed at addressing these challenges through structural economic transformation and five other priority areas that are expected to be the foci of development interventions in LLDCs. UN-OHRLLS commissioned this study as a background paper for the midterm review of the implementation of the Vienna programme of Action held in December 2019.

Science, technology and innovation (STI) play critical roles in transformation of economies, and the contributions of knowledge and technological innovation to economic progress in recent decades are widely acknowledged. The main objective of this paper is therefore to review STI profiles and progress made by LLDCs in structural economic transformation since the adoption of VPoA, highlight the evidence of the contribution of STI to structural economic transformation in LLDCs, and make recommendations that would enable increased investments in assets that generate knowledge and innovation required for structural economic transformation of LLDCs.

The methodological approach to the paper involved extensive review of literature on the links between STI and economic transformation, trend analysis of economic performance of LLDCs and regional economic performances, correlation analysis between STI input and output indicators, and use of case illustrations of the impact of STI policies and global STI initiatives on economic performance of LLDCs. The STI actors' competences and capacity to innovate as described in the analytical framework of STI readiness presented in UNECA (2018) is applied to provide a review of the roles of the actors in the national system of innovation and their capacity to foster structural economic transformation.

The findings of the study demonstrate that overcoming the challenges associated with landlockedness is feasible and would require an enduring international partnership that understand how to harness the opportunities created by science, technology and innovation for structural economic transformation of LLDCs. The results reveal that the pace of economic structural change has been very slow among LLDCs in spite of the implementation of VPoA, and the national and international commitments for the realization of the global 2030 development agenda. Though it may be argued that the period 2014 to 2017/2018 is too short to measure VPoA impact on the economies of LLDCs, the fact remains that the changes observed in key economic indicators, especially in the structure of production in LLDCs, are too marginal to suggest that structural economic change is about to take root and possibly increase in pace of occurrence.

There is evidence that STI policies aimed at fostering knowledge based and innovation driven economies in LLDCs exist at national levels, and development partners have reached a consensus that VPoA and global 2030 agenda for sustainable development cannot be effectively implemented without global support for developing countries' investment in STI. In this respect, the Technology Facilitation Mechanism (TFM) is a major international framework from which LLDCs can draw support for technology transfer and deployment in the process of implementation of VPoA.

The analysis of the STI profiles of the LLDCs showed that the effect of the implementation of VPoA on STI actors' competences and capacity to innovate are weak and would require more action and incentives that would make STI actors pro-active in the drive for generation and use of technological innovation in a functional national system of innovation. The analysis of the STI profiles also indicate that though a few LLDCs in Asia performed remarkably well in structural economic transformation in recent years, it is difficult to ascribe their good performance entirely to the implementation of VPoA because industrial policies in these countries predate VPoA. It is also important to state that African LLDCs generally lag behind other LLDCs in economic performance and in their capacity to learn and harness the opportunities provided by new and emerging technologies.

Based on the findings of this paper, eight recommendations are made as practical solutions that would foster the employment of STI for structural economic transformation in LLDCs. The recommendations are:

1) Embark on reform for structural economic change

It appears from the findings that most of the LLDCs have no economic reform measures that aggressively tackle the challenge of weak productivity especially in the agricultural and manufacturing sectors. The share of agriculture and industry in total output remains relatively unchanged for most LLDCs since the adoption of VPoA in 2014. A few LLDCs showing remarkable improvement in share of industry in GDP are those that have aggressive economic reform measures before the adoption of VPoA. LLDCs should therefore embark on economic and industrial policies that aggressively pursue structural economic transformation. As amply demonstrated by the findings of this paper, the reform measures should foster the employment of STI for production activities to ensure that economic transformation is real and sustainable. The reform measures require the support of international development partners in order to encourage technology transfer and create opportunities to learn from other countries that have successfully achieved structural economic transformation. LLDCs need to establish clear and consistent national policies on research and knowledge generation with effective mechanisms for incentivizing private sector creativity and innovation, rewarding excellence in science and technology and protecting scientific and technological rights.

2) Build human capital, technological capability and skills

The findings of this paper indicate that LLDCs especially in Africa lack local technological capability required for assimilating foreign technology and keeping pace with technological advances. To respond to rapid technological change, LLDCs will need to build human capital by investing more in education of its citizenry through reforms in education and training systems, and promote lifelong learning so they could acquire requisite skills for transforming the economies of LLDCs. The results of the analysis in this paper indicate that LLDCs must establish science, technology and innovation as the cornerstone of their human capital development strategy by significantly improving the level of investments in education and training. Increasing the share of budgetary allocation to science, technology, engineering and mathematics (STEM) in the formal education system budget will particularly help improve the quality and reach of infrastructure

required for STEM education, and consequently boost enrolment in STEM and related disciplines. It is also critical for public investments in education to support close interactions between the generation of science and technology in knowledge institutions and their application in the real sectors such as agriculture and manufacturing. Investment in education and skills should be particularly focussed on building the capacity of LLDCs to harness the opportunities being created by new and emerging technologies (e.g., biotechnology, nanotechnology, artificial intelligence, machine learning, big data, cloud computing, 3D printing, etc) for economic development and competitiveness.

3) Improve Research and Development expenditure

International support for technology transfer and knowledge creation would not result in structural economic transformation as long as domestic investment in Research and Development (R&D) is very low. National R&D expenditure in LLDCs should be significantly improved to raise local capacity for technology acquisition. If local capacity to adapt, absorb and assimilate foreign technology is low, structural economic transformation would remain highly constrained because the economy would be incapable of delivering the skills and knowledge platform for foreign and superior technology to thrive.

4) Support for STI investments

Support for STI investments is very crucial for strengthening the national system of innovation and increasing the capacity of STI actors to innovate and participate effectively in global value chains. Support for STI investments in LLDCs must be global with full commitment of developed countries and international development partners. The support for STI investments should be delivered by consensus or on agreed STI initiatives that directly promote manufacturing competitiveness of LLDCs, strengthen their capacity to diversify their economy and integrate into global value chains. If support for STI investments in LLDCs is sincere, structural economic transformation will take place at remarkable speed in LLDCs. Notable areas of specific STI investment support include ICT infrastructure (e.g., broadband Internet access and mobile devices), e-Libraries in educational institutions, digitalization of cross-border transaction facilities, etc.), and clean energy technologies (e.g., renewable energy systems).

5) Improve support for LLDCs in international STI initiatives

International development partners should improve support for LLDCs in international STI initiatives by focusing international STI policies on:

- Strengthening of institutions for STI in LLDCs;
- Supporting R&D in LLDCs;
- Building STI infrastructure for trade facilitation in LLDCs; and
- Advising LLDCs governments on STI policies.

Technology transfer does not happen by default, but rather by building local technological capability that is strong enough to adopt and assimilate foreign and superior technologies. Development partners should thus improve support for building technological capabilities in LLDCs in order to acquire knowledge and innovation for the achievement of the structural economic transformation priority of VPoA.

6) *Promote digitalization of the economy through investments in ICT infrastructure*

The findings of this paper amply demonstrate that trade and regional integration between LLDCs and transit countries would benefit immensely from local and international efforts aimed at promoting digitalization of the economies of LLDCs and cross-border activities between LLDCs and transit countries. The scaling up of ICT investments would enhance digitalization of LLDC economies. The global economic competition is increasingly determined by digitalization, and LLDCs cannot afford to be left behind like it happened in the previous waves of technological change. Promoting digitalization of LLDC economies through massive ICT investments and appropriate uses would transform every sector of the economy and provide opportunities for micro, small and medium enterprises (MSMEs) to thrive, become competitive and integrated into global value chains. The participation of LLDCs in global trade would thus be significantly improved and structural economic transformation of LLDCs would consequently be effectively stimulated.

7) *Pursue innovation policies as strategic instruments of economic diversification and competitiveness*

The findings of the paper revealed that only 11 of the 32 LLDCs have a policy document specially dedicated for the promotion of investments in STI, 18 LLDCs have STI policies embedded in broader development plan or economic policy frameworks, and there is no evidence that three LLDCs have STI policy. Industrial economies and newly industrializing countries have a history of ardent pursuit of innovation policies as instruments of economic diversification and competitiveness. In this respect, innovation policy is an integration of STI and economic policies in a strategic policy framework that aims at fostering economic growth, creating new processes and products with sufficiently superior value that change market dynamics in favour of the economy. LLDCs should learn from this established economic development paradigm by pursuing innovation policies that effectively integrate STI policies with economic policies. The findings also revealed that STI policies in most LLDCs have in recent years shifted in focus to a more realistic problem-solving approach to STI. It should however be noted that the effectiveness of the STI policies depend on the STI regulatory environment which is determined by the governing rules and regulation, existence of modern transparent institutions, functional infrastructure and good judicial system. A clear understanding of the peculiarities of sectoral systems is also necessary for identifying sources of innovation and the applicable innovation policies in specific sectors.

8) *Special support mechanism for African LLDCs*

African LLDCs generally lag behind in most of the indicators of structural economic transformation analysed in this paper. They are also relatively weak in the performance of STI actors and capacity to innovate in a national system of innovation. These findings suggest that LLDCs in Africa would need a more specialized support to ensure they overcome current challenges associated with landlockedness and remove the inertia restricting innovative and knowledge generating activities. The special support mechanism should be initiated and packaged by the relevant United Nations, international and regional organizations in collaboration with regional organizations such as the African Union and the African Development Bank after adequate sensitization to achieve the support of international development partners, civil societies

and national governments. The organized private sector in each of the LLDCs should also be actively involved because creativity and innovation are products of interactions among actors often driven by the imperatives of the market.

SCIENCE, TECHNOLOGY AND INNOVATION FOR STRUCTURAL ECONOMIC TRANSFORMATION OF LANDLOCKED DEVELOPING COUNTRIES

1. INTRODUCTION

1.1. Global Economy and the Imperative of Innovation

In spite of economic progress made in recent decades through consensus global and regional development agendas, poverty, environmental degradation and social exclusion remain daunting development challenges. The advanced industrial economies have been able to appreciably address these challenges through long term investments that enabled economic structural transformation, social change and shared prosperity. This notwithstanding, issues of environmental degradation and climate change are still contentious, and both developed and developing countries are cautious in agreeing to international frameworks aimed at ensuring that future generations are not made to suffer the consequences of current unsustainable production and consumption behaviours. The Sustainable Development Goals (SDGs) articulate the various aspects of global development agenda for 2030 with the expectation that all countries would be supportive in ensuring that the world economy grows sustainably with benefits to all, and with responsibility for environmental and social justice.

At the core of global development agenda is how to address the economic and social challenges associated with under-development. These challenges are pronounced in many developing countries by lack of requisite resources and capacity to cope or effectively participate in global economic competition. Besides, developing countries are disadvantaged in global economic competitiveness due to the fact that they are largely agricultural economies, commodity export dependent, and lack of technological capability required for value addition and improvement in services. The situation has become more worrisome because global economic competitiveness is increasingly knowledge based and innovation driven, and developing countries need to increase investments to improve knowledge and foster technological catch-up.

To underscore the critical role of knowledge and technological innovation in economic progress in recent decades, the 2018 Nobel Prize in economic sciences was awarded for research efforts that elucidated the contributions of knowledge and innovation to global economic growth.¹ The 2018 OECD Science, Technology and Innovation (STI) Outlook Report also highlights the disruptive consequences of technological innovations in the economy and society. The OECD STI outlook particularly emphasizes the emerging importance of digitization in transforming innovation processes, lowering production costs, promoting collaborative and open innovation, blurring the boundaries between manufacturing and service innovation, and generally speeding up innovation cycles (OECD, 2018). While digitization extends the frontiers of innovation at a pace that may further worsen the economic competitiveness of late industrializers, it may also provide windows of opportunity for the emergence of solutions that would remove constraints on growth and economic transformation in developing countries.

¹The 2018 Nobel Prize in Economics was awarded to William D. Nordhaus "for integrating climate change into long-run macroeconomic analysis" and Paul M. Romer "for integrating technological innovations into long-run macroeconomic analysis". <https://www.nobelprize.org/prizes/economic-sciences/2018/summary/> (ACCESSED 16 March 2019).

1.2.The Challenge of Economic Transformation of LLDCs

There are 32 landlocked developing countries (LLDCs) distributed across four continents as shown in Table 1.1. These countries are mostly low-income or lower middle-income developing countries and suffer from the challenges enunciated above.² The development challenges of LLDCs are compounded by the constraints of lack of access to the sea, geographical remoteness, and poor physical infrastructure. As rightly captured by a recent statement on the plight of LLDCs,³ though LLDCs are diverse with respect to economic systems, natural resource endowment and levels of development, these common set of challenges impose on them rising transaction and transport costs which make attainment of global economic competitiveness an arduous task. The high transaction and transport costs restricts trade, make manufacturing in LLDCs more expensive thereby preventing real sector investments required for structural economic transformation, and hinders the regular productivity improvements that move countries up in the global value chains.

Table 1.1: List of landlocked developing countries by regions

Africa		Asia		Europe	South America
Botswana	Malawi	Afghanistan	Mongolia	Armenia	Bolivia
Burkina Faso	Mali	Bhutan	Nepal	Azerbaijan	Paraguay
Burundi	Niger	Kazakhstan	Tajikistan	Moldova	
Central Africa Republic	Rwanda	Kyrgyzstan	Turkmenistan	North Macedonia	
Chad	South Sudan	Lao PDR	Uzbekistan		
Eswatini	Uganda				
Ethiopia	Zambia				
Lesotho	Zimbabwe				

Source: UN-OHRLLS

LLDCs also exhibit major challenges in the area of information and communication technologies (ICTs) infrastructure, which remain relatively less developed in spite of its crucial role as a driver of network relationships for trade facilitation and integration into the global economy. ICTs are especially important for overcoming the constraints due to remoteness by facilitating access to information on global markets for producers and consumers; and they also promote technology transfer required for productivity growth and unlocking the economic potentials of the LLDCs.

In addition to relatively weak transport and ICT infrastructure, LLDCs face severe challenges in access to energy with LLDCs in Africa fairing worse relative to their counterparts in other regions (UN-OHRLLS, 2013; EASTECO, 2019). Most LLDCs have very low power generation capacity,

²The 32 LLDCs comprise of 14 low income economies (per capita GDP, \$1.025 or less), 13 lower middle-income economies (per capita GDP, \$1.026 -\$4,035), and 5 upper middle-income economies (per capita GDP, \$4.036 - \$12,475).

³See the statement by Ms. Fekitamoeloa Katoa 'Utoikamanu at the Ambassadorial Meeting of the Landlocked Developing Countries in New York on 18 December 2018. http://unohrlls.org/custom-content/uploads/2018/12/USG-STATEMENT_LLDC-Ambassadorial-Meeting_18-Dec-18.pdf (ACCESSED, 02 April 2019)

despite substantial untapped potential including in renewable sources notably hydroelectricity, solar, and wind energy

The challenge of landlockedness compel most LLDCs to depend on their neighbouring transit countries to access international market. According to Faye et al (2004), such dependence is classified into four: dependence on neighbours' infrastructure; dependence on sound cross-border political relations; dependence on neighbours' peace and stability; and dependence on neighbours' administrative practices.

Many landlocked developing countries are highly commodity dependent, and their export is majorly heavy and low value goods which often lead to high transport costs. Primary commodities accounted for more than half of the exports of 27 out of 32 LLDCs in 2017, and resource-based goods, that is to say, primary goods and resource-based manufactures, accounted for some three quarters of all exports of goods and services of LLDCs as a group. The average share of primary commodities, precious stones and non-monetary gold in merchandise exports in LLDCs is 82.9 percent in 2017 (UN-OHRLLS, 2018a). The vulnerability of LLDCs due to geographical remoteness and dependency thus hinders the economic transformation and yield different sets of challenges and priorities in each landlocked country. Moreover, the geographical challenges of LLDCs are often compounded by weak transit-transport infrastructure, inefficient customs operations, and over-dependence on the exports of primary commodities.

In view of the foregoing constraints on economic transformation in LLDCs, the United Nations recognized that the achievement of the global development goals of eradicating poverty, inclusive growth, and environmental sustainability would be impossible in LLDCs without a concerted effort by the international community to address the challenge of landlockedness. The second United Nations Conference on Landlocked Developing Countries accordingly adopted the Vienna Programme of Action for Landlocked Developing Countries for the Decade 2014-2024 (hereafter, VPoA) in November 2014.

Structural economic transformation is one of the six priorities of VPoA and science, technology and innovation (STI) play critical roles in transformation of economies. This paper was commissioned by the UN-OHRLLS to serve as a background paper for the midterm review of the implementation of the VPoA. The main objective of this paper is therefore to review STI profiles and progress made by LLDCs in structural economic transformation since the adoption of VPoA, highlight the evidence of the contribution of STI to structural economic transformation in LLDCs, and make recommendations that would enable increased investments in assets that generate knowledge and innovation required for structural economic transformation of LLDCs.

1.3. Methodological Approach

The methodological approach to the paper is desk research involving extensive review of literature on the links between STI and economic transformation, trend analysis of economic performance of LLDCs and regional economic performances, correlation analysis between STI inputs and outputs indicators, and use of case illustrations of the impact of STI policies and global STI initiatives on economic performances of LLDCs. The STI actors' competences and capacity to

innovate as described in the analytical framework of STI readiness presented in UNECA (2018) is applied to provide a review of the roles of the actors in the national system of innovation and their capacity to foster structural economic transformation. Since VPoA covers 2014 to 2024, the situation analysis in 2014 would have been based on data for 2012/2013 for different countries. In order to ascertain what has happened since adoption of the VPoA, the trend analysis and review in this paper cover the period 2012 to date or period of latest available data for LLDCs. The trend analysis groups LLDCs into four: African (16 countries), Asian (10 countries), Europe (4 countries), and South America (2 countries).

Sources of data include national reports on review of progress in VPoA implementation in LLDCs, World Bank World Development Indicators, World Bank Ease of Doing Business Reports, Global Competitiveness Index Reports, Human Development Index Reports, Statistical Annex on LLDCs compiled by UN-OHRLLS, FAO Stats, UNCTAD Trade Stats, UN-COMTRADE data, OECD Stats, UNESCO Stats, World Intellectual Property Organization (WIPO)– Patents and Trademarks Data, and Country Economic Profile/Data on country website and country statistical bureau/agency.

1.4. Structure of the Paper

The paper is structured as follows: the next section presents an overview of the VPoA and global STI initiatives; section three reviews structural economic transformation in LLDCs since the adoption of the VPoA; section four discusses the role of STI in economic transformation and the achievement of 2030 Agenda for Sustainable Development; section five presents an analysis of STI actors in the national system of innovation and their capacity to foster structural economic transformation in LLDCs; section six presents evidence of how STI has stimulated or supported structural economic transformation in LLDCs since the launch of VPoA; and the final section concludes the paper and makes recommendations on the way forward.

2. OVERVIEW OF VPoA FOR LLDCs FOR THE DECADE 2014-2024 AND GLOBAL STI INITIATIVES

2.1. Scope and Objectives of VPoA

The Vienna Programme of Action for LLDCs (VPoA) is a follow up to the Almaty Programme of Action (APoA). The VPoA was adopted at the Second United Nations Conference on Landlocked Developing Countries in Vienna held on 3-5 November 2014. The VPoA has a holistic approach aimed at fostering understanding and taking appropriate actions that enable LLDCs, transit countries, and international development partners address the development challenges faced by LLDCs. As stated in paragraph 21 of the VPoA, the overarching goal of the Programme of Action is to address the special development needs and challenges of LLDCs arising from landlockedness, remoteness and geographical constraints in a more coherent manner and thus contribute to an enhanced rate of sustainable and inclusive growth, which can contribute to the eradication of poverty by moving towards the goal of ending extreme poverty. The VPoA states that particular attention is given to the decade 2014-2024 for the development and expansion of efficient transit systems and transport development, enhancement of competitiveness, expansion of trade, structural transformation, regional cooperation, and the promotion of inclusive economic growth and sustainable development to reduce poverty, build resilience, bridge economic and social gaps. It is thus apparent from that the main objective of VPoA is to provide solutions to the special development needs and challenges of LLDCs within the decade of 2014-2024, and thereby making significant contributions to efforts aimed at achieving the global development goals encapsulated in 2030 Agenda for Sustainable Development. The scope of VPoA include six specific priorities for action which are enunciated as follows:⁴

Priority 1: Fundamental transit policy issues

Priority 2: Infrastructure development and maintenance

a) Transport infrastructure

b) Energy and information and communications technology infrastructure

Priority 3: International trade and trade facilitation

a) International trade

b) Trade facilitation

Priority 4: Regional integration and cooperation

Priority 5: Structural economic transformation

Priority 6: Means of implementation

The specific objectives of VPoA are to:

a) Promote unfettered, efficient and cost-effective access to and from the sea by all means of transport, on the basis of freedom of transit, and other related measures, in accordance with applicable rules of international law;

b) Reduce trade transaction costs and transport costs and improve international trade services through simplification and standardization of rules and regulations, so as to increase the

⁴For full description of the six priorities, see United Nations (2014). Vienna Programme of Action for Landlocked Developing Countries for the Decade 2014-2024, Second United Nations Conference on Landlocked Developing Countries, Vienna, November 2014.

- competitiveness of exports of LLDCs and reduce the costs of imports, thereby contributing to the promotion of rapid and inclusive economic development;
- c) Develop adequate transit transport infrastructure networks and complete missing links connecting LLDCs;
 - d) Effectively implement bilateral, regional and international legal instruments and strengthen regional integration;
 - e) Promote growth and increased participation in global trade, through structural transformation related to enhanced productive capacity development, value addition, diversification and reduction of dependency on commodities;
 - f) Enhance and strengthen international support for LLDCs to address the needs and challenges arising from landlockedness in order to eradicate poverty and promote sustainable development.

2.2. Relationships between VPoA and SDGs

Though VPoA predates the 2030 Agenda which came into effect in 2015, the shortfalls in achieving the Millennium Development Goals (MDGs)⁵ in LLDCs were sufficiently instructive for the VPoA and the extension of the goals of the VPoA to align with Sustainable Development Goals (SDGs).

The Vienna Programme of Action and the SDGs adopted by the United Nations Member States in 2014 and 2015 respectively provided a shared blueprint for inclusive economic growth, poverty reduction, environmental sustainability, peace and prosperity for the people of LLDCs. While the VPoA is specifically tailored for the LLDCs and covers only the decade of 2014 to 2024, the SDGs are global development agenda until 2030. The 2030 Agenda for Sustainable Development and the SDGs have a common broad objective with VPoA. This broad objective recognizes that ending poverty and other deprivations are imperatives that must be addressed irrespective of natural or man-made constraints on economic and social development. Economic growth must be inclusive and job creating, lead to shared prosperity, and organized to limit climate change and preserve the global environment. It is noteworthy that the 2030 Agenda specifically identified in SDG 9 the critical role of building resilient infrastructure, industrialization and innovation in addressing the challenge of poverty, unemployment, climate change and environmental degradation. SDG 9 can thus be regarded as a major link with the VPoA since all the six priorities of VPoA are directly related to building physical and social infrastructure for addressing the challenge of landlockedness and how to foster industrialization as a means of structural economic transformation of LLDCs. An important dimension introduced by SDG 9 is the role of innovation in industrialization and the building of critical infrastructure for development.

Innovation occurs when there are different and often nouveau combination of productive resources. The development of the innovation input resources and the process of innovation are both dependent on science and technology applications at different levels of economic development. Capacity to innovate varies across and within countries whether landlocked or not. Actions that are aimed at the six VPoA priorities accordingly need to be guided by policies and

⁵The Millennium Development Goals (MDGs) were eight global development goals adopted for the year 2015 at the United Nations Millennium Summit in 2000.

programmes that are aimed at fostering innovation-driven economies while taking into cognizance the context and peculiarities of each of the LLDCs. As rightly pointed out by Giovannini et al (2015), the VPoA and SDGs put new pressure on both national and international policies, and actions to achieve them are needed in the following major areas:

- a) National policies aimed at improving local conditions in LLDCs. These local conditions include economic growth, prosperity, human rights, governance, rule of law, education, health, income equality within nations, environmental protection, etc.
- b) National policies and actions that have an impact on other developing regions and countries. These may involve policy and actions that affect consumption, investment and production patterns, Green House Gas emissions, resource use, agriculture and fisheries, transboundary movements, environmental pollution, etc.
- c) International policies and cooperation agreements. These include policies and agreements on foreign development cooperation and integration, trade, migration, remittances, financial systems, etc.

2.3.Implementation of VPoA

2.3.1 Overview of implementation progress

Following the adoption and implementation of the VPoA, LLDCs have initiated important policy reforms to address the challenges associated with landlockedness. In this respect, the LLDCs have sought to improve trade facilitation and productive capacities of their economies. Efforts have been ongoing aimed at encouraging the harmonization of transport and transit policies, laws, procedures and practices with transit countries. Several regional and sub-regional transit facilitation agreements have been concluded and adopted for implementation. With support of development partners, some LLDCs and transit countries have, through regional trade agreements, free trade areas and customs unions, developed supportive institutional frameworks. Such institutional framework includes transport and trade facilitation bodies or coordination committees, regional collaboration on STI and road funds. Border facilities and procedures have also been streamlined and harmonized, leading to increased efficiency and fewer delays in doing business. Progress has been made towards upgrading and expanding road and rail transport infrastructure, as well as improving access to energy and ICT.

While a few of the LLDCs (e.g., Nepal, Ethiopia, Rwanda, Burkina Faso, Lao, Tajikistan, Turkmenistan, Armenia and Paraguay) have actually experienced increase in economic growth since the implementation of VPoA, there is however a general slowdown in growth in LLDCs and a decline in their share of global exports since the adoption of the VPoA in 2014. The progress on structural economic transformation and the diversification of their economies has also been limited. While most LLDCs have ratified the WTO Trade Facilitation Agreement, their implementation of the Agreement is lagging behind. LLDCs also experience lack of adequate financial resources for infrastructure facilities that connect with transit countries and a lack of capacity in formulating financially viable infrastructure projects.

UN-OHRLLS has been particularly supportive of LLDCs in the implementation of the VPoA by coordinating UN system, organizing high-level and expert group meetings, mobilizing resources, monitoring and reporting on progress made. The latest report of the UN Secretary-General on the progress made in the implementation of VPoA concluded that while progress in implementing the

Vienna Programme of Action has been tangible in some areas, it has been limited in others and many challenges remain for the full implementation of the Vienna Programme of Action⁶. Support for the implementation of the Programme of Action needs to be strengthened, and increased efforts are needed to assist LLDCs in overcoming the geographical and structural obstacles to their development. It is therefore necessary to accelerate the implementation of reforms in order to ensure that the VPoA objectives are effectively realized across the LLDCs.

2.3.2. Strategies of VPoA implementation

Landlocked Developing Countries have adopted several strategies to mobilize domestic resources for the development of infrastructure and transit facilities, promotion of STI, as well as for the overall socioeconomic transformation and development of their respective countries. Efforts have also been made by LLDCs and their international development partners to improve strategies for mobilization of local resources and to encourage inflow of external resources for the implementation of VPoA. From the national VPoA implementation progress reports submitted to UN-OHRLLS in the lead up to the high-level comprehensive midterm review on the implementation of the VPoA, the specific strategies for VPoA implementation address issues of financing, infrastructural development, public-private partnerships, foreign direct investment, good governance and rule of law, stable and sound macroeconomic policies, diversification of production, planning and managing public procurement, national feedback or coordination mechanisms, and promotion of Science, Technology and Innovation (STI). Overview of key strategies is provided as follows:⁷

- i) *Financing the VPoA*: Sources of financing VPoA initiatives include government annual budget provisions, domestic and external borrowing, remittances and earned income from abroad, and support and assistance from internal and external development partners.
- ii) *Good governance and rule of law*: This aims at ensuring accountability, transparency in government and a good judicial system where the rule of law is upheld, and gender inclusiveness is promoted.
- iii) *Infrastructural development*: This involves progressive efforts to develop and upgrade road and rail infrastructure and the maintenance of the existing infrastructure at the national, sub-regional and regional levels in order to improve the trade potentials.
- iv) *Public-private partnership (PPP)*: PPP models involving public sector collaborations with the private sector agents are being encouraged in order to mobilize resources and ensure transparent and accountable implementation of VPoA.
- v) *Foreign direct investment (FDI)*: FDI promotion is being pursued by LLDCs because it is viewed as critical especially for the real sector development.
- vi) *Stable and sound macroeconomic policies*: The economies of LLDCs strive to ensure reasonable macroeconomic stability through sound macroeconomic policies aimed at improving business environment through effective management and monitoring of key macroeconomic indicators.

⁶ Report of the Secretary-General on the Implementation of the Vienna Programme of Action for Landlocked Developing Countries for the Decade 2014-2024, A/74/113

⁷See national reports on review of progress in VPoA implementation in LLDCs at: <http://www.lldc2conference.org/national/> (ACCESSED 09 March 2019)

- vii) *Diversification of production*: LLDCs are in pursuit of diversification of productive base of their economies and recognize the need to improve technological capabilities in order to expand production, foster value addition, and move away from commodity-based economies to higher goods and services.
- viii) *Planning and managing public procurement*: Efforts are being made in LLDCs to plan and enforce contracts so that there is value for money in public procurement and significant reduction in corruption.
- ix) *National feedback or coordination mechanisms*: Follow-up, monitoring and review of the implementation process of VPoA are being undertaken at national, sub-regional and global levels.
- x) *Promotion of science, technology and innovation (STI)*: Investment in science and technology infrastructure are being encouraged because STI could tremendously help in overcoming the major challenges faced by LLDCs.
- xi) *Regional integration and connectivity*: Regional integration and connectivity through infrastructure and trade are being promoted by LLDCs and their development partners to reduce cost of doing business and facilitate trade.

Annex A presents a matrix of VPoA implementation strategies and achievements identified in each LLDC from 2014 to 2018.

2.4. Global STI Initiatives Relevant to LLDCs

Advanced industrial economies have the pioneer advantage of learning to harness the opportunities created by advances in science and technology for economic and social development. Newly industrializing economies or emerging economies have learnt from experiences of advanced industrial economies and economies that have succeeded in achieving economic and technological catch up in the process of addressing development challenges. However, many extant developing countries have lagged behind in technology and economic development, and the prospects of technological and economic catch up appear to have considerably diminished due to intense global competition that is increasingly knowledge based. The situation is more worrisome for developing countries because of increasing returns to scale associated with knowledge accumulation that determines the capacity to harness the global public goods encapsulated in science and technology. It is thus difficult for developing countries that are late industrializers to improve their technological capability without a concerted global support.

Landlocked developing countries are typically late industrializers and the constraints of landlockedness introduce the need for peculiar scientific and technological solutions that would unlock them to overcome natural and man-made barriers to economic structural transformation and global competitiveness. Global science, technology and innovation initiatives in support of developing countries are many. Besides, Science, Technology and Innovation (STI) have become important and strategic instruments for the achievement of the global 2030 Agenda for sustainable development. STI is fundamental and crosscutting in application for the realization of the 17 SDGs. Global initiatives on STI often have projects and programmes that are tailored for regional implementations in accordance to domestic or regional economic and STI policies. STI policies are measures for addressing issues of technological learning and local technological capability

building, organization of research and development, and the diffusion, transfer, and commercialization of technology. It is however important to note that only few global STI initiatives pay attention to the peculiar needs of LLDCs.

2.4.1 Global forum initiative

An example of global STI initiative which addressed the challenges of LLDCs is the Global Forum Initiative which emanated from a United Nations and World Bank Forum on STI for development in 2007. According to World Bank (2008), the Global Forum Initiative (GFI) explored strategies, programmes, and policies for building STI capacity in order to promote sustainable growth and poverty reduction in LLDCs. The main objectives of GFI include:

- a) Understand the STI capacity building processes that are under way in different countries;
- b) Share lessons of experience in building STI capacity, see which STI capacity building programs are working effectively, and which are not generating the desired outcomes, and understand some of the reasons behind these disparate outcomes;
- c) Build government capacity for STI policy making and enhance donor capacity to design successful STI capacity building projects; and
- d) Discuss how donor organizations could work together under the auspices of the Paris Declaration on Aid Effectiveness and other similar international initiatives to improve their STI capacity building partnerships with developing countries.

Several case studies on STI capacity building initiatives in LLDCs were discussed at the 2007 global forum. The key lessons or messages that emerged from the case studies as presented in Watkins and Ehst (2008) are:

1. Countries cannot achieve the MDGs if they do not have the scientific, engineering, and technical or vocational capacity to handle such mundane but necessary tasks as repairing farm machinery or testing drinking water.
2. Building STI capacity for growth and poverty reduction is not about theoretical and abstract scientific research, but rather “solve, transform, and impact.”
3. The capacity to absorb and diffuse existing knowledge is at least as important as the capacity to produce new knowledge.
4. Committed, capable national leadership with coherent STI capacity building policies are absolute necessity.
5. Basic literacy is essential, but it is not sufficient. Developing countries will not have the capacity to address their social and economic problems if they focus only on basic literacy to the exclusion of secondary and tertiary education.
6. The centrality of women to poverty reduction means that STI capacity building should target gender disparities in strategies to achieve the MDGs.
7. STI capacity building is about much more than high tech. High-tech industries—electronics, computers, and so on—are not always synonymous with high value added, high wages, and rapid growth. On the contrary, developing countries may get more development “bang for the buck” by helping low-tech but knowledge-intensive sectors, such as horticulture and food processing, become more competitive and innovative than by trying to compete in a few high-tech niche products and industries. The non-high-tech industries may be precisely the ones that generate the greatest social and economic returns to STI capacity building.

8. Regional initiatives are an important component of STI capacity building. It may not be feasible or desirable to establish duplicate STI institutions in every country. This is especially true in regions that have large numbers of smaller countries with limited STI capacity. The trained manpower may simply not be available. Expensive facilities may lie idle for long periods of time. Instead of spending money on what could turn out to be underutilized, duplicate, poorly staffed facilities, countries may be able to reap substantial economies of scale or financial savings by banding together to support regional STI capacity building initiatives that complement national STI capacity building programs.
9. Centres of excellence do not have to be only brick-and-mortar institutions. They can be virtual institutions, encompassing networks of scientists from different institutions in the same country or even from different countries. The important point is that scientists join forces to work on a common set of problems. Physical facilities to support the work will undoubtedly be required.
10. A good business climate must be paired with STI capabilities to develop an innovative, globally competitive economy. It makes little sense to build STI capacity if the legal, regulatory, financial, and economic conditions deter entrepreneurs and investors from investing and innovating.
11. Fostering entrepreneurship is a critical component of STI capacity building. The ability to absorb and utilize new technology and the capacity to innovate must reside in private enterprises.
12. STI capacity building should not be confined to science and technology (S&T) projects and programmes or higher education projects and programmes. STI capacity building must become an integral component of all investment activities.
13. There is no single correct recipe for building STI capacity. Different countries have developed various policies and programmes for building STI capacity. But while the programs differ in technical details and specific tactics, successful programmes tend to focus on a common set of core issues: promotion of entrepreneurship; adaptation and adoption of existing technology; both the supply and demand for S&T capacities; specific social and economic goals; and promotion of interactions among public institutions, academia, and the private sector.
14. Success in building STI capacity requires a continuous process of institutional learning by the government agencies that create and administer STI policies and programmes and the laboratories, universities, and firms that create and use knowledge.

The above fourteen lessons on STI capacity building apply not only to LLDCs but generally to late industrializers. The VPoA and the SDGs are post GFI development agendas, and the STI capacity building lessons which emanated from the GFI case studies remain apparently critical for the achievement of the goals of VPoA and the SDGs.

2.4.2 Technology facilitation mechanism

As a global STI initiative, the Technology Facilitation Mechanism (TFM) was conceived during the United Nations Conference on Sustainable Development (UNCSD) in 2012, Rio +20. The TFM was aimed at supporting the implementation of the 2030 Agenda for Sustainable Development which was structured as 17 Sustainable Development Goals (SDGs). The TFM is designed to facilitate multi-stakeholder collaboration and partnerships through the sharing of

information, experiences, best practices and policy advice among Member States, Civil Society, the private sector, the Scientific Community, United Nations entities and other development stakeholders. After a series of multilateral negotiations, the TFM was established in July 2015 by an agreement within the context of Addis Ababa Action Agenda (AAAA) of the Third International Conference on Financing for Development (FfD3) (See paragraph 123 of AAAA).

The initial objectives of technology facilitation mechanism were:

- Support the achievement of the SDGs;
- Provide a multi-stakeholder collaboration to achieve SDGs; and
- Strengthen coherence and synergies among science and technology initiatives within the UN system.⁸

The TFM should foster meaningful and sustained capacity building and technical assistance for developing countries on technology development, transfer and deployment. The above specific objectives of the TFM were later modified to include:

- Assist developing countries to build or strengthen their capacity to identify technology needs, to facilitate the preparation and implementation of technology projects and strategies that foster sustainable development;
- Stimulate technology cooperation;
- Enhance the development and transfer of technologies;
- Support country assessments of technology needs and collaborate with national stakeholder to prioritize technologies within sectors and analyze technologies including performing economic analysis, market assessment, barriers analysis, employment opportunities, and enabling framework creation;
- Support the design and establishment of country-tailored policies spurring technology transfer and enabling frameworks for the transfer of clean and environmentally sound technologies, with a focus on public-private interface and intellectual property rights;
- Build capacity in public and private institutions to deliver technology transfer services;
- Facilitate regional and global peer learning, technology exchange and training programmes.

It is expected that the TFM would be delivered through a cost-effective and highly flexible structure which has the ability to respond quickly and competently to many national requests for technology support. The Technology Facilitation Mechanism as stated in paragraph 123 of AAAA has three components:

1. *Interagency task-force team on STI*: A UN inter-agency task team on STI for SDGs to promote coordination, coherence and cooperation within the UN system on STI related matters;
2. *Online platform on existing STI initiatives*: an online platform to establish a comprehensive mapping of, and serve as a gateway for information on existing STI initiatives, mechanisms and programmes so as to facilitate access to information, knowledge and experience, best practices and lessons learned, and facilitate the dissemination of relevant open access scientific publications generated worldwide; and

⁸ See <https://www.unenvironment.org/explore-topics/technology/what-we-do/technology-facilitation-mechanism> (ACCESSED 01 April 2019)

3. *Multi-stakeholder annual global forum on STI initiatives*: a multi-stakeholder forum on STI for SDGs to be convened once a year, for a period of two days, to discuss STI cooperation around thematic areas for the implementation of the SDGs, congregating all relevant stakeholders to actively contribute in their area of expertise.

All three components of the TFM are currently active or being developed and are supportive in harnessing STI for achieving SDGs.⁹ Four STI forums have taken place since the establishment of the TFM, with the fourth held at the United Nations Headquarters in New York on 14 and 15 May 2019. The United Nations General Assembly has also decided that the forum meetings would be co-chaired by two Member States of the UN. The TFM online platform as a gateway for information on existing STI initiatives, mechanisms and programs is yet to be in operation. However, work is already ongoing on the design, development and operation of the online platform. A working prototype of the platform was released in 2018.

The UN interagency task team on STI for SDGs was initially composed of the UN Department of Economic and Social Affairs, UNEP, UNIDO, UNESCO, UNCTAD, ITU, WIPO and the World Bank. Currently, 42 UN system entities are part of the task team. The Task Force has been working along several work streams and in particular STI roadmaps for the SDGs have been developed a first phase of the Global pilot Programme on STI for SDGs Roadmap has been launched in five pilot countries. The results of the pilots will lead to the development of Guidebook for the preparation of STI for SDGs Roadmaps. A 10-Member Advisory Group, appointed by the Secretary-General has also been set up to support the TFM, with rotational annual membership to bring in diversity of viewpoints.

⁹ The information in this paragraph is from <https://sustainabledevelopment.un.org/tfm> (ACCESSED, 10 April 2019) and <https://www.un.org/development/desa/statements/mr-liu/2019/05/multi-stakeholder-stif-sdgs.html> (ACCESSED, 25 June 2019)

3. STRUCTURAL ECONOMIC TRANSFORMATION IN LLDCs SINCE VPoA

This section reviews economic performance in LLDCs to ascertain the extent of structural economic transformation achieved since the adoption of VPoA. As defined by Ogbu et al (2012), economic transformation is the process involving increases in productivity, technological capability, economic diversification, and international competitiveness that support rapid, sustained and shared growth in employment and incomes. Structural economic transformation accordingly includes the twin issues of sustained economic growth and structural transformation that is inclusive.

Structural economic transformation leads to reallocation of resources from low- to high-productivity sectors, often involving industrial development, and it can dramatically increase the income levels of poor countries, supporting poverty eradication and sustained economic growth. As a country undergoes economic structural change, the demand for manufactured products rises, the share of employment in agriculture declines and employment in industry or urban-based services rises, accompanied by productivity increases. Services then become more prevalent with rising incomes, and the shares of manufacturing and agriculture in national output tend to fall while the share of services sector rises. Economic growth and wellbeing are consequently sustained especially if economic policy intervention pay sufficient attention to issues of social and environmental protection.

3.1. Economic Growth Performance and Structural Change

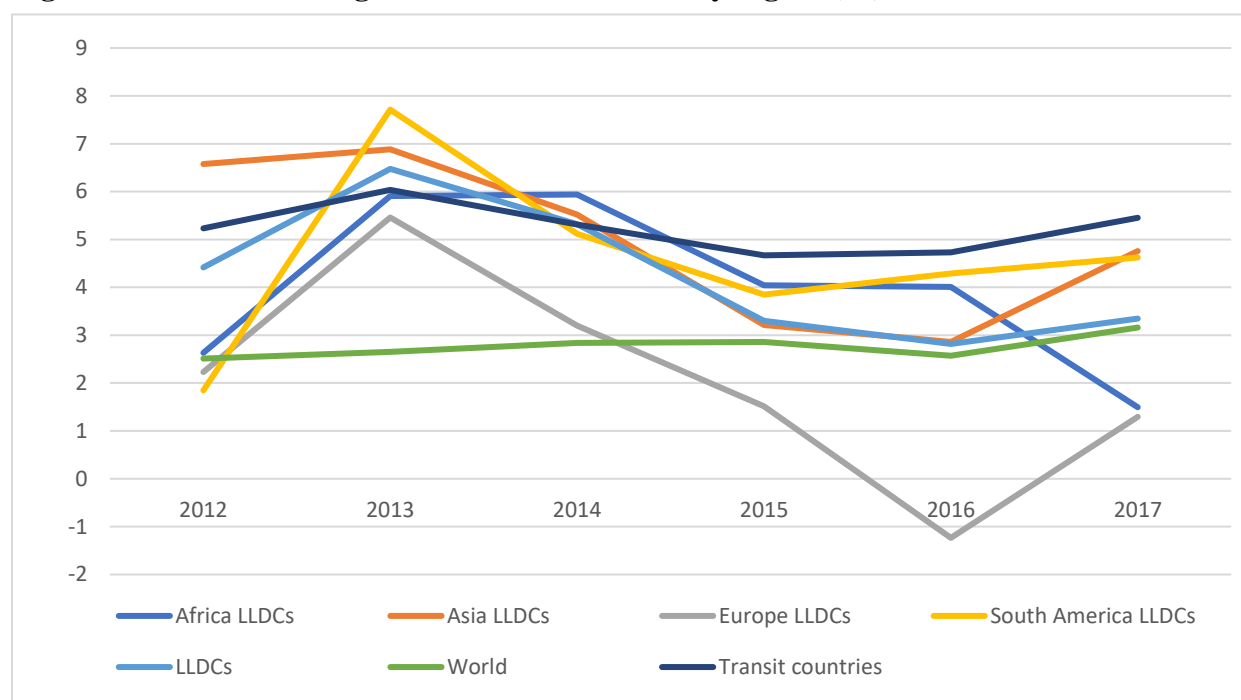
Table 3.1 presents the key economic performance indicators of LLDCs from 2012 to 2017. The trend in growth performance demonstrates that the growth declined shortly after the adoption of VPoA in 2014 and picked up again in 2017. The growth rate decline in 2015 is apparently due to the slump in commodity prices on the international market. It is noteworthy that the decline in growth rate from 2014 to 2016 is less pronounced among the transit countries. This is apparently a reflection of the challenge of landlockedness in LLDCs and the profound advantage of access to the sea by the transit countries. Figure 3.1 demonstrates that the average economic growth rate in most of the regional groupings declined from 2013 to 2016 and followed by some signs of recovery in 2017, except for African LLDCs. It is noteworthy that both total GDP and total population of LLDCs grew from 2014 to 2017, though gradually, and the growth in GDP could not significantly outpace the growth in total population. Thus, the average per capita GDP of LLDCs improved only marginally from US\$1,514 in 2014 when VPoA was adopted to US\$1,581 in 2017. The most dramatic decline in growth rate occurred in European LLDCs, falling from 5.46% in 2013 to -1.23% in 2016, before rising in 2017. Growth among the Asian LLDCs declined from average of 6.58 per cent in 2012 to less than 3.00 per cent in 2016 before an increase in 2017. The decline in African LLDCs continued between 2014 and 2017 from 5.94% to 1.49%. (See Annex C for basic economic performance data for LLDCs in 2012 and 2017).

Table 3.1: LLDCs' key economic performance indicators

Economic performance indicator	2012	2013	2014	2015	2016	2017
Total GDP in constant 2010 US\$ (billion)	615.74	655.10	689.94	714.40	735.74	769.15
GDP growth rate (annual %)	4.42	6.47	5.32	3.30	2.82	3.35
Average GDP per Capita in const. 2010 US\$	1,416	1,472	1,514	1,527	1,533	1,581
Share of manufactures in total merchandise exports (%)	15.63	15.23	16.72	20.26	24.17	21.92
Share of manufactures in total merchandise imports (%)	65.78	67.40	68.00	68.96	69.67	69.50
Manufacturing, value added (% of GDP)	9.60	9.58	9.56	9.76	10.00	10.11
Manufacturing, value added (annual % growth)	4.66	6.94	6.00	3.59	3.62	5.06
Agric., value added (% of GDP)	20.94	20.38	20.06	19.37	19.49	19.16
Agric., value added (annual % growth)	2.58	5.88	3.89	1.99	3.32	3.10
Services, value added (% of GDP)	44.85	45.39	45.89	47.82	47.52	47.30
Services, value added (annual % growth)	5.43	5.39	6.87	4.84	3.94	4.56
Industry, value added (% of GDP)	26.70	26.37	26.26	25.63	25.08	26.01
Industry, value added (annual % growth)	6.07	6.10	5.32	3.25	3.25	4.75
Population (million)	446.31	457.39	468.72	480.20	491.83	503.55

Source: World Bank, World Development Indicators

Figure 3.1: Annual GDP growth rates for LLDCs by region (%)

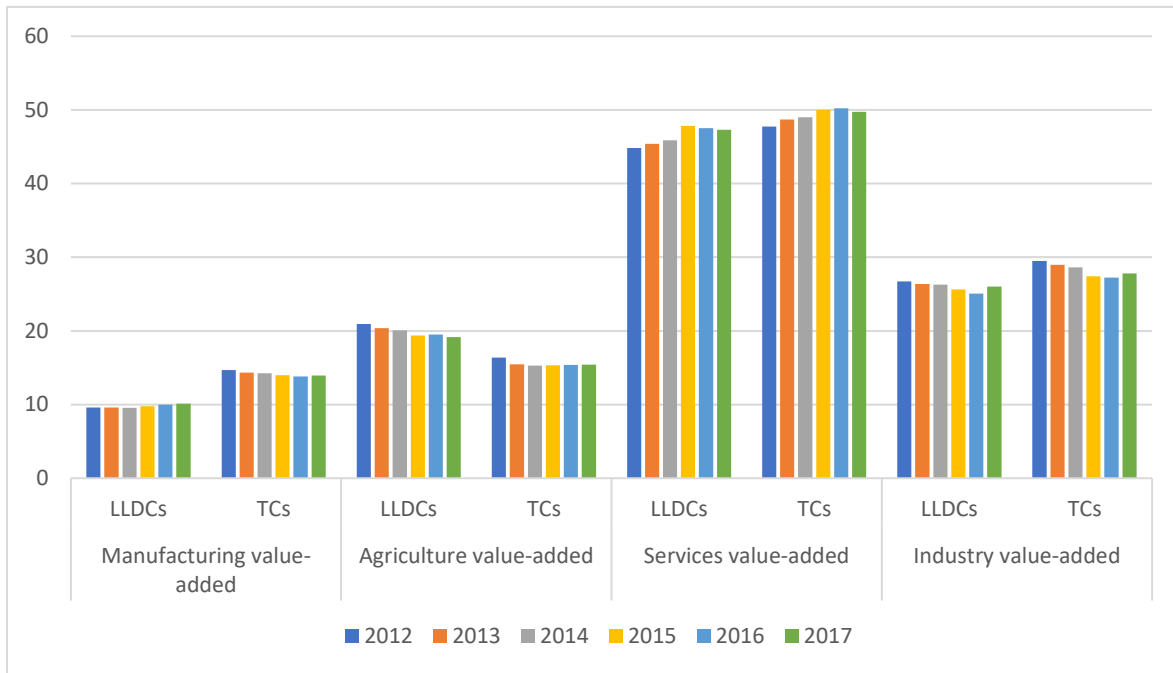


Source: World Bank, World Development Indicators

Figure 3.2 demonstrates that the structure of production has generally not experienced a remarkable change in LLDCs since the implementation of VPoA, nor in transit developing countries. The industry value added and manufacturing value added, as well as services value added are slightly higher in the transit countries, while agricultural value added is higher in the LLDCs. This is also a reflection of the fact that access to the sea promotes trade and consequently more access to intermediate manufacturing inputs and opportunities for manufacturing exports. By 2017, the share of agricultural value added have not improved over the 2014 levels, with slight improvement in manufacturing and industry value added. Table 3.1 also indicates that the growth rates of sectoral outputs in 2017 are below 2014 levels, though there are improvements in 2017 for industry and manufacturing share in LLDCs compared to 2016. These general trends based on average of 32 LLDCs may not aptly represent the performance of some of the LLDCs. For example, data on structure of production presented for all countries in Annex D indicate that a few LLDCs had made notable improvements in manufacturing value-added between 2014 and 2017.

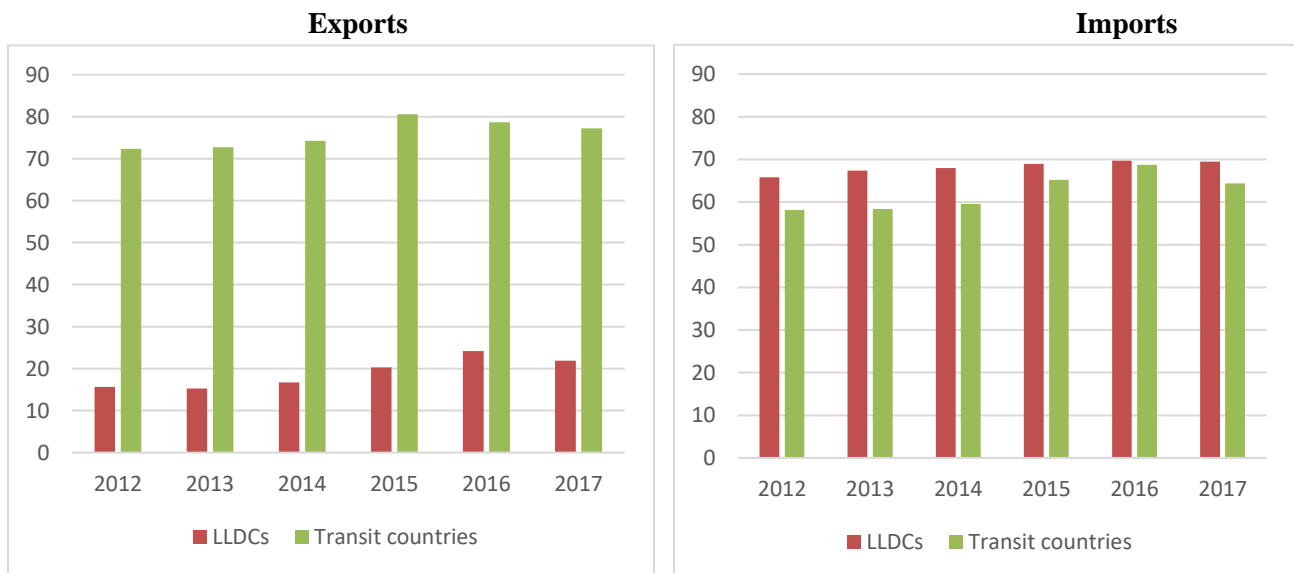
Figure 3.3 shows the shares of manufacturing in merchandise imports and exports increasing between 2013 and 2016, with decreases in 2017. The economies of the LLDCs remain heavily dependent on manufacturing imports, with almost 70% share, while only around 22% of LLDCs' exports were manufactured goods in 2017. In effect, the trends demonstrate that improvement in the share of manufacturing exports is powered by imported intermediate manufacturing inputs in the LLDCs. Compared to the transit developing countries, the share of manufacturing in exports is much lower in the LLDCs throughout the period. It is worth noting however that large portion of transit countries' manufactured exports can be attributed to China, India and Pakistan. The share of manufacturing imports in total merchandise imports is slightly higher in LLDCs compared to transit countries from 2012 to 2017.

Figure 3.2: Structure of production in LLDCs and transit developing countries, 2012-2017 (% of GDP)



Source: World Bank, World Development Indicators

Figure 3.3: Manufacturing share in merchandise exports and imports of LLDCs



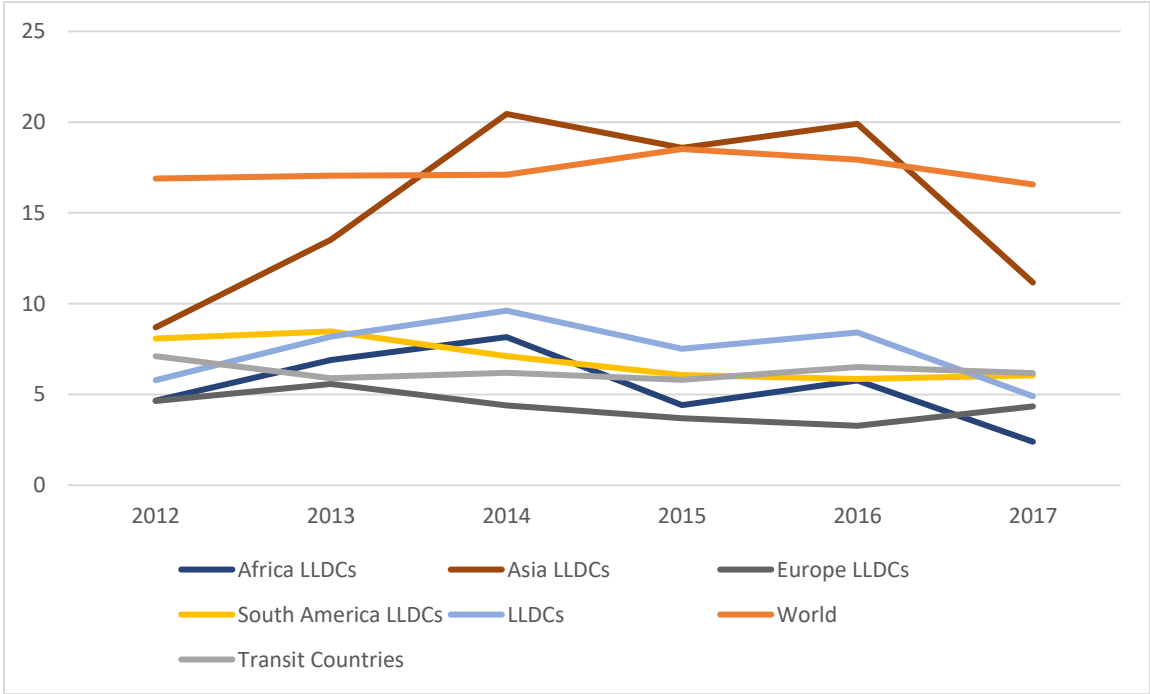
Source: World Bank, World Development Indicators

The LLDCs have been overly dependent on imports of manufactures while export of manufactures has remained relatively small because LLDCs lack capacity to effectively participate in global trade and manufacturing is mainly in consumer products (See Annex D). Two major components of the manufactured imports are: consumer goods and capital goods imports. The consumer goods imports, when disaggregated, show imports of basic manufacture that LLDCs could easily import-substitute. Three things explain the rise in share of manufactures in merchandise imports: the middle class with taste for imported commodities; trade liberalization; and the general lack of competitiveness of the LLDCs’ manufacturing sector. The manufactured exports are composed largely of refined minerals (e.g., diamonds, oil and gas), agro-food and textile consumer products and intermediate products which signify that manufacturing in LLDCs composes of mainly low technology activities.

Figure 3.4 shows the trend in high tech exports in manufacturing exports for regional groupings from 2012 to 2017. The share of high-tech exports in manufacturing exports is generally very low for LLDCs in Africa, Europe and South America. Asian LLDCs had low share of high-tech exports before 2014, but it compared favourably with world average from 2014 to 2016. This may suggest that the implementation of VPoA among Asian LLDCs are beginning to positively affect trade performance in goods with high technology content.

The country average for LLDCs is generally higher than the country average for the transit countries. This should not be misconstrued to imply a better performance of LLDCs in high tech exports because only a few LLDCs have relatively high share of high-tech exports while other LLDCs have relatively very low share. LLDCs with relatively high share of high-tech exports include Rwanda, Mongolia, Lao PDR, Mongolia, Kazakhstan and Kyrgyzstan.

Figure 3.4: High-technology exports (% of manufactured exports)



Note: Simple average
 Source: World Bank, World Development Indicators

According to the national reports on implementation of VPoA submitted to UN-OHRLLS in preparations for the high-level comprehensive midterm review on the implementation of the VPoA, several LLDCs are making efforts to diversify and transform their economies. For example, Nepal is currently implementing its 14th Periodic Plan and the strategies adopted by the Plan reflect the priority areas of the VPoA which includes structural economic change through the agricultural sector's transformation and expansion of tourism sector, industries and small and medium enterprises (SMEs).¹⁰ Other illustrative examples of efforts at diversifying the economies of LLDCs are highlighted in Box 3.1.

Box 3.1: Illustrative cases of LLDCs' efforts to diversify and transform their economy

1. **Uzbekistan** follows import-substitution industrialization focused initially on labour intensive industries with a gradual increase in their technology intensity. Also, Uzbekistan and other independent commonwealth states collaborated with ITU in organising a workshop on big data and cloud computing to enhanced the capacity of participants on the benefit these technologies bring to support e-commerce and global markets.
2. **Kazakhstan's** development targeting is currently aimed, among others, at transport services, energy efficiency and agriculture.
3. **Mongolia's** National Development Strategy 2030 targets agriculture, tourism, energy and industrial materials processing as priority sectors for economic development.
4. **Kyrgyzstan's** economic diversification includes developing textile industry.
5. **Lao PDR** saw the establishment of many new manufacturing firms in Lao PDR's special economic zones, with the cooperation of China.
6. **Ethiopia's** national development plan has the key objective of bringing about a structural change in the economy by broadening the industrial base, supporting small and medium-sized enterprises, increasing productivity and strengthening linkages among industries. Specifically, agricultural productivity was high for Ethiopia in 2018.
7. **Rwanda** implemented the evaluation of wireless broadband project in May 2018. ITU is now providing capacity building to establish online platforms to sell their local products.
8. **Botswana** is undertaking reforms to promote the development of services, industry, tourism and agriculture.
9. **Burundi:** Burundi promotes agriculture, formulated a vision 2025 and participates in regional collaboration on STI and economic integration. There are trade and trade facilitation policies, improvement in education, infrastructural and ICT development. Ease of doing business is also actively promoted.
10. **Uganda:** Uganda adopted a vision 2040 in 2013 which promotes agriculture, development of infrastructures such as energy, ICTs, transport routes, etc. Foreign trade and trade facilitation policies are implemented along with efforts at fostering regional cooperation and integration. Launching of the business process outsourcing incubation centre has been done, and improving education in order to build human capital for STI is being encouraged.
11. **North Macedonia:** Macedonia has adopted a national innovation strategy, 2012-2020 which includes a national programme for scientific research and development 2012-2016. The primary aim of the strategy is to promote a competitive economy. Creative subsidies and tax incentives, sustainable management of natural resources, reforming education, regional cooperation and integration, trade and trade facilitation policies, infrastructural

¹⁰A Report on the Status of Implementation of the Vienna Programme of Action in Nepal: Nepal's Mid-Term Review

development (in energy, ICT and transportation) are key features of efforts aimed at promoting the diversification of the Macedonian economy.

Source: UN-OHRLLS (2018c); Delgado, 2019

3.2. Agricultural Productivity

Most of the LLDCs are agricultural economies and structural transformation cannot take place without significant increase in agricultural productivity. For example, a recent report on Africa's economic transformation emphasized the critical importance of agriculture in powering African economic transformation (see ACET, 2017). Stiglitz (2017) also in a framework for learning-led growth, stated that agriculture which is the basis of employment in most developing countries, can be restructured in ways that are more dynamic, with more learning, learning to learn, in order to achieve a kind of *in situ* transformation of African economies. The trend in agricultural productivity is therefore an important indicator of the potential for structural economic transformation in agricultural economies.

Table 3.2 presents data on agricultural productivity as measured by agriculture value added per worker and cereal yield in LLDCs from 2012 to 2017. The performance of agricultural productivity does not show any remarkable improvement across the LLDCs since the adoption of VPoA in 2014. The agricultural productivity among African LLDCs is considerably lower than in other regions suggesting that African LLDCs would require relatively more learning on how to improve productivity as a means of transforming the agricultural sector and fostering structural economic transformation.

Table 3.2: Agricultural productivity in LLDCs

Region	2012		2013		2014		2015		2016		2017	
	Agric prod. (Kg per worker)	Cereal yield (Kg per hectare)	Agric prod. (Kg per worker)	Cereal yield (Kg per hectare)	Agric prod. (Kg per worker)	Cereal yield (Kg per hectare)	Agric prod. (Kg per worker)	Cereal yield (Kg per hectare)	Agric prod. (Kg per worker)	Cereal yield (Kg per hectare)	Agric prod. (Kg per worker)	Cereal yield (Kg per hectare)
African LLDCs*	908.21	1353.61	915.07	1314.97	943.16	1352.13	946.16	1332.21	961.42	1277.03	1019.69	..
Asian LLDCs*	1547.60	2539.00	1746.77	2644.01	1934.21	2671.33	2080.79	2684.55	2187.38	2739.28	2207.25	..
Europe LLDCs*	3711.24	2617.38	3850.21	2999.48	3902.46	3146.83	3772.26	2909.38	4040.26	3284.08	4389.48	..
South American LLDCs*	2540.85	2574.45	3617.64	2700.55	3801.80	2617.4	4243.20	3214.65	4042.22	3258.95	4273.72	..
LLDCs*	1509.21	1958.32	1663.20	2027.46	1754.01	2067.79	1818.03	2069.21	1872.86	2108.73	1906.20	..
Low income countries	568.21	1475.45	564.42	1439.40	574.99	1516.57	574.15	1565.63	570.89	1518.84	..	..

* Simple averages

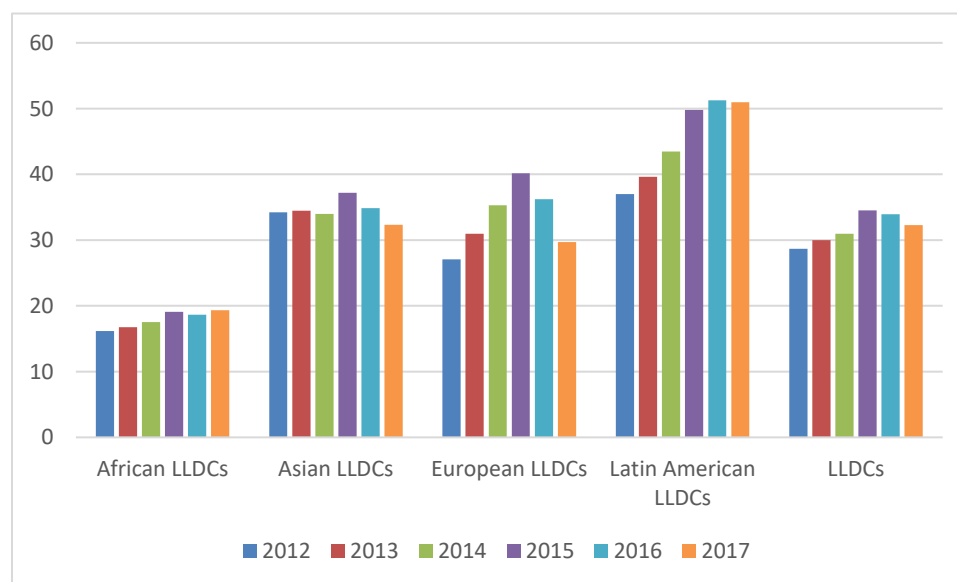
Source: World Bank, World Development Indicators

3.3. Role of Private Sector in Structural Economic Transformation

The role of the private sector is very important in creating the economic dynamism that serves as catalyst for the process of structural economic transformation. The private sector specifically contributes to economic growth and poverty eradication through the building of productive capacity, creation of decent jobs, promotion of innovation, economic diversification and competition (Popov, 2018; Tadjoeeddin, 2019). The private sector accordingly plays a pivotal role in the pathways toward the achievement of the SDGs and the VPoA in LLDCs. The private sector is a major stakeholder in the WTO Trade Facilitation Agreement (TFA); and in LLDCs, the private sector is actively involved in activities related to transit and trade facilitation, including as traders, freight forwarders, insurance providers and transporters. The sector is also a source of tax revenue and domestic investment, and partners with government in attracting FDI (Popov, 2018).

A key policy variable impacting on the expansion of the private sector is the relative size of domestic credit allocated to the private sector as a percentage of GDP. As shown in Figure 3.5, the value of domestic credit to private sector has risen in the LLDCs from 28.7% in 2012 to a high of 23.4% in 2015 before falling slightly to 32.3%. This lags greatly behind the global average of 130%. Domestic credit to the private sector in African LLDCs recorded slight increase between 2012 and 2017, from 16.2% to 19.3%. Asian LLDCs have not recorded a significant change. The highest increase has been recorded among the South American LLDCs. The value in European LLDCs has increased rapidly up to 2015 before falling. It is noteworthy that despite the situation in African LLDCs, the case of Botswana and Burkina Faso is encouraging as they have the highest value among African LLDCs. Relatively high expansions of domestic credit to private sector are also recorded in Nepal, Mongolia, Armenia, North Macedonia, Bolivia and Paraguay. According to Tadjoeeddin (2019), the relatively large increase in domestic credit (reaching almost 80% in 2017) in Nepal is truly exceptional and indicative of the Nepali private sector dynamism, while that of Mongolia was probably related to resource boom.

Figure 3.5: Domestic credit to private sector in LLDCs (% of GDP)



Source: World Bank, World Development Indicators

Given the private sector's role being central in achieving productivity-led growth, LLDCs should strive to create an enabling environment to support its development, through relevant taxation and tariff policies, capacity building, technology transfer and innovative measures like the creation of industrial clusters, Export Processing Zones (EPZ) or regional centres for excellence. They should especially target Small and Medium-sized Enterprises (SMEs) being regarded as the main job creators in LLDCs, and Public-Private Partnerships (PPP) as an innovative source of financing.

3.4. Sustainable Economic Transformation

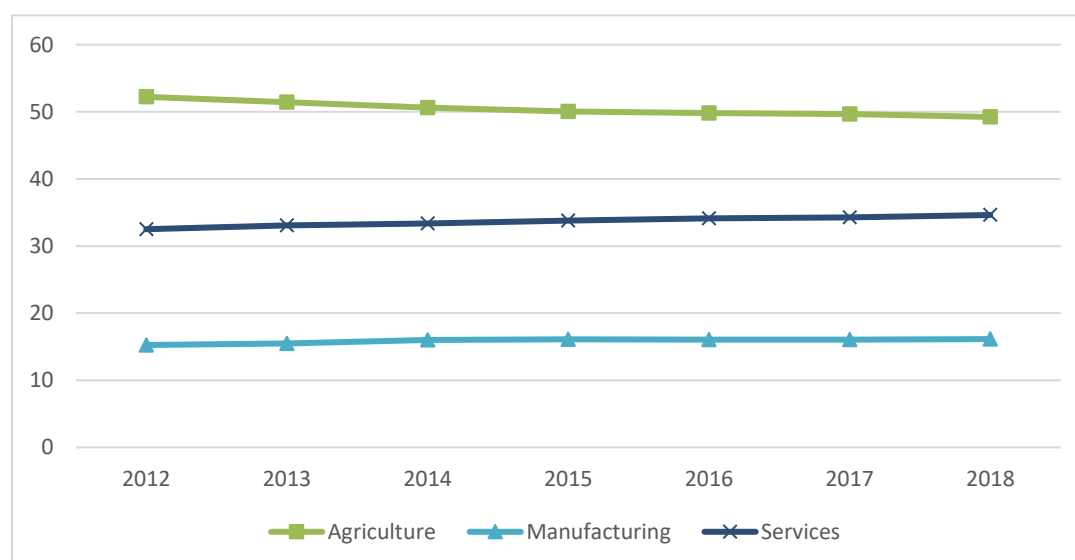
Economic structural change would engender sustainable economic transformation when structural change is accompanied by shared prosperity with distinctive features of improved human welfare and protection of the environment. However, structural economic transformation has been commonly understood as a process of shifting proportion of output and the distribution of employment from low- to high-value-added economic activities (ESCAP, 2015). Structural transformation is operationally measured as the shift of output and employment from agricultural to manufacturing, and subsequently to the services. That is, during the process of structural transformation, the share of agriculture declines while the share of manufacturing increases. Then as the economy continues to progress toward maturity and advancement, the share of manufacturing should decline as in agriculture and the share of modern and high productivity services continues to rise. Rowthorn and Wells (1987) described this process of advanced structural transformation as a positive de-industrialisation experienced by most of developed countries. Making a distinction between positive and negative de-industrialisation, Rowthorn and Wells (1987) regarded positive de-industrialisation as "... the normal result of sustained economic growth in a fully employed, and already highly developed economy. It occurs because productivity growth in the manufacturing sector is so rapid that despite increasing output, employment in this sector is reduced, either absolutely or as a share of total employment. However, this does not lead to unemployment, because new jobs are created in the service sector on a scale sufficient to absorb any workers displaced from manufacturing. Paradoxically, this kind of de-industrialisation manifests as economic success." (Rowthorn and Wells 1987, p.5). In contrast, negative de-industrialisation is "a product of economic failure and occurs when industry is in severe difficulties ... labour shed from the manufacturing sector - because of falling output or rising productivity - will not be reabsorbed into the service sector. Unemployment will therefore rise." (Rowthorn and Wells 1987, p.5).

For economic transformation to be real, employment should improve in absolute terms and poverty reduction should be evident. Economic transformation is however not a static occurrence but must be sustained especially in an age where technological innovation continues to effect creative destruction in industrial processes and evolution of products. As demonstrated in the previous section (Section 3.1-3.3), there is no evidence of a remarkable economic structural change across the LLDCs since the adoption of VPoA, nor in transit developing countries. What exist is a few country level economic performances that suggest mild economic structural change and transformation.

Figure 3.6 shows the trend of the sectoral distribution of employment in LLDCs from 2012 to 2018. The trend demonstrates that there has been only a slight change in employment distribution since 2014. Poverty headcount ratio in LLDCs (measured as percentage of population living on

less than US\$1.90 per day) has fallen slightly from 32% in 2012 to 30.2% in 2015, according to available estimates. The world poverty headcount ratio was 9.9% in 2015. Table 3.3. shows the rural and urban poverty headcount ratios for available LLDCs. These findings on employment distribution and poverty incidence suggest that though no firm deduction can be made on the implementation of VPoA significantly affecting structural economic transformation, slight poverty reduction has occurred since 2012 but without obvious changes in employment distribution. Sustainable economic transformation is otherwise accompanied by poverty reduction and employment deepening that follow the pathway leading to positive de-industrialization.

Figure 3.6: Trend in sectoral distribution of employment in LLDCs (% of total employment), 2012 - 2018



Source: World Bank, World Development Indicators

Table 3.3: Poverty headcount ratio at national poverty lines (urban and rural)

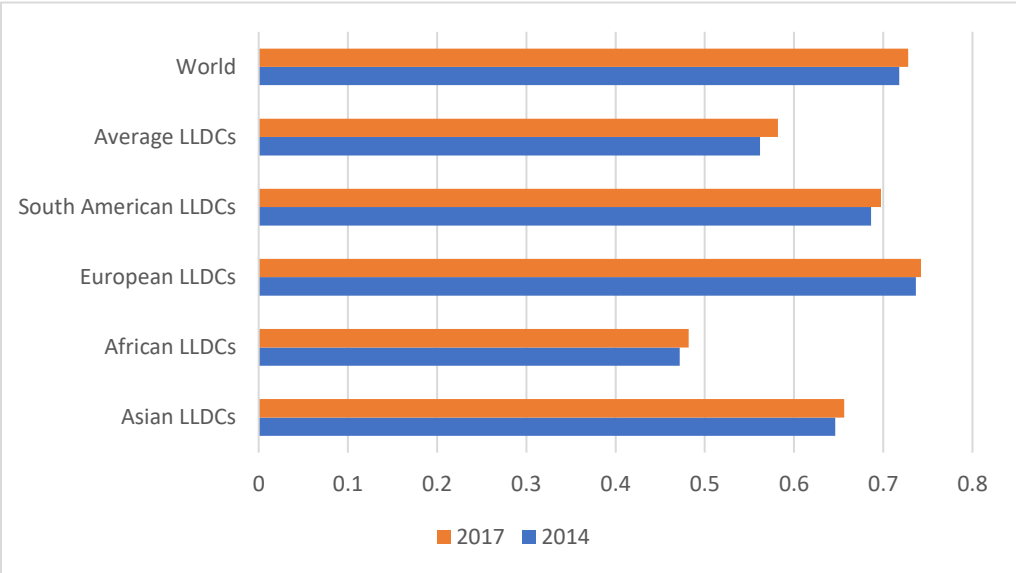
	Rural poverty headcount ratio at national poverty lines (% of rural population)				Urban poverty headcount ratio at national poverty lines (% of urban population)			
	2012	2013	2014	2015	2012	2013	2014	2015
Armenia	32.1	31.7	29.9	..	32.5	32.2	30	..
Bhutan	16.7	..	..	..	1.8	..	..	..
Bolivia	61.2	59.9	57.6	..	34.7	29	30.6	..
Burkina Faso	..	..	47.5	..	..	..	13.7	..
Burundi	..	..	68.8	..	..	..	27.6	..
Kazakhstan	6.1	4.9	4.7	4.4	1.9	1.3	1.3	1.3
Kyrgyz Republic	39.6	41.4	32.6	33.6	35.4	28.5	26.9	29.3
Lao PDR	28.6	..	..	..	10	..	..	..
Moldova	22.8	18.8	..	..	8.2	..	..	..

Mongolia	35.4	..	26.4	..	23.3	..	18.8	..
Tajikistan	..	37.4	36.1	35.2	..	27.8	23.5	23.2
Uganda	22.4	..	..	..	9.6	..	..	..

Source: World Bank, World Development Indicators

Furthermore, human development index (HDI) for the LLDCs generally increased across countries from 2014 to 2017. This is consistent with increase in HDI in other regional groupings and the world HDI which increased from 0.718 in 2014 to 0.728 in 2017. Figure 3.7 shows the HDI regional averages for LLDCs in 2014 and 2017. Since the positive change is similar to occurrence in the world, it is difficult to ascribe the change to VPoA implementation but rather to the fact that the world is making gradual improvement in the achievement of inclusive and sustainable development.

Figure 3.7: Human development index for LLDCs, 2014 and 2017



Source: World Bank, World Development Indicators

4. ROLE OF STI IN ECONOMIC TRANSFORMATION AND ACHIEVEMENT OF 2030 AGENDA

The section focuses on the links between Science, Technology and Innovation (STI) and the Structural Transformation of the economy of Landlocked Developing Countries (LLDCs) in progress towards achieving the 2030 Agenda for Sustainable Development.

4.1. Science, Technology and Innovation, Society and the Economy

Science and technology are global public goods, but innovation is localized and therefore understanding the context for replication and diffusion is essential. With the emergent of the fourth industrial revolution, lessons learnt from the first three about the speed and range of societal impact of STI should help optimize the economic transformational outcomes of new technologies. STI investments have accordingly become more critical than ever before in facilitating macroeconomic stability and expansion as well as profits and market shares of the firms at micro level. In addition, social development occurs if a society can make STI advances and mainstream them for use in the social and cultural spheres. On one hand, technological progress enhances wealth creation by increasing income levels, while on the other hand, it causes social and environmental challenges that threaten the ability of future generations to sustain human wellbeing. For the advanced industrial economies of the OECD, technology has produced enormous wealth at the expense of the environment and global social welfare considerations. The 2030 Agenda strives to reverse the external diseconomies of global industrial establishments and introduce social considerations of equity and inclusiveness as well as environmental considerations in economic development.

4.2. Science, Technology and Innovation in SDGs

Science, technology and innovation (STI) have been recognised as the main drivers of productivity increases and major determinants of long-term economic growth and prosperity. In contrast to MDGs, STI features as a crosscutting issue and strategic input into the process of implementing SDGs. In this respect, STI appears strongly both in Goal 17 on Means of Implementation, as well as a cross-cutting input for achieving several sectoral Goals and Targets, most prominent of which is Goal 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. The Addis Ababa Action Agenda (AAAA), which is an integral part of the 2030 Agenda, has also identified concrete policies and actions - including STI – as supportive for meeting the SDGs. Furthermore, the negotiations for the UNFCCC COP in December 2015 addressed STI issues, most notably underlining that cooperative action is key to facilitate and promote technology, and the proposition of a framework for enhanced action on technology development and transfer.

In particular, the AAAA recognises that “the creation, development and diffusion of new innovations and technologies and associated know-how, including the transfer of technology on mutually agreed terms, are powerful drivers of economic growth and sustainable development”. It underscores that STI strategies must be integral elements of national sustainable development strategies to help to strengthen knowledge-sharing and collaboration and contains an entire chapter on STI, underlining:

- the need to craft policies that incentivise the creation of new technologies, that foster research and that support innovation in developing countries;
- the importance of an enabling environment at all levels, including enabling regulatory and governance frameworks, in nurturing science, innovation, the dissemination of technologies, particularly to micro, small and medium-sized enterprises, as well as industrial diversification and value added to commodities;
- a commitment to promote social innovation to support social well-being and sustainable livelihoods;
- knowledge-sharing and the promotion of cooperation and partnerships between stakeholders, including between governments, firms, academia and civil society, in sectors contributing to the achievement of the SDGs; the important role of public finance and policies in research and technological development, as well as the use of public funding to enable critical projects to remain in the public domain, and open access to research for publicly funded projects;
- the need to step up international cooperation and collaboration in science, research, technology and innovation, including through public-private and multi-stakeholder partnerships, and on the basis of common interest and mutual benefit, focusing on the needs of developing countries and the achievement of the SDGs;
- areas for special attention, such as research and development of vaccines and medicines, preventive measures and treatments for the communicable and non-communicable diseases, food security, agricultural productive capacity in developing countries, marine technology in order to improve ocean health.

As earlier stated in section 2 of this paper, the 2030 Agenda also launched a Technology Facilitation Mechanism (TFM) in support of the implementation of SDGs. It is important that the Mechanism serves all countries to improve development cooperation and capacity building in STI for Sustainable Development. Research and innovation must be demand-driven, responsive to the needs of society, and based on multi-stakeholder participation in the design, development and delivery of solutions. Stakeholders include actors or partners from governments, private sector, civil society, research community and relevant international partners (especially the UN bodies) brought together by the TFM.

Major issues in the successful implementation of the 2030 Agenda for Sustainable Development and its 17 Goals are the goals' consistency (or otherwise) with other political processes (e.g., UNFCCC), implementability (e.g., interactions between goals), and measurability (e.g., indicators). Science, technology and innovation can contribute to all these aspects by providing the fundamental knowledge base necessary for decision-making and practical implementation of the goals. While SDGs provide a coordinating and synthesising framework for public (and private) sector decision-making, science can play a pivotal role, for example in representing sustainability challenges in different contexts (data, analysis and scenario building), creating models that explore how different targets interact, and tracking progress towards goals (Dasgupta *et al.*, 2014; Yonglong *et al.*, 2015; Nilsson *et al.*, 2016). Besides, in many cases there may be a need to prioritise SDGs from a local and regional perspective in the areas where they are going to be implemented. Due to complex dependencies between goals, conflicting issues may lead to tough choices. In such cases, decision-makers could benefit from one of science's biggest strengths: holistic systems thinking. In the context of SDGs, systems thinking is essential for identifying knowledge gaps,

initiating solutions-oriented research as well as developing integrated assessments with the participation of multiple stakeholders. It is therefore vital to pursue an integrated approach using datasets from the natural sciences as well as the social and behavioural sciences (Nilsson *et al*, 2016).

4.3. Features of STI Policies in LLDCs

Building technological capability is very crucial for structural economic transformation and STI policies are employed to create the environment that is germane for technological capability. The interplay of free market mechanism alone may not support technological development and effective technology transfer that are necessary for innovation. Policy intervention is therefore necessary to ensure that the economy takes advantage of technological opportunities that promote structural economic transformation. The constraints of landlockedness introduce additional rationale for policy interventions for promoting STI in LLDCs.

4.3.1 Regulatory environment and STI policies

Since the adoption of VPoA and the 2030 Agenda, many countries (including LLDCs) have sought for appropriate STI policies and regulatory frameworks that meet their needs and structurally transform their economies. Government policy is crucial in providing the enabling environment for the application of STI measures for economic development. Regulatory environment and policies provide incentives for public and private actors that are investing in STI. It lays the principles, rules, laws, institutions and conditions that support the operation of key actors in the environment. The existence of functional rules, institutions and sound infrastructure in a country provides the basic foundation for the development of STI.

Government policies alone may be necessary but not sufficient for structural transformation of the economy. Political will, good governance and an effective judicial system, enhance government commitment on STI and economic development. Though the private sector is the major focus of government regulation and policies, the private sector complements the role of the government in transformation processes. In this case, the role of the government and the private sector on STI development has to be clearly defined and the government must be committed. The role of the development partners has to be clearly defined also. The governments of Botswana, Kazakhstan, and Armenia recorded high GDP growth rates because of economic reforms implemented and strong government regulations that positively affected investments in STI with support from the organized private sector. (UNESCO, 2018).

Table 4.1 shows the status of STI policies in LLDCs. Only 11 of the 32 LLDCs have a policy document specially dedicated for the promotion of investments in STI. Eighteen LLDCs have STI policies embedded in broader development plan or economic policy frameworks. The effectiveness of the regulatory environment for STI policies depends on rules and regulation, strength of institutions, and level of infrastructural development. The existence of modern transparent institutions, functional infrastructural and good judicial system foster innovative competition and the development of STI in the economy.¹¹

¹¹ See <https://climatestrategies.org/wp-content/uploads/2012/09/policy-brief---innovation-systems-in-developing-countries.pdf> (ACCESSED 22 March 2019)

It is also important to note that governance of STI and STI policies have been influenced in recent years by environmental considerations in some regions or countries. This raises expectations on science and technological solutions to environmental challenges through discovery of alternative sources of energy, geo-political events that reshaped science, and the quest for green growth strategies. New technologies are increasingly focused on environmental soundness in design and performance.

Given the imperative of sustainable development, the available STI policies in LLDCs indicate the emergence of the following features:

- Information and data sharing: the interconnectivity of the world, knowledge sharing, data use and reuse, and sharing of country experiences have resulted in a new approach to STI development. New policies on STI are now shaping old fashioned models of learning and teaching in LLDCs.
- Increasing collaborative science among LLDCs: researchers can now share data and results on online platforms so that further collaborative scientific research could be done using the data and results anywhere in the world. Also, regional governments are also collaborating on STI policies with transit countries and development partners to promote evidence- based growth.
- Shift from basic research towards big science of solving problems: the focus of STI policy is to promote relevance and usefulness of STI. Policy is now shifting from basic or adventurous research to solving pressing developmental needs to achieve sustainable development goals for LLDCs.
- Citizen engagement and participation: STI can only be inclusive when all parties or stakeholders (i.e. government, academia, private sector and the general public) are duly involved. STI policies in LLDCs are becoming all-encompassing and participatory.

Table 4.1: Status of national STI policies in LLDCs

Country	Policy Available	Year Adopted	Title of Policy
Afghanistan	MBP	2014	Afghanistan National Medicine Policy 2014-2019
Armenia	MBP	2010	Science and Technology Development Priorities 2010- 2014
Azerbaijan	MBP	2009	National Strategy for Development of Science in the Republic of Azerbaijan 2009-2018
Bhutan	MBP	2013	Eleventh National Five-Year Plan 2013-2018
Bolivia	No	-	-
Botswana	Yes	2011	National Policy on Research, Science, Technology and Innovation 2011
Burkina Faso	Yes	2012	National Policy for Scientific and Technical Research 2012 National Innovation Strategy 2014
Burundi	Yes	2011	National Policy on Science, Research and Technical Innovation 2011
Central African Republic	No	-	-
Chad	MBP	2018	Draft Chad Country Strategic Plan 2019-2023

Eswatini	Yes	2011	National Science, Technology and Innovation Policy 2011
Ethiopia	Yes	2010	National Science, Technology and Innovation Policy 2010
Kazakhstan	MBP	2007	National Programme for Scientific Development 2007-2012
Kyrgyzstan	MBP	2012	National Strategy for Sustainable Development 2013-2017
Lao PDR	MBP	2017	Lao's Country Strategic Plan 2017-2021
Lesotho	Yes	2006	National Science and Technology Policy 2006-2011
Malawi	Yes	2011	Strategic Plan for Science, Technology and Innovation 2011-2015
Mali	MBP	2015	Mali Country Programme Document, 2015 – 2019
Moldova	MBP	2013	Innovation Strategy for Competitiveness 2013-2020
Mongolia	MBP	2015	Moldova's National Action Plan 2016-2018
Nepal	MBP	2013	Nepal's Thirteenth National Plan 2014-2016
Niger	Yes	2013	National Policy on Science, Technology and Innovation 2013
Paraguay	MBP	2010	Technological Development and Innovation for Health 2010
Rwanda	Yes	2006	The Republic of Rwanda Policy on Science, Technology and Innovation, October 2006
South Sudan	MBP	2007	National Strategic Plan 2007-2031
Tajikistan	MBP	2012	National Strategy of Education Development in the Republic of Tajikistan 2012-2020
North Macedonia	MBP	2017	National Strategy for Scientific R&D Activities 2017 – 2020
Turkmenistan	No	-	-
Uganda	Yes	2009	National Science, Technology and Innovation Policy 2009
Uzbekistan	MBP	2012	Eight National Priorities for R&D 2012-2020
Zambia	MBP	2017	Seventh national development plan 2017-2021
Zimbabwe	Yes	2012	The Second National Science and Technology Policy 2012

Note: MBP = Mentioned in Broader Plan

Source: Government reports online

4.3.2 International dimensions of STI policy

The STI policy has international dimensions and implications since countries are interconnected through trade, transport and ICT infrastructure. International organizations like the United Nations, World Bank, IMF, International Finance Corporation (IFC), International Labour Organization (ILO), World Trade Organizations (WTO), etc. have championed the application of STI policies in the global space. However, the rules and standards set by these international institutions seems to affect the capacities of LLDCs to use STI policies effectively in their countries. Given the limited resources available in LLDCs for development, LLDCs could strategically partner with other countries especially development partners to fast-track policies that will achieve regional and national development. According to Giovannini, et al (2015), 'the global partnership may be in the form of alliance between countries, governments, businesses, non-governmental organizations, multilateral organizations and civil society with the aim of creating a shared value for all stakeholders.' Partnership in international STI policy in LLDCs requires massive investments in the area of trade and trade facilitation, economic integration and cooperation, STI collaboration and development, FDI, migration, remittances, development aid and industrialization. With respect to the LLDCs, international STI policies should therefore focus on:

- Strengthening of institutions for STI in LLDCs;
- Supporting research and development (R&D) in LLDCs;
- Building STI infrastructure for trade facilitation in LLDCs; and

- Advising LLDCs governments on STI policies.

Since economic transformation is a learning process that involves the creation of new knowledge in productive activities, governments play crucial role in facilitating the generation, use and diffusion of knowledge in the economies. Infrastructural standards should be set and achieved at the international level to enable the private sector function effectively in the learning processes that generate new knowledge and technological innovation.

4.3.3 Sectoral policies and their impacts

Sectoral policies relate to the rules that guide the nature and structure of innovation system and production across sectors. Sectoral system of innovation and production in LLDCs is often associated with manufacturing subsectors (automobiles, electronics, steel, and crude oil refining, etc.) and the transformation of the primary sectors (agriculture and mining). The link between innovation and production in LLDCs appears to be very weak because of the very low contribution of manufacturing to GDP as discussed in section 3 of this paper. The contribution of services sector as a percentage of the GDP is higher than other sectoral contributions to GDP in LLDCs.¹² This suggests that LLDCs cannot achieve real sustainable economic development because the links between key actors and institutions, private firms, and other stakeholders are not strong. Firms' operations or activities in a sector are similar sometimes but also heterogeneous in terms of interaction, learning processes and capabilities among agents. Therefore, sectoral policies should reduce the discrepancies between sectors and access to innovation system. A clear understanding of the peculiarities of sectoral systems is therefore necessary for identifying the sources of innovation and development in LLDCs in specific sectors.

According to UNCTAD (2018), 'the experiences of successful developing countries shows that STI policies that are well integrated into national development strategies and combined with institutional and organizational changes (sectoral innovation system) can help raise productivity, improve firm competitiveness, support faster growth and create jobs.'¹³ Sectoral policies usually include mapping of innovation systems along with in depth studies of specific sectors or issues relating to STI that are particularly important for economic development. For instance, the need to identify, acquire and adapt foreign technologies in LLDCs may require sectoral innovation policies. Policy issues may start by getting trade and finances right and then address specific sectors like industry, agriculture, mining, etc. The Malawi growth and development strategy II for example, identified five priority areas that include, agriculture, water sanitation and climate change management; education and skills development; transport and ICT infrastructures, energy, industry; and tourism development; and health and population. In implementing the plan, Malawi faces a number of challenges arising from inadequate resources, limited knowledge, lack of baseline information, poor data, poor infrastructures, and lack of skilled workers which constrained the achievement of the plan. However, Malawi recorded marginal GDP growth of 2.3 percent, 4.0 percent and 3.4 percent in 2016, 2017 and 2018 respectively.¹⁴ Sectoral policies that take into

¹² See Annex D for the statistics on structure of production in LLDCs in 2017.

¹³Science, Technology and Innovation for Development, https://unctad.org/en/Pages/DTL/STI_and_ICTs/STI4D.aspx (ACCESSED, 22 March 2019.)

¹⁴See Government of Malawi, (2018), 'Malawi Report as Part of the Comprehensive High-Level Mid-Term Review of the Vienna Programme of Action for the Decade 2014-2024'

consideration relevant technological opportunities for addressing sectoral challenges could have been helpful to improve Malawi's performance.

4.4. Overview of Industrial Policies and Industrialization in LLDCs

Industrial policy is an instrument of economic and technological catch-up and structural transformation that has been employed by many advanced and newly industrializing economies to achieve the integration of their economies into global trade and production networks. According to Oqubay (2015), industrial policy often includes a range of implicit or explicit policy instruments selectively focused on specific industrial sectors for the purpose of structural change in line with a broader national vision and strategy.

There continues to be convincing evidence that manufacturing is critical to structural change and sustained economic growth. This is because of the value adding capacity of manufacturing and the attendant learning by doing, technological development, and productivity gains, together with the strong links between manufacturing and other sectors. Manufacturing also has powerful direct and, perhaps even more important, indirect employment effects (Kaldor 1967; Thirlwall 2013). Industrialization of LLDCs thus requires a set of industrial policies that can effectively address the challenge of landlockedness, improve productive capacities and manufacturing competitiveness, and foster the integration of LLDCs into global trade. The following is an overview of industrial policies in LLDCs with illustrative country cases. The selection of the country cases is largely dependent on availability of data/information on industrial policies and performance in LLDCs.

The case of North Macedonia

The share of manufacturing in Macedonia GDP is 12% and the manufacturing sector depends largely on the export market because of the relatively small domestic market. Industrial policy in Macedonia is thus export oriented and is driven by Macedonia's aspiration to join the European Union, which requires that member countries attain 20% manufacturing contribution to GDP by 2020. In December 2017, the Government of Macedonia adopted an Economic Growth Plan (EGP) containing specific designed measures for supporting industrial firms. The EGP contains measures within three pillars, two of which focused on Financial Support of Investments, while the third supports a Medium-Term Programme for Financial Support of Micro, Small and Medium Enterprises 2018-2020, Innovation and Technological Development. Macedonia has a new Industrial Strategy for the period 2018-2027, adopted by the Government in November 2018. The industrial strategy integrates the measures of the EGP and a set of new measures for creating industry based on green, innovative, circular and smart growth. The new strategy has 38 measures divided into five strategic goals aimed at reinforcing the manufacturing foundation, raising productivity, innovation and technology transfer, catalyzing green industry and green manufacturing, stimulating manufacturing export and building a learning manufacturing sector. (Republic of Macedonia, 2018).

The case of Bolivia

Although industrial policy in Bolivia targets several industries which play a significant role in the economy, manufacturing which accounts for approximately 15% of Bolivia's GDP in 2018, is a major focus of the industrial policy. Most manufacturing in Bolivia is small-scale, and the largest segment within the manufacturing industry is food processing, accounting for 39% of the

industry.¹⁵ Bolivia's informal sector is the largest in South America, and industrial policy seeks to encourage formalization of firms in order to improve productivity and value addition.¹⁶

The case of Rwanda

Improving the business environment, focusing on the ease of doing business, has been a key objective for Rwanda over recent years (Ndagijimana, 2018). It is now ranked second in Africa, after Mauritius, on the overall Ease of Doing Business indicators compiled by the World Bank.¹⁷ There are a number of important areas where Rwanda performs very strongly. For instance, it is a strong performer in terms of procedures for starting a business. Similarly, Rwanda is ranked second in the world for registering property, a very important point for all types of commercial activity, whether involving local or foreign investor. It also has a very high rank in terms of getting credit, sixth globally. By contrast, Rwanda ranks 112th in the world in terms of dealing with construction permits, an area where procedures could be streamlined and time and cost reduced. The electricity supply is a well-known constraint on industrial development in Rwanda, and generation and transmission capacity will need to be sharply upgraded as part of an overall approach to industrial policy. Currently, Rwanda ranks 119th globally on the electricity indicator in Doing Business, primarily due to the length of time required to obtain a connection and its corresponding cost. Trading across borders is also a constraint, with Rwanda ranking 87th. Another area that may need attention is the time and cost of enforcing contracts, where Rwanda currently ranks 85th globally.

As a small economy of 12 million people, Rwanda cannot feasibly use its domestic market to support the development of economies of scale required for sustained productivity upgrading in the industrial sector. Rwanda's trade flows are difficult to predict because they often depend on the fate of a very small number of firms, and relatively micro-level determinants and transactions. It is therefore advisable that Rwanda's industrial policy concentrates on sectors where the pattern of trade and of comparative advantage is durable. Specific examples include mining; primary agriculture (fruits, nuts beverages, and spices; animal farming) and forestry; textiles and leather; processed foods (dairy products, starches, grain milling, meat products, oils and fats, liquors, processed fruits and vegetables, alcohol, and fish products); light manufacturing (plastics, jewellery, metal goods, electronics, machinery, instruments, bicycles, and wood products); and some heavy manufacturing sectors (pesticides, fertilizers, and cement).

The case of Zambia

Zambia is undoubtedly one of the resource rich countries in the world with significant mineral endowments of great economic importance. According to current rankings, Zambia is the second largest producer of copper in Africa, after Congo DR, and eighth in the world. Its annual production has, in the recent past, averaged around 750,000 metric tonnes, and it is expected that copper production will achieve one million tonnes per annum in the near future. In addition, the country has numerous other mineral resources, which include cobalt, manganese, precious and semi-precious stones.

¹⁵ See <https://www.worldatlas.com/articles/which-are-the-biggest-industries-in-bolivia.html> (ACCESSED, 26 June 2019)

¹⁶ See <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/LACEXT/EXTLACREGTOPECOPOPOL/0..contentMDK:21783867~pagePK:34004173~piPK:34003707~theSitePK:832499.00.html> (ACCESSED, 26 June 2019)

¹⁷See Annex A on ease of Doing Business Rankings in 2018.

In the recent past, Zambia's developmental agenda took a long-term view with a drive towards economic diversification in a Vision 2030 development agenda for Zambia launched in 2006. The Vision 2030 document has formed the basis for developing five-year national development plans since 2006. The aim of Vision 2030 is to build a strong industrial and dynamic middle-income nation, with competitive, self-sustaining economy which is resilient to external shocks. The vision 2030 is anchored on four strategic objectives: to diversify and make the economic growth inclusive; enforce environmentally and socially sustainable development principles; improve competitiveness and innovation; and strengthen governance mechanisms and institutional capacities for sustainable development (Republic of Zambia, 2006).

Local content development in the mining supply chain is promoted as a tool for industrialisation especially in Zambia's key economy sector, copper mining. The main objective of local content policy is to ensure meaningful participation and development of local capabilities along the copper value chain. The main pathways commonly used to pursue local content objectives may be summarised under three key areas: Supply Chain, Capital, and Employment. Participation of local financial institution and the capital market is critical to the issue of local content in the extractive industry, so are issues relating to employment, ownership and decision making in the running of companies in the mining value chain.

The case of Ethiopia

The Ethiopian government has been keen on drawing inspiration and gaining practical experience on industrial policy from successful East Asian economies. Industrial policy dialogue supported by the Japanese government and scholars has been in place since July 2008. Later developments include the institutionalization of the Japanese Kaizen approach, the transformation of technical and vocational education training (TVET) and university system along German lines, the establishment of sectoral institutes, and science and technology universities in line with the South Korean model, and learning from China's policymaking and industrialization strategy (Lin and Oqubay 2019).

Ethiopia has pursued an active industrial policy since the early 2000s with a large set of carefully designed policy instruments. These include the promotion of exports and productive investment, industrial financing, and the use of state-owned enterprises (SOEs) to shape strategic sectors. The focus has been on sectors such as leather and leather goods, apparel and textiles, meat processing, food processing and beverages, cement and steel, and horticulture. There has also been recognition of reciprocity and the political economy constraints that hinder productive investment in export-oriented manufacturing, with evidence of learning from the East Asian experience (such as target setting in exports, export coordination councils, sectoral institutes, industrial financing, and the active role of SOEs).

Many policy instruments, however, have not been entirely effective. First, most of the export-promotion schemes required effective coordination, automation of the customs system, and qualified professional staff, but these were often lacking. Second, sectoral institutes set up to support priority sectors were unable to attract staff with the professional skills, qualifications, and experience required to support firms. Moreover, the institutes had to assist with administrative requirements, as not all government channels have been streamlined to support exports and

industrialization. Some efforts have been made to strengthen the institutes by twinning them with Indian institutes with similar mandates.

The case of Uzbekistan

Uzbekistan has in the past ten years been a very successful economy by developing country standards. The economy is characterized by high growth rate (average 8 percent), low unemployment and reasonable macroeconomic stability, low domestic and international debt. As reported by Popov (2014), even more impressive are the structural shifts that happened within the 25 years after Uzbekistan became independent:

- decrease in production and export of cotton (that was previously a mono culture), increase in food production and achievement of self-sufficiency in food;
- achievement of self-sufficiency in energy and becoming a net fuel exporter; and
- increase in the share of industry in GDP and the share of machinery and equipment in industrial output and export (a competitive export-oriented auto industry was created from scratch).

In recent years Uzbekistan promotes heavy chemical industries (production of synthetic fuel and polypropylene goods from natural gas). This is the next stage of industrial policy after reaching food and energy self-sufficiency and successful auto industry development. In 2011 it became 15th country in the world to launch high speed train line between Tashkent and Samarkand (it was continued to Bukhara and Karshi in 2015 and 2016). The train is made by Spanish Talgo and runs a distance of 600 km between Tashkent and Bukhara in 3 hours 20 minutes.

Uzbekistan's development achievements, though not as spectacular as that of China, have been due to deliberate government policies. It is acknowledged that Uzbekistan enjoyed favourable external environment. However, its rapid growth is due to reasonable macroeconomic stability and industrial policies rather than the result of market reforms that triggered growth conforming to its factor endowment and/or natural comparative advantages. The relatively successful economic performance is even more impressive given that Uzbekistan is not a major oil and gas exporter.

In spite of the relatively successful economic outlook, Uzbekistan still remains a relatively poor country, with PPP GDP per capita of below \$6000 in 2014 against over \$20,000 in Russia and Kazakhstan, \$17,000 in Azerbaijan, and over \$14,000 in Turkmenistan; and many Uzbeks are migrating to find a job in Russia and not vice versa. It is important, however, to distinguish between the growth rates and the level of per capita income. It is necessary to separate the effects associated with the dynamics of output from the effects of the terms of trade and financial flows. At the end of the Soviet period, in the 1980s, real incomes in Uzbekistan were about half of the Russia's level. After the collapse of the USSR real incomes in non-resource republics fell dramatically due to the change in relative prices – oil, gas and other resources became several times more expensive relative to ready made goods. Uzbekistan was a large importer of oil and its trade with all countries, including other Soviet republics, if recalculated in world prices, yielded a deficit of 9 percent of GDP.

And diversification in industry and expansion of manufacturing exports was mostly the result of protectionism and government / central bank policy of low exchange rate. Uzbekistan maintained a low (undervalued) exchange rate due to rapid accumulation of foreign exchange reserves. In

addition, there were non-negligible tax measures to stimulate exports of processed goods (50 percent lower tax rate for manufacturing companies that export 30 percent and more of their output). Although comparable statistics from WDI for Uzbekistan is lacking, national statistics suggests that the share of non-resource goods in exports increased to over 70 percent against less than 30 percent in 1990, before independence (Popov, 2014).

4.5. Establishment of Technology Incubation Centres in LLDCs

Technology incubation centres are potent instruments of industrial policy that have enabled remarkable economic transformation in developed and newly industrializing countries. The following are a few examples in LLDCs.

Kyrgyzstan- High Tech Park

The park benefits from low income tax (5%) and no corporate tax apart from a 1% levy for the directorate of the Park for companies that export at least 80% of their output. As of 2016, the park hosted 27 companies with turnover of US\$3.5 million and employing 251 people. The largest export markets are Kazakhstan, the United States, Ireland, Russia and Japan. The KG Labs Public Foundation maintains a list and a map of start-ups and related resources, and is active in running contests, hackathons, and incubation and mentoring sessions; while Ideagrad.com runs an incubation program.

Mongolia National Information Technology Park Incubator

The incubator is the first fully-operational non-profit governmental business incubator in Mongolia. It was established in 2002-2003. The incubator concentrates on supporting companies and businesses with innovative ideas and new technologies in the IT sector with the provision of a comfortable working environment and comprehensive management support. The aim is to help them become capable of producing national brand products and be able to compete in domestic and foreign markets toward innovation.

Bhutan-Thimphu Tech Park

Launched in May 2012, the Tech Park offers office space and services for tech companies. It incubates start-ups via the Bhutan Innovation and Technology Centre (BITC). BITC provides six months free working space for start-ups, offers courses and competitions for entrepreneurs, and encourages overseas experts to spend time in residence sharing their experience. It has 15 start-ups, and the facility is fully occupied, with further expansion in the pipeline. The Tech Park has also attracted foreign firms, which mainly provide digital services outside Bhutan, using local talent forming an emerging ICT export industry.

Rwanda-Kigali Innovation City (KIC)

KIC aims to unite multinational information technology firms with domestic start-ups alongside higher education institutions. The hopes are that the synergies from anchoring educational institutions alongside tech companies will generate innovative applications and services and help grow the domestic ICT industry as well as generate exports. Carnegie Mellon University of the United States is one of the core anchor institutions. An innovation lab and skills academy are planned. The projected impacts of KIC include 4,500 highly skilled ICT jobs by 2022 and export

earnings up to an estimated US\$180 million by 2022. The Knowledge Lab (kLab) features an open space with room for around 60 people providing free Wi-Fi. It organizes various events such as workshops and hackathons and offers mentoring to help turn ideas into business models. Next door is the Rwanda FabLab, which opened in 2016 as the first hardware space in Central Africa. There is a range of equipment for users to experiment with such as 3D printers, milling machine, and a computer-controlled laser cutter.

Ethiopia EthioICT-Village

Inaugurated in 2015, EthioICT-Village features a data centre and an incubator for digital start-ups, high-speed fibre optic connectivity and reliable electricity. Over 20 companies are currently housed there. It is hoped that international companies can be attracted given the park is inside an export processing zone and therefore has attractive investment incentives. It is also planned to leverage EthioICT-Village as an outsourcing hub. Ethiopia does have some experience in that area with exports as well as familiarity with English among university graduates.

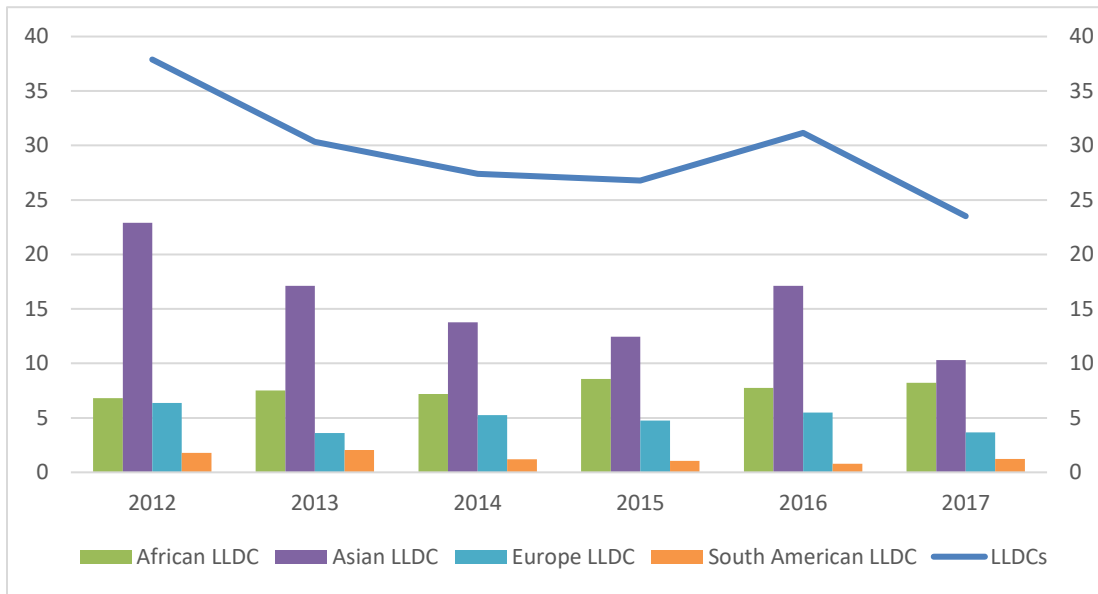
4.6. Role of FDI and Trade in Technology Transfer in LLDCs

The acquisition and transfer of technology is vital to sustained productivity and growth of an economy. International trade and foreign direct investment (FDI) are two important channels of technology transfer and they remain key elements of national technology and innovation strategies. Foreign affiliates of national or local firms may bring new technologies or opportunities that encourage innovation and technology spill-overs from which other firms can draw inspiration or improve extant knowledge. The nature of technology, the means of its storage and transfer, as well as the economic context and policies that shape the incentives and conditions of its application in foreign markets, have evolved considerably in recent decades (OECD 2017, UNCTAD 2004). The several tasks and business functions in global value chains have created new opportunities for the application and transfer of technology, particularly to developing countries. This has sharpened the interdependencies between trade, FDI and technology, and influenced the debate about the role of openness in technology and innovation strategies. Figure 4.1 shows the trend in FDI inflows to LLDCs from 2012 to 2017. The trend in FDI inflows indicates that the level of FDI inflow in 2017 is generally lower than in 2014 across LLDCs. The FDI inflow in 2016 is however a little higher than in 2014. These findings suggest that there is no evidence of significant improvement in FDI inflows in LLDCs since the implementation of VPoA in 2014. This is however likely an indication of the falling trend in global FDI flows in recent years.¹⁸

The quality or technology contents of FDI is very important with respect to technology transfer in that high FDI with low technology content may not foster structural economic transformation. It is however difficult to assess the quality of FDI from the trend data available for this study. Data from the annual surveys on global competitiveness by the World Economic Forum in which business executives were asked “*To what extent does foreign direct investment (FDI) bring new technology into your country?*” on a likert scale of 1 to 7 reveals that FDI has not improved as a source of technology transfer to LLDCs from 2012 to 2018 (See Figure 4.2).

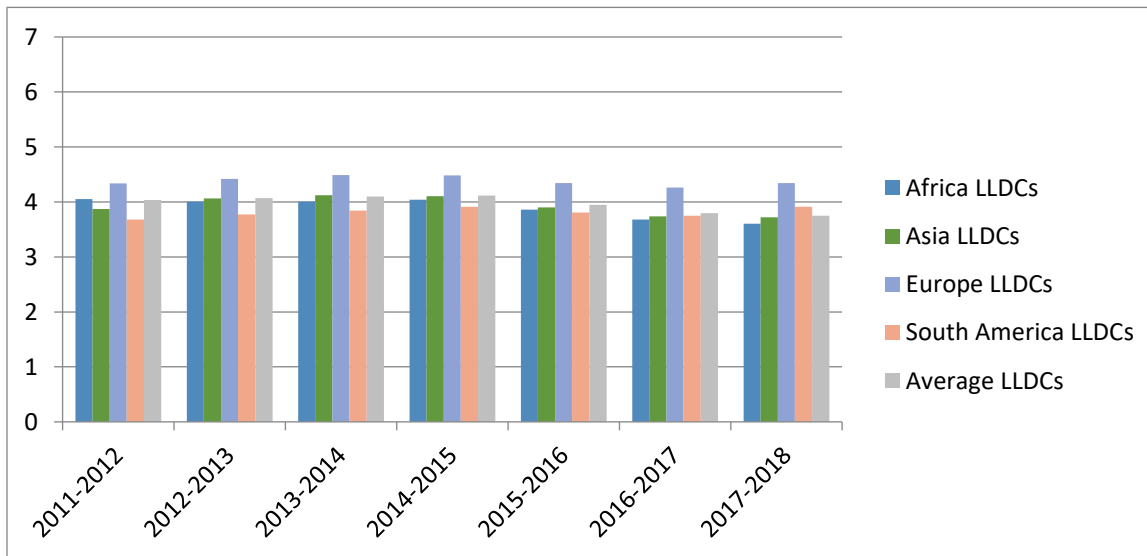
¹⁸ UNCTAD (2019) reports that global FDI flows slid by 13% in 2018, to US\$1.3 trillion from US\$1.5 trillion the previous year – the third consecutive annual decline.

Figure 4.1: Foreign direct investment, net inflows (BoP, current US\$, billions)



Source: World Bank, World Development Indicators

Figure 4.2: FDI and technology transfer



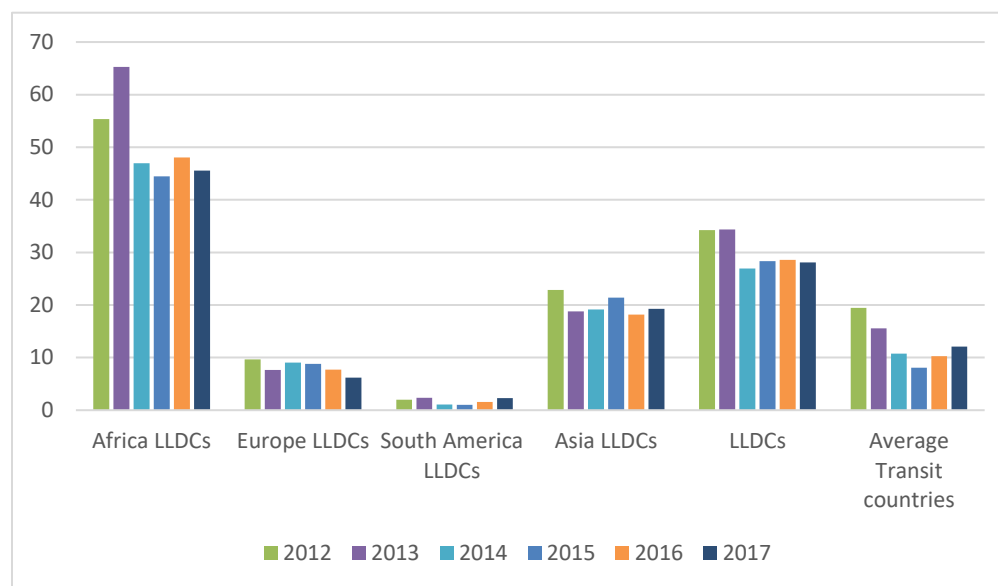
Source: World Economic Forum (The Global Competitiveness Index dataset 2007-2017)

4.7. Role of Development Cooperation in Technology Transfer in LLDCs

Development cooperation traditionally takes the form of either North-South or South-South Cooperation involving development finance assistance. Figure 4.3 and Figure 4.4 respectively show the trend in Official Development Assistance (ODA) flows to LLDCs and the technology transfer related flows indicated by ODA to research and scientific institutions from 2012 to 2017. The highest recipients of ODA as proportion of central government expense are African and Asian

LLDCs.¹⁹ ODA as proportion of central government expense is particularly high for African LLDCs. It is also important to point out that Figure 4.3 indicates that ODA as proportion of central government expense has not significantly improved for LLDCs and transit countries from 2014 to 2017.

Figure 4.3: Net ODA received (% of central government expense)



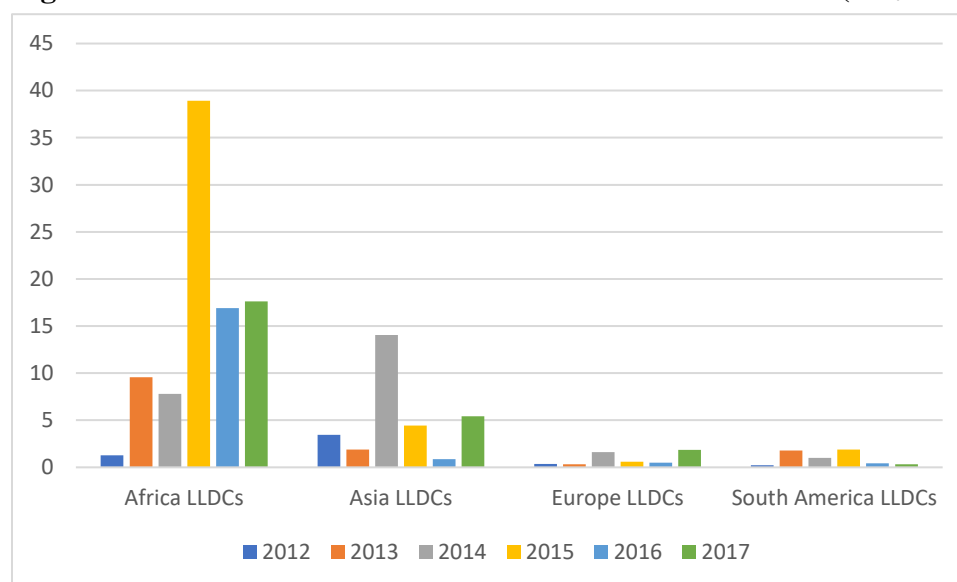
Note: Simple averages

Source: OECD Stat

The trend in technology transfer related ODA shown in Figure 4.4 shows that total net ODA to research and scientific institutions is highest for African LLDCs from 2014 to 2017, suggesting that international support for technology transfer to LLDCs in Africa improved after the launch of VPoA. The total ODA to research and scientific institutions in LLDCs improved considerably from 2013 to 2015 from \$5.3 million to \$46 million but declined to below the 2014 level in 2016 and 2017, when it reached \$19 million and \$25 million respectively. Thus, ODA to research and scientific institutions in LLDCs has generally been sporadically improved rather than being systematically and sustainably increased. It appears that donor countries would need to be more engaging with ODA recipient countries in North-South development cooperation dialogue aimed at determining the priority technology transfer options over a medium to long term plan. As pointed out by Alcorta (2019), STI capacity building is also a major area for North-South cooperation.

¹⁹ Central government expense is cash payments for operating activities of the government in providing goods and services. It includes compensation of employees (such as wages and salaries), interest and subsidies, grants, social benefits, and other expenses such as rent and dividends (WDI, 2018).

Figure 4.4: Total ODA to research and scientific institutions (US\$ millions)



Source: OECD Stat

Over the past decade, South-South technical and financial cooperation has rapidly gained increasing importance for LLDCs especially for improving the transport infrastructure. Improvement in the transport infrastructure can serve as a critical channel for technology transfer and improvement in connectivity resulting in significant boost in the participation of LLDCs in global value chains and trade. For a growing number of LLDCs, a few transit countries (China, India, South Africa, the United Arab Emirates, and Nigeria) have become important markets, as well as sources of foreign investment (UN-OHRLLS, 2017c). In recent times, China receives more imports from Africa than the United States. Major South-South and triangular cooperation and investment projects benefitting LLDCs include the Almaty-Bishkek highway, partly financed by the Asian Development Bank, the Turkmenistan-Afghanistan-Pakistan-India Natural Gas Pipeline Project, the US\$500 million ASEAN Infrastructure Fund, and China’s US\$40 billion Silk Road Infrastructure Fund. In Africa, many manufactured imports, including motor vehicles, are procured from India (UN-OHRLLS, 2018c).

In African and in Latin American LLDCs, construction of transport infrastructure has begun to advance rapidly as a result of the productive and mutually beneficial South-South inter-governmental and corporate sector cooperation between their respective national entities and Chinese technology and financing partners. In Latin America alone, China has become a leading partner in infrastructure development, implementing more than 20 large-scale highway, waterway, power grid and telecommunication projects across the continent. There are also a number of special South-South transport infrastructure development cooperation programmes for specific LLDCs.²⁰ A major gap in the South-South cooperation efforts for infrastructure development is that the reality of low technology absorptive capacity of recipient countries is often not taken into

²⁰ See reports on these LLDCs transport infrastructure programmes at: <https://unctad.org/en/pages/aldc/Documents%20and%20Publications/Land-Locked-Developing-CountriesTransit-Traffic-and-Transport-infrastructure.aspx> (ACCESSED, 26 June 2019)

consideration in the implementation of the infrastructure development plans. The focus of recipient LLDCs is on the short-term gains of improved connectivity rather than building capacity to maintain and upgrade the new infrastructure so that technology transfer can effectively take place.

5. STI ACTORS' COMPETENCES AND CAPACITY TO INNOVATE

This section provides an analysis of the roles of actors in the national system of innovation and their capacity to foster structural economic transformation in LLDCs.

5.1. National System of Innovation Framework

Innovation is widely viewed as the main driver of growth and engine of long-term economic development. Successful economic development is largely linked to the country's capacity to acquire, absorb, assimilate and apply modern technologies (Adeoti, 2002; Metcalfe and Ramlogan, 2008; Adeoti, 2016). Innovation performance is strongly shaped by the national system of innovation (NSI). The understanding of the structure and functioning of the NSI is therefore crucial for policymakers and other development stakeholders. A summary of conceptual definitions of national system of innovation and the level/nature of innovation in focus is provided in Table 5.1.

The common features of the national systems of innovation framework as reported by Adeoti (2007) include:

- The firm is the core of the NSI framework: it is the place where factor combinations take place, and is also the centre of innovative activities.
- System view of innovation: networks and feedback among agents, network economies.
- A contact between demand and supply of R&D: NSI emphasis on the generation and use of technological knowledge makes demand for R&D an important issue alongside R&D programmes and projects.
- Innovation as the engine of growth.
- Institutions matter for system effectiveness in interaction among economic actors.
- Market not always sufficient for innovation to happen, so policy matters.
- Learning is essential (by doing, using and interaction modes).
- Knowledge-based and technology-driven development.
- Co-evolutionary processes, the system is dynamic.

Table 5.1: Definitions of NSI and level/nature of innovation in focus

Definition of NSI	Level and/or nature of innovation in focus
"... the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1987)	<ul style="list-style-type: none"> ▪ Technology new to the firm ▪ Technology new to the world ▪ Technology as artefact
"... the elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge and are either located within or rooted inside the borders of a nation state" (Lundvall, 1992).	<ul style="list-style-type: none"> ▪ Technology new to the world ▪ Technology as knowledge resources
"... the set of institutions whose interactions determine the innovative performance of national firms." (Nelson and Rosenberg, 1993)	<ul style="list-style-type: none"> ▪ Innovation at firm level
"... the national system of innovation is constituted by the institutions and economic structures affecting the rate and direction	<ul style="list-style-type: none"> ▪ Rate and direction of technological change

of technological change in the society.” (Edquist and Lundvall, 1993)	
“... a national system of innovation is the system of interacting private and public firms (either large or small), universities, and government agencies aiming at the production of science and technology within national borders. Interaction among these units may be technical, commercial, legal, social, and financial, inasmuch as the goal of the interaction is the development, protection, financing or regulation of new science and technology.” (Niosi et al, 1993)	<ul style="list-style-type: none"> ▪ Production and use of new science and technology ▪ Technology new to the world ▪ Technology as artefact ▪ Technology as knowledge resources
“... the national institutions, their incentive structures and their competences, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country”. (Patel and Pavitt, 1994)	<ul style="list-style-type: none"> ▪ Technological learning
“... that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provide the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies”. (Metcalf, 1995)	<ul style="list-style-type: none"> ▪ Technology new to the world ▪ Innovation process ▪ Technology as artefact ▪ Technology as knowledge resources

Source: Adeoti (2007) and Niosi (2002)

According to Jacobson and Johnson (2000), the functional boundaries of the national system of innovation are beyond the “overall function of producing, diffusing and using innovations”, and the primary functions of the NSI are:

- Create ‘new’ knowledge;
- Guide the direction of the search process;
- Supply resources, i.e., capital and competence;
- Facilitate the creation of positive external economies (in the form of an exchange of information, knowledge, and visions); and
- Facilitate the formation of markets.

Other researchers (Rickne, 2000, as cited in Edquist, 2001) have expanded the list to include:

- Create human capital;
- Create and diffuse technological opportunities;
- Create and diffuse products;
- Incubate in order to provide facilities, equipment, and administrative support,
- Facilitate regulation for technologies, materials, and products that may enlarge the market and enhance market access;
- Legitimize technology and firms;
- Create markets and diffuse market knowledge;
- Enhance networking;
- Direct technology, market, and partner research;
- Facilitate financing; and

- Create a labour market that can be utilized.

5.2. STI Actors and their Roles

Supportive institutions are important prerequisites for an effective innovation system but their presence will not necessarily spur innovative output. Ultimately, dynamic STI actors are the drivers of the innovation process. The outcome of innovative processes is not affected solely by actors who are directly involved in R&D but also by those who fund, lobby for and use its products. These are typically aggregated in three broad sets of STI actors:

- Government* (and other public sector) bodies;
- Industry* (firms or individual entrepreneurs);
- Academia* (universities and research centres).

The interactions between these three STI actors in the innovation process are known as the “*Triple Helix of Innovation*” and was first advanced by Etzkowitz and Leydesdorff (2000); and the triple helix model evoke evolutionary connotations and underline mutual dependence. Although theoretically distinct, the three actors are in practice less neatly distinguished. A characteristic that is common among them is that innovation is not an exclusive strategic target which STI actors unfailingly dedicate resources to but may often be an activity removed from the core of their operations. STI actors often exhibit overlapping responsibilities and utilise common pools of resources, while having at the same time different roles within the system and are motivated by discrete incentives.

Each of the STI actors could be likened to an engine’s component parts. The NSI comprises of various subsystems, where STI actors have key roles. Importantly, the role of each component part is different so their contribution to the engine’s performance can only be measured by taking into account their distinct roles. STI actors also have different roles and sometimes divergent motivations for their actions. Categorising STI actors according to the capacity in which they act enables an understanding of the dynamics of the innovation system. It also allows for capturing in a holistic analytical approach the distinct rationalities of policy, market processes and network arrangements. Table 5.2 presents types of STI actors along with the capacities typically associated with each actor.

Table 5.2: STI actors and their capacities

Type of STI Actors	STI Actor Capacities
<i>Government</i> - top-level government - other public sector bodies	policy makers, policy enactors technology lobbyists, technology users, technology producers
<i>Industry</i> - indigenous enterprises - multinational enterprises - investment banks	technology producers technology lobbyists technology users
<i>Academia</i> - universities - research centres	technology producers technology lobbyists technology users

Source: Pontikakis et al, 2005

5.3. Analysis of STI Profiles of LLDCs

As explained by UNECA (2018), reporting country STI profiles would include information on the state of STI investments and strategies employed in developing the country STI base. The ensuing STI profiling will, as much as possible, provide information on the resources – physical, human and financial – devoted to strengthening the STI performance of the economy. The broad framework of the NSI can be characterized by four components that may be regarded as pillars of the country STI profiles (OECD, 2012). UNECA (2018) described these pillars of country STI readiness to include 1) STI actors’ competences and capacity to innovate; 2) STI actors’ interactions; 3) human resources for innovation; and 4) STI policy governance. Each pillar has detailed input and output indicators for a comprehensive analysis of country STI readiness. Given the scope of this paper, the focus would be on the first pillar: STI actors’ competences and capacity to innovate.

The first pillar identifies the major STI actors within the national context and the competences that have enabled them play significant roles in the economy. This may include the analysis of the science base, structure of investments in scientific activities as can be illustrated by public sector research institutions (including universities), evidence of private sector investments in scientific activities either directly or indirectly, business R&D and innovation activities. The input indicators of STI actors’ competences and capacity to innovate as presented in UNECA (2018) include:

1. R&D intensity
2. R&D intensity of industry
3. Public sector investment in R&D
4. Private sector investment in R&D
5. Education expenditure as percent of GDP
6. Science and engineering enrolment ratio
7. ICT expenditure (public and private) as percent of GDP
8. Royalty and license fees
9. Level of investment in renewable energy technologies
10. Case studies of indigenous knowledge in the informal sector

The output indicators of STI actors’ competences and capacity to innovate would include:

1. Proportion of population with secondary and tertiary level education
2. Share of low, medium and high technology products in total manufacturing output
3. Share of low, medium and high technology exports in total exports
4. Patents, trademarks and designs registered
5. Scientific and technical journal articles per million population
6. New technology products introduced
7. Process improvements introduced

In order to ascertain the effect of the implementation of VPoA on STI actor’s competences and capacity to innovate, the performance of LLDCs with respect to some of these input and output indicators are examined using correlation analysis. Table 5.2 shows the results of the Pearson correlation analysis between selected STI inputs and STI outputs in LLDCs between 2012 and 2017. The selection of indicators for the review is based on data availability. While some of the

STI input indicators have a positive correlation with STI outputs, the Pearson correlation is statistically significant for only one of the correlation coefficients. The correlation between individuals using Internet and number of scientific & technical publications is 0.9295 and is statistically significant at 5 percent. The lack of correlation between most of the STI inputs and outputs may be due to the short period since the VPoA implementation (i.e., 2014 to 2017).

Table 5.3: Results of correlation analysis between STI inputs and outputs indicators

	R&D expenditure (% of GDP)	Government expenditure on education (% of GDP)	Individuals using internet (%)	Fixed broadband subscription	Number of patents	Number of trademarks	Number of Scientific & technical publications	High-tech exports (% of manufactured exports)
R&D expenditure (% of GDP)	1.0000							
Govt. expenditure on education (% of GDP)	0.4553	1.0000						
Individuals using internet (%)	-0.4862	-0.4869	1.0000					
Fixed broadband subscription	-0.5925	-0.6833	0.9100	1.0000				
Number of patents	-0.2808	-0.1068	0.6275	0.6890	1.0000			
Number of trademarks	0.1688	0.3662	-0.0878	0.0836	0.5150	1.0000		
Number of Scientific & technical publications	-0.3079	-0.2036	0.9295	0.9114	0.4276	-0.0419	1.0000	
High-tech exports (% of manufactured exports)	0.2110	0.6050	0.1696	-0.0801	0.5229	0.1805	0.2915	1.0000

Furthermore, the STI actor's competences and capacity to innovate in LLDCs from 2012 to 2017 are discussed in accordance with the following three criteria specified by UNECA (2018) for analysing the first pillar of country STI readiness:

- Science base and structure of investments in scientific activities;
- Business R&D and innovation activities;
- Technological learning experiences and opportunities

5.3.1. Trend in science base and structure of investments in scientific activities

Education and training institutions

The state of education and training institutions is a major determinant of the science base and the structure of investment in scientific and innovation engendering activities. The education and training in LLDCs are accordingly discussed in terms of enrolment rate, out of school children, school completion rate, adult literacy rate, and government expenditure on education as a percentage of GDP.

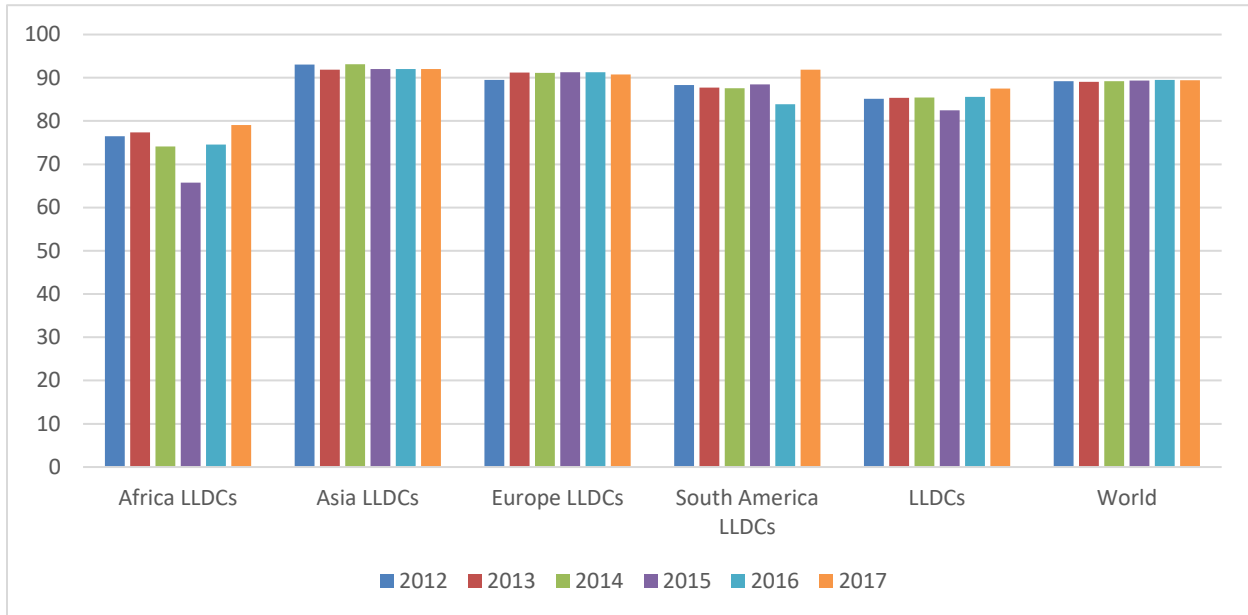
Figure 5.1, Figure 5.2 and Figure 5.3 present the trends in school enrolment, children out of school, and primary school completion rates respectively for LLDCs from 2012 to 2017. As shown in Figure 5.1, there were steady increases in the primary school enrolment in most LLDCs from 2015 to 2017. Lowest enrolment rate was recorded in LLDCs in Africa which stood at 79 percent in 2017 as compared to at least 90 percent in other LLDCs. The proportion of primary school enrolment in African LLDCs is still lower than the global average of 89.44 percent in 2017. It should also be noted that the average in European LLDCs is lower than the average for countries in the European Union.

Furthermore, the proportion of out of school children has been decreasing especially for LLDCs in Africa from 2015 to 2017, but still remains at close to 20% (see Figure 5.2). This proportion was highest in LLDCs in Africa. The LLDC average was 10% in 2017, while it is worthy of note to say that the proportion of out of school children is less than 8 percent in other LLDC regions in the most recent year. Also, only LLDCs in Africa still lag behind using the global average as a benchmark. Other LLDCs (Asia, Europe and South-America) are not performing well relative to the EU and East Asia and Pacific averages.

Primary school completion rate (Figure 5.3) has improved only marginally for LLDCs in Asia, Europe and South America where over 90 percent of the children completed primary school education from 2014 to 2017. These LLDCs are performing better relative to the global average. LLDCs in Africa are the worst performing LLDCs as primary school completion rate is lower than the sub-Saharan Africa and global averages. In a similar vein, as shown by Table 5.4, adult literacy is relatively low among LLDCs in Africa. LLDCs in Asia, Europe and South America have all recorded values mostly higher than world average.

Table 5.5 presents the proportion of government expenditure on education as a percentage of GDP in LLDCs. The trend has been dwindling across LLDCs especially among the African LLDCs. This indicates that LLDCs need to commit significantly higher proportion of government expenditure to education financing.

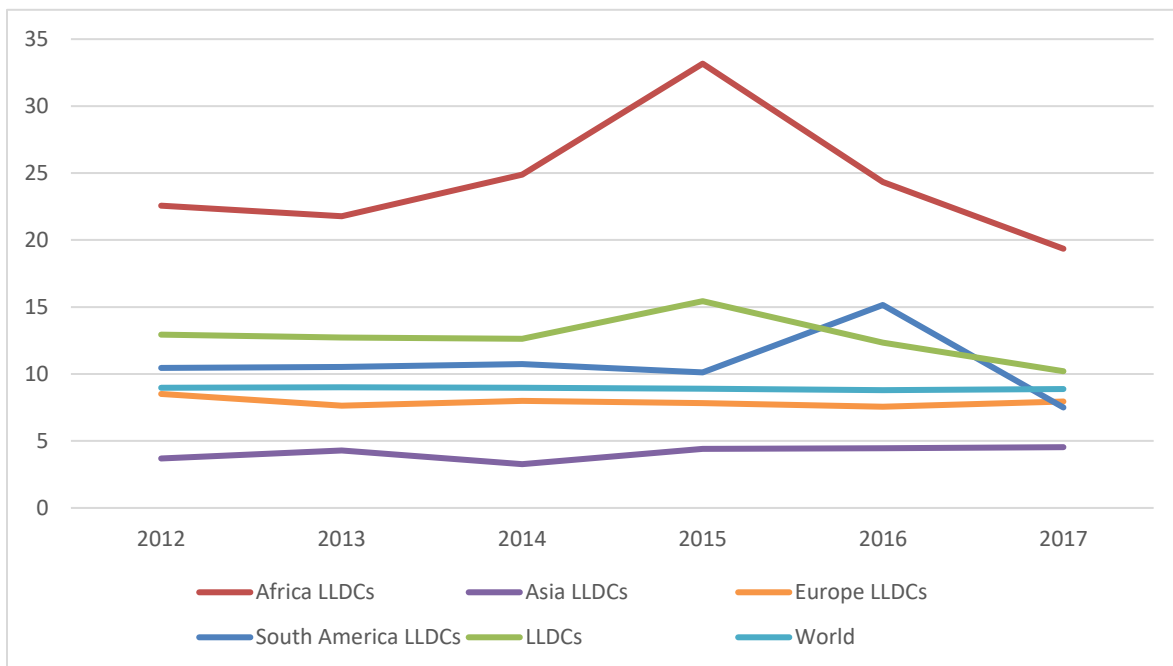
Figure 5.1: School enrolment, primary (% net)



Note: Simple averages

Source: World Development Indicators

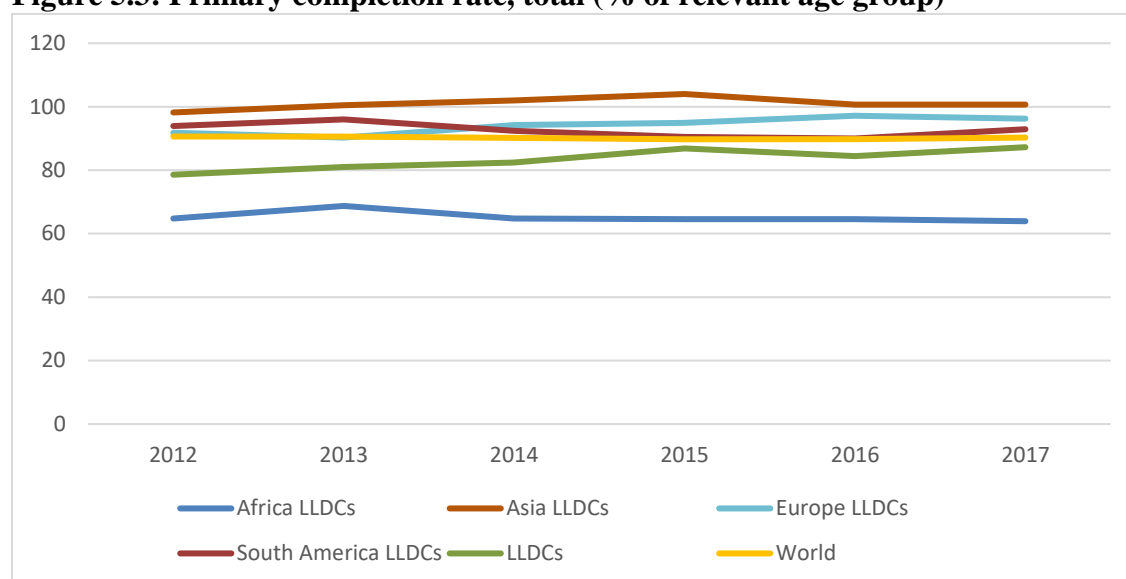
Figure 5.2: Children out of school (% of primary school age)



Note: Simple averages

Source: World Development Indicators

Figure 5.3: Primary completion rate, total (% of relevant age group)



Note: Simple averages

Source: World Bank, World Development Indicators

Table 5.4: Literacy rate, adult total (% of people ages 15 and above)

	Latest value	Year (2012-2016)
Botswana	87.70	2014
Burkina Faso	34.60	2014
Burundi	61.57	2014
Chad	22.31	2016
Lesotho	76.64	2014
Malawi	62.14	2015
Mali	33.07	2015
Niger	30.56	2012
Rwanda	70.80	2014
Uganda	70.20	2012
Zimbabwe	88.69	2014
Bhutan	57.03	2012
Lao People's Democratic Republic	84.66	2015
Tajikistan	99.80	2014
Turkmenistan	99.70	2014
Uzbekistan	99.99	2016
Azerbaijan	99.79	2016
Republic of Moldova	99.14	2012
Bolivia (Plurinational State of)	92.46	2015
Paraguay	94.65	2016
World	86.25	2016

Source: World Bank, World Development Indicators

Table 5.5: Government expenditure on education, total (% of GDP)

	2012	2013	2014	2015	2016	2017
Afghanistan	2.52	3.43	3.67	3.24	4.21	3.93
Armenia	2.77	2.65	2.25	2.81	2.76	..
Azerbaijan	2.07	2.44	2.63	2.95	2.90	..
Bhutan	..	5.59	5.90	7.39	6.81	7.05
Bolivia (Plurinational State of)	6.43	6.26	7.29	..	..	..
Botswana	..	..	..	..	..	..
Burkina Faso	4.05	4.59	4.56	4.17	..	..
Burundi	5.82	5.41	5.93	6.45	4.62	4.34
Central African Republic	..	..	..	..	..	..
Chad	2.21	2.85	..	..	..	..
Eswatini	..	..	7.13	..	..	..
Ethiopia	5.57	4.50	4.60	4.74	..	..
Kazakhstan	..	..	..	2.79	2.98	..
Kyrgyzstan	7.38	6.78	5.53	5.99	6.59	7.21
Lao People's Democratic Republic	1.82	3.23	2.94	..	..	..
Malawi	..	5.42	4.84	5.61	4.75	4.03
Mali	3.48	3.28	3.64	3.80	..	..
Mongolia	5.20	4.94	4.71	4.18	5.18	4.07
Nepal	3.76	3.47	3.99	3.70	4.44	5.10
Niger	4.33	4.92	6.73	5.99	4.81	4.45
Paraguay	4.96	..	..	..	4.52	..
Republic of Moldova	8.35	..	7.46	..	6.66	..
Rwanda	4.64	4.95	4.31	3.75	3.54	3.21
South Sudan	..	1.08	1.52	1.36	1.50	0.98
Tajikistan	4.02	..	..	5.23	..	..
Turkmenistan	3.05	..	..	..	..	..
Uganda	2.48	2.21	2.25	2.77	2.56	2.64
Uzbekistan	..	7.28	7.32	7.08	6.91	6.41
Zimbabwe	7.29	7.41	7.53	..	..	..
Simple Average LLDCs	4.39	4.41	4.85	4.42	4.45	4.45
World	4.54	4.68	4.72	4.81	..	..

Source: World Bank, World Development Indicators

5.3.2. Business R&D and innovation activities

Trend in research and development

Investment in research and development (R&D) is one of the key innovation inputs required for sectoral and national economic competitiveness. The most widely used R&D indicator is R&D

expenditure as a percentage of GDP. It is also known as R&D intensity and it is a measure of countries' efforts on science, technology and innovation (STI). Increasing R&D intensity remains a long-term objective worldwide. In the European Union, for example, the Europe 2020 target for R&D is 3 percent of GDP (Eurostat, 2016). Similarly, African Governments have committed themselves, through the African Union, to invest at least 1 percent of their GDP in R&D.

The trend in R&D expenditure by LLDCs is shown in Table 5.6. In 2016, the global average for R&D expenditure as proportion of GDP was 1.68 percent. It was 0.24 percent for LLDCs and 1.83 percent for the EU. Many developing countries have set a target of reaching at least 1 percent of GDP devoted to R&D expenditure, and it is observed that the LLDCs are quite far away from this target. Positive exceptions are Chad (0.32 percent), Mali (0.29 percent) Moldova (0.33 percent) and North Macedonia (0.35 percent), which are all above the LLDC average, although with still some way to go before hitting the 1 percent target. Botswana and Ethiopia recorded 0.54% and 0.6% respectively in 2013. In general, R&D expenditures in the LLDCs are low and hardly show increasing trends, which is not supportive for innovations required for facilitating economic transformation through knowledge acquisition and innovation.

Table 5.6: R&D expenditure (percentage of GDP)

	Latest value	Year
Afghanistan	..	..
Armenia	0.23	2017
Azerbaijan	0.19	2017
Bhutan	..	..
Bolivia (Plurinational State of)	0.16	2009
Botswana	0.54	2013
Burkina Faso	0.22	2015
Burundi	0.12	2011
Central African Republic	..	..
Chad	0.32	2016
Eswatini	0.25	2016
Ethiopia	0.60	2013
Kazakhstan	0.14	2016
Kyrgyzstan	0.11	2017
Lao PDR	0.04	2002
Lesotho	0.05	2015
Malawi	..	..
Mali	0.29	2017
Mongolia	0.13	2017
Nepal	0.30	2010
Niger	..	..
North Macedonia	0.35	2017
Paraguay	0.15	2016
Republic of Moldova	0.30	2017

Rwanda	..	..
South Sudan	..	..
Tajikistan	0.12	2017
Turkmenistan	..	..
Uganda	0.17	2014
Uzbekistan	0.19	2017
Zambia	0.28	2008
Zimbabwe	..	..
Average, LLDCs	0.24	2016
World	1.68	2016

Source: United Nations SDG Indicators Database

It is noteworthy that UNESCO (2018) reported that the density of researchers is also very unevenly distributed around the world, with Europe and North America leading. All regions with the exception of sub-Saharan Africa and Central and Southern Asia, have experienced significant growth in density of researchers since 2000.

Table 5.7 presents the number of researchers relative to the population of each LLDC. Data are expressed in full-time equivalent, which can be considered as the true volume of the effort devoted to R&D. The global average for this indicator is about 1,459 researchers per million inhabitants. The LLDC rough average stands at around 250 researchers per million. From available data, the LLDC average is still very much lower than averages in South-East Asia and Europe. It is however interesting to note that indicator is positive for some LLDCs in Asia (Kazakhstan and Uzbekistan) and Europe (Moldova and North Macedonia) which are higher than the LLDC average and hover around South-East Asia average.

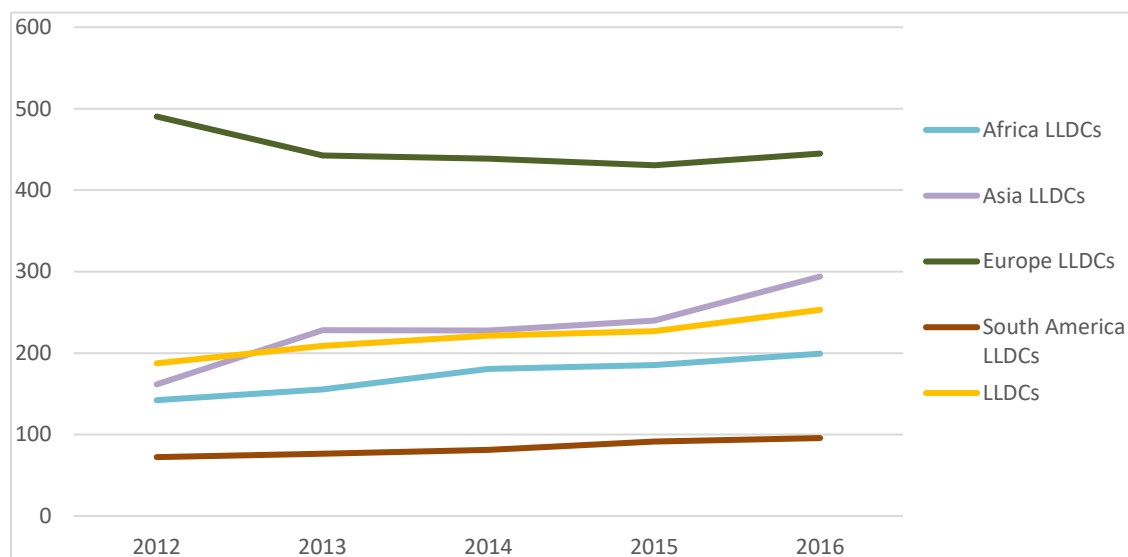
Table 5.7: Researchers per million inhabitants (FTE)

	Latest value	Year (2012-2017)
Botswana	179.5	2013
Chad	58.3	2016
Eswatini	119.1	2015
Ethiopia	45.0	2013
Kazakhstan	687.6	2016
Lesotho	22.8	2015
Mali	32.8	2017
Paraguay	122.1	2016
Republic of Moldova	723.9	2017
North Macedonia	729.0	2017
Uganda	26.5	2014
Uzbekistan	496.3	2017
Zimbabwe	88.7	2012

World	1,459.5	2015
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Source: UNESCO Institute for Statistics (UIS)

Figure 5.4: Scientific and technical journal articles (average number)



Source: World Bank, World Development Indicators

Furthermore, the trend in the number of scientific and technical journal articles published by researchers in LLDCs is presented in Figure 5.4. There are steady increases in the number of journal articles across LLDCs but the average was much higher among LLDCs in Europe and least among LLDCs in South America. Overall, articles published by researchers in LLDCs account for less than 0.4% of global scientific and technical journal articles.

Access to energy

Access to energy services, energy efficiency and renewable energy are the main pillars of SDG-7 (Ensure access to affordable, reliable, sustainable and modern energy for all), and these are key enablers for business R&D and structural economic transformation. Promoting the use of energy to support productivity and competitiveness is of strategic importance to overcome landlockedness through its potential contribution to trade and development. Figure 5.5 presents the trend in the proportion of population with access to electricity in LLDCs and regional averages from 2013 to 2017.

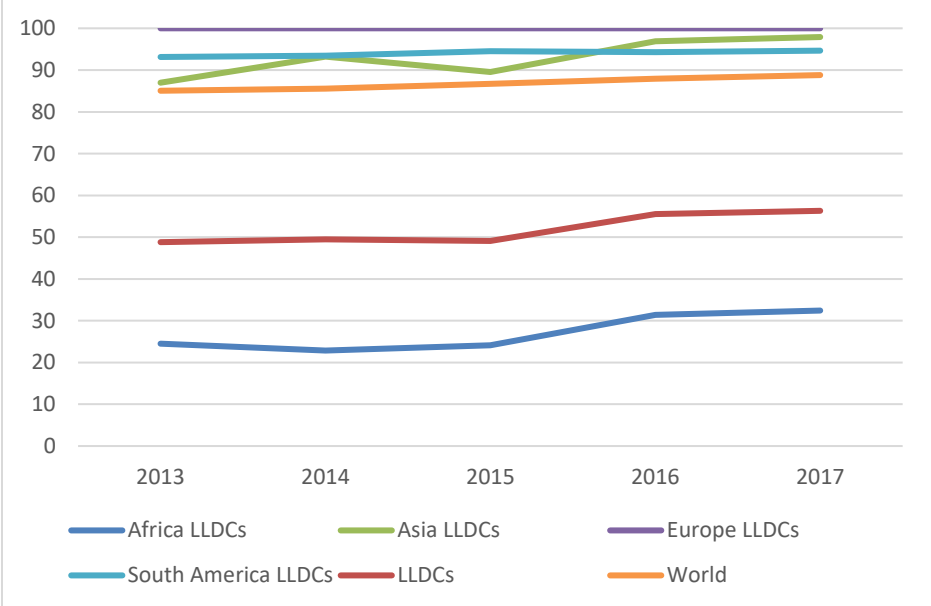
Despite the potential that modern energy has for the development of the LLDCs, the average proportion of population having access to electricity in LLDCs in 2017 was 56.3%, compared with global average of 88.8%. In African LLDCs, access has increased from 24.5% in 2013 to 32.4% in 2017, but remains very low. LLDCs in Africa have significantly lower access to electricity than other LLDCs in Asia, Europe and South America. The proportion of population with access to electricity is steadily increasing in LLDCs in Asia, reaching almost 100%, while all LLDCs in Europe boast complete access. About 95% of population of LLDCs in South America have access to electricity. The proportion of the population with electricity in LLDCs in Africa and Asia

increased since 2013, but the need to intensify efforts so to improve access to electricity is more acute for LLDCs in Africa because there is a wide gap in access.

The proportion of population with primary reliance on clean fuels and energy has gradually increased in LLDCs from 27% in 2010 to 28.6% in 2017. This is below the global average of 59.8%. This is mainly due to the situation in African LLDCs. The proportion of the LLDCs in Africa with access to clean fuels and energy for cooking, such as gas and electricity has remained stable between 2010 and 2017, at only close to 8%. All other LLDC regional groupings have equal or higher access than world average and have experienced an increase in access between 2010 and 2015. In Asian LLDCs, the proportion with access increased from 53% to 58% and 60% between 2010, 2015 and 2017. European LLDCs reached 91.4% access, while 76% of the population in South American LLDCs rely primarily on clean fuels and energy.

It is also noteworthy that LLDCs have undertaken efforts to improve access to clean fuel and energy technologies. A major example is the rural electrification, biogas and improved cook stoves reported by Clean Energy Info Portal-Reegle (2016). In Africa, between 2012-2014, the World Bank supported a project Africa Clean Cooking Energy Solutions that was an enterprise-based platform to promote clean fuels and technologies (Uganda was one of the pilot countries). In East Asia between 2012 and 2015 the World Bank supported Mongolia, and Lao PDR in capacity building, policy development, knowledge sharing and institutional strengthening on clean stoves. The large-scale adoption and sustained use of clean cook stoves is constrained by financing in terms of a lack of investment and working capital for producers, and lack of information, awareness, and cultural barriers for consumers. This underscores the importance of awareness raising; markets and preferences; technologies and standards; and innovative financing. Growth in access to clean fuels and technologies for cooking has been slow with the exception of LLDCs in South America where a decline was experienced. Box 5.1 presents country cases of energy efficiency among LLDCs.

Figure 5.5: Proportion of population with access to electricity (%)



Source: World Bank, World Development Indicators and United Nations SDG indicators database

Box 5.1: Country Cases on Energy efficiency in LLDCs

Botswana

The scale-up of the public transport system as an alternative to using private cars presents opportunities for an efficient urban transport system in Botswana. This thinking permeates the draft Botswana Integrated Transport Policy. The options vary from the sophisticated rapid bus transport system to elementary changes such as dedicated lanes for mini buses and increased signage (at bus stops) depicting which bus-route passes where. With signage integrated with branding and advertisement, these can be done through private sector with no costs to the municipalities.

Lesotho

As laid out in Lesotho Energy Policy (2015-2025), government will promote energy efficient practices and equipment in all sectors of the economy. Strategies: a) Implement demand side management programmes and projects b) Introduce a metering system and tariff structure that will support energy efficiency and demand side management c) Discourage the use of intensive energy use devices and promote the use of energy efficient technologies d) Carry-out dissemination campaigns on wise use of energy e) Promote the adoption of renewable energy technologies that reduce total end-use electricity consumption f) Implement energy efficiency programmes in buildings g) Introduce incentives to support energy efficiency programmes and activities h) Support applied research and development in energy efficiency programmes and activities i) Develop specific principles for the policy statement

Tajikistan

A Law on energy efficiency and energy saving was adopted on 19 September 2013. The law stipulates the legal and organisational framework for energy efficiency and provides for the introduction of energy efficiency materials, appliances and technologies. The law has provisions for introducing mandatory energy audits, establishing procurement procedures that incorporate criteria on energy efficiency, and requirements for energy use in buildings and household appliances, etc. Currently, Government financing is not available for energy efficiency activities and projects in Tajikistan. The establishment of the National Energy Efficiency Fund envisaged in the new Law on energy efficiency and energy saving energy; furthermore, this framework is expected to be capitalised with the support of donors and international financial institutions as well as with national budget allocations.

Uganda

The Promotion of Renewable Energy and Energy Efficiency Programme (PREEEP) is a key project by the Ministry of Energy and Mines in collaboration with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), to promote energy efficiency and renewable energy. The government is also promoting the use of energy saving bulbs by distributing approximately 800,000 of them to low-income households. The Energy Advisory Project, also funded through the GTZ, aims to provide energy users with information about energy efficiency, as well as promote the use of efficient equipment and appliances in manufacturing and at home, and assess the benefits that improved efficiency could have on the transport and agricultural sectors, particularly in terms of maintenance of fleet vehicles and auditing of agricultural businesses. Efficiency standards-setting is another goal of the project. The Energy Advisory Project goals have recently been incorporated into the PREEEP, and as such continue to be pursued. The government, under the recently-implemented Renewable Energy and Energy Efficiency Policy, acknowledges a number of key areas where energy efficiency could be improved, by the policy's goal date of 2017. These include increasing solar water heater installations to 30,000 m², and implementing industrial energy auditing and the dissemination of efficient equipment to industries.

Zimbabwe

Through the draft national energy policy, the government plans to ensure efficient utilization of energy resources. The International Energy Initiative has previously run programs to promote the efficient use of energy, most notably the Zimbabwe Energy Efficiency Project (ZEEP). Under ZEEP, industrial

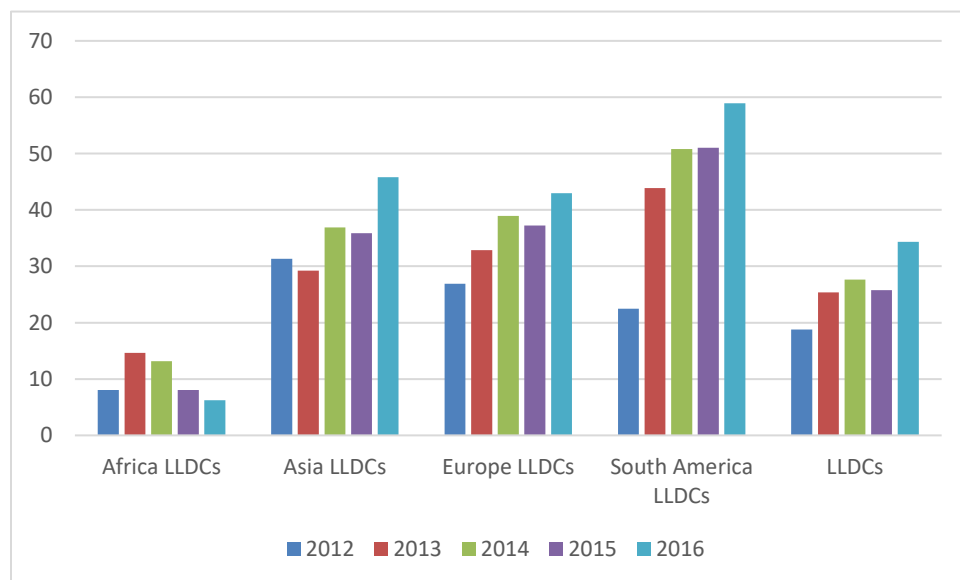
efficiency has been increased and efforts were undertaken to produce government standards for efficient appliances and equipment, for example, lighting, water heaters and refrigerators. Transmission and distribution losses in the country are considerably lower than in many African nations, standing at approximately 11 percent. Demand-side efficiency could be further encouraged in the country, as electricity tariffs remain amongst the lowest in Africa, at roughly US\$ 0.06/kWh, due to heavy subsidies. The low non-technical losses in the transmission and distribution system have been attributed to the exceptionally low power tariffs.

Source: Clean Energy Info Portal- Reegle, 2016

Royalty and licensing fees

Figure 5.6 shows the trends in royalty and technology licensing fees paid by firms operating LLDCs from 2012 to 2016. The average royalty and licensing fees increased from 2012 to 2016 suggesting that technology transfer to LLDCs generally improved during the period. The improvement occurred in all LLDC regional groups with the exception of the African LLDCs where the royalty and licensing fees declined from 2013 to 2016. The improvement in royalty and licensing fees was more striking from 2015 to 2016. This may be an indication that efforts at encouraging technology transfer by international community are beginning to have positive effects in LLDCs with the exception of African LLDCs.

Figure 5.6: Royalties and License Fees (US\$ million, average)



Source: UN COMTRADE

Patents and trademarks

Table 5.8 and Table 5.9 present the distribution of the number of patents and trademarks registration in LLDCs and transit countries in 2014 and 2017. While Asian LLDCs took the large part of the patents in 2014 and 2017, their share and actual number however decreased by 2017. African LLDCs, though had the lowest share of patents in 2014, have remarkably improved the number of patents by more than four-fold between 2014 and 2017 and by 2017 have taken second place amongst LLDC regions. The improvement in patents taken by African LLDCs is an

indication that with sufficient support, African LLDCs can make significant and rapid generation of new knowledge. The patents generation in transit countries is dominated by China and Brazil. This suggest that LLDCs could benefit from new knowledge from these two countries if they have sufficient local capacity to assimilate and adapt foreign knowledge.

Asian and European LLDCs have the largest share of the trademarks while African and South American LLDCs have the lowest shares. As in the case of patents, China and Brazil dominate the trademarks registered by transit countries.

Table 5.8: Distribution of patents in LLDCs and transit countries in 2014 and 2017

Region/Country	2014		2017	
	Number	% of total	Number	% of total
<i>LLDCs</i>				
Africa LLDCs	102	2.64	485	14.87
Asia LLDCs	3,031	78.40	2,221	68.09
Europe LLDCs	430	11.12	220	6.74
South America LLDCs	303	1.00	336	10.30
Total LLDCs	3,866	100	3,262	100
<i>Transit Countries</i>				
Transit Countries (excluding Brazil and China)	93,505	8.78	101,910	6.69
Brazil	30,342	2.85	25,658	1.69
China	940,825	88.37	1,394,961	91.62
Total Transit Countries	1,064,672	100	1,522,529	100

Source: WIPO

Table 5.9: Distribution of trademarks registrations in LLDCs and transit countries in 2014 and 2017

Region/Country	2014		2017	
	Number	% of total	Number	% of total
<i>LLDCs</i>				
Africa LLDCs	9,682	17.56	9,586	17.75
Asia LLDCs	22,489	40.77	24,193	44.80
Europe LLDCs	15,048	27.28	13,782	25.52
South America LLDCs	7,940*	14.39	6,445	11.93
Total LLDCs	55,159	100	54,006	100
<i>Transit Countries</i>				
Transit Countries (excluding Brazil and China)	457,512	23.59	698,871	31.50
Brazil	85,738	4.42	123,362	5.56
China	1,396,520	71.99	1,396,520 **	62.94
Total Transit Countries	1,939,659	100	2,218,753	100

Note: * only Bolivia; ** 2014 data

Source: WIPO

5.3.3. Technological learning experiences and opportunities

The emergent fourth industrial revolution has profound opportunities for technological learning that can be advantageous to late industrializers typified by LLDCs. STI investments and adoption of new technologies (whether new to the world or new to the user environment) are necessary to provide learning experiences that result in innovation and structural economic transformation. As stated in section one, in addition to their geographical remoteness, LLDCs exhibit major challenges in the area of information and communication technologies (ICTs). Investment in ICTs is a major component of STI investments and has become an important driver of overall economic performance, competitiveness and integration into the global economy. Moreover, digitization is increasingly pervasive and investment in ICT infrastructure determines the extent to which STI actors can effectively learn and employ digitization for removing obstacles to structural economic transformation. For LLDCs, ICTs are especially important because they provide technological solutions to constraints of geographical remoteness by facilitating access to information on global markets and improving the management of cross-border transactions.

There are several indicators of investment in ICTs and these include:

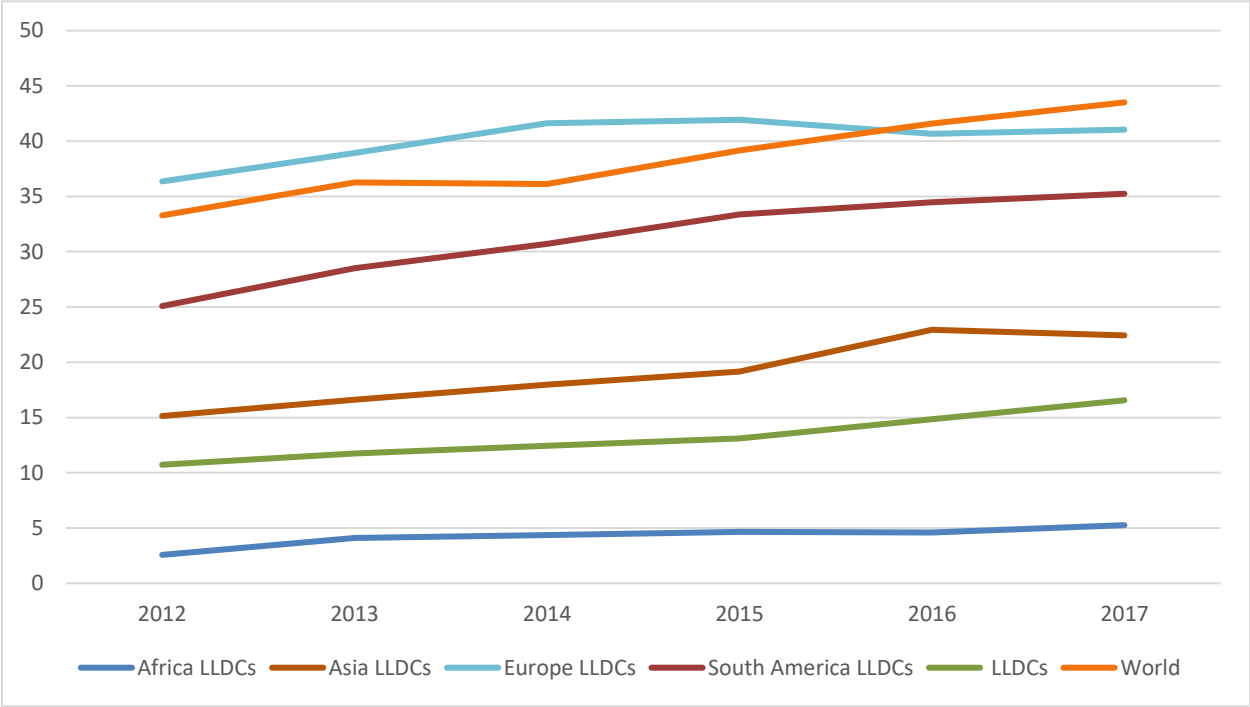
- ATM use per 100, 000 adults
- Fixed broadband subscription per 100 people
- Fixed telephone subscription per 100 people
- Individuals using internet (%)
- Mobile cellular subscriptions (per 100 people)
- Households with a computer (%)
- Households with internet access at home (%)
- Population covered by at least 3G mobile network (%)
- Telecommunications investment (% of revenue)
- Telecommunications revenue (% of GDP)
- Charges for the use of intellectual property, payments (BoP, current US \$)
- Charges for the use of intellectual property, receipts (BoP, US\$ million)
- ICT goods export
- ICT goods import
- ICT service exports (% of service exports, (BoP)
- Online service index (0-1, 1- highest presence)
- Big data and Internet of Things applications
- High-technology exports (% of manufactured exports)

A few of these indicators would be used to illustrate the growing importance of STI investments in the implementation of VPoA and their implications for the structural economic transformation of LLDCs.

Automated Teller Machine (ATM) technology is an important medium for facilitating financial transactions that could reduce transaction costs associated with cross-border movement of goods and services, and thereby improve trade. Figure 5.7 presents the trend in ATM use per 100,000 adults among LLDCs. The ATM use has been increasing across LLDCs but is still comparatively low. The situation is worse in African LLDCs where usage was just around 5 per cent in 2017,

though marginally increasing. With the exception of European LLDCs, all other LLDCs fall way below the global average for ATM use. However, the usage among European LLDCs is still below the EU average. This shows the low rate of ATM usage among LLDCs. Asian LLDCs even decreased ATM use slightly from 2016 to 2017.

Figure 5.7: ATM use per 100,000 adults

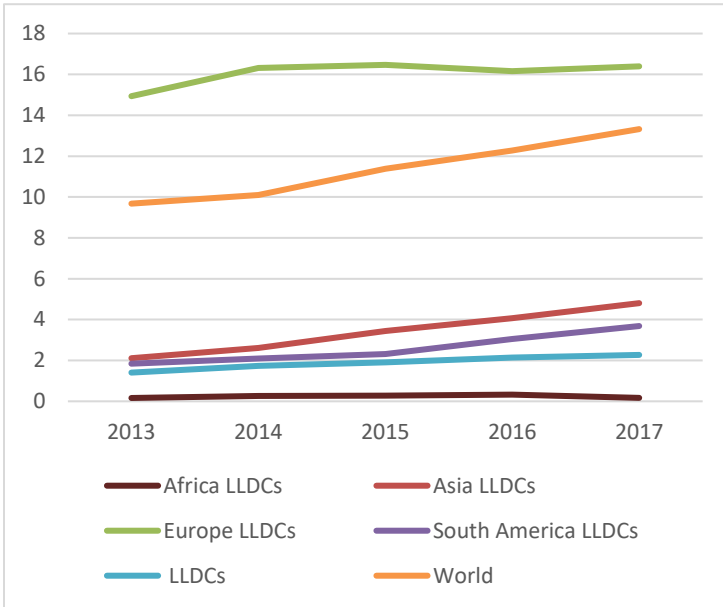


Source: World Bank, World Development Indicators

Generally speaking, LLDCs exhibit relatively low levels of development in the ICT sector as demonstrated by low rates of utilization of the fixed broadband subscriptions, internet, and mobile cellular subscriptions as shown respectively in Figure 5.8, Figure 5.9 and Figure 5.10. The usage is lower than that obtained in the EU and East Asia. Only European LLDCs are typically close to the world averages, with African LLDCs lagging most behind. Also, the proportion of households with and those with internet at home has been increasing but relatively lower than coastal countries and global average (See Figure 5.11).

As shown in Figure 5.12, the population covered by 3G mobile network in LLDCs in 2016 has also appreciably increased over the 2010 level. This increase however is lower compared to coastal countries. The remoteness of LLDCs apparently contributes to the gaps in access to internet services. Despite the fact that access and coverage remain insufficient in most LLDCs, these countries have experienced rapid increase in the penetration of ICT infrastructure and services. Access and utilization of ICT has increased in all regions, with sub-Saharan Africa and its LLDCs lagging behind.

Figure 5.8: Fixed broadband subscription per 100 people



Source: ITU

Figure 5.9: Individuals using internet (%)

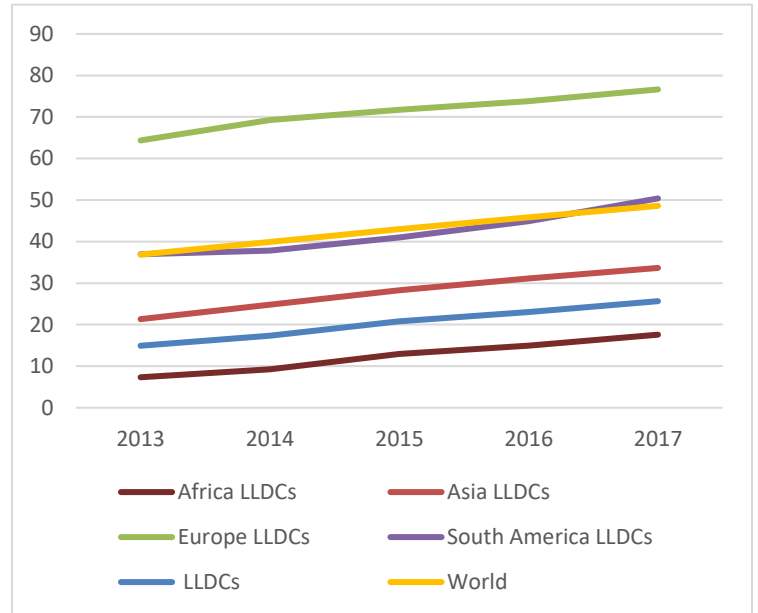
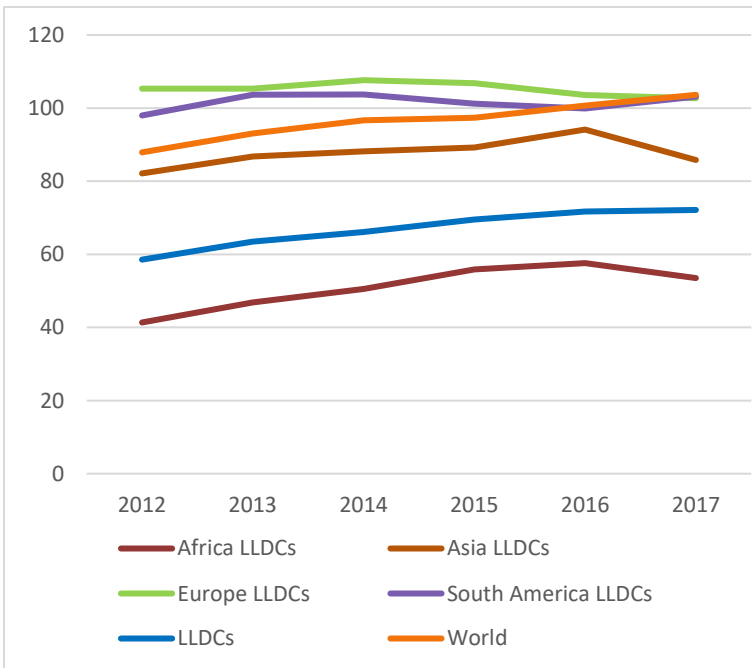


Figure 5.10: Mobile cellular subscriptions (per 100 people)



Source: ITU

Figure 5.11: Households with internet access at home (%)

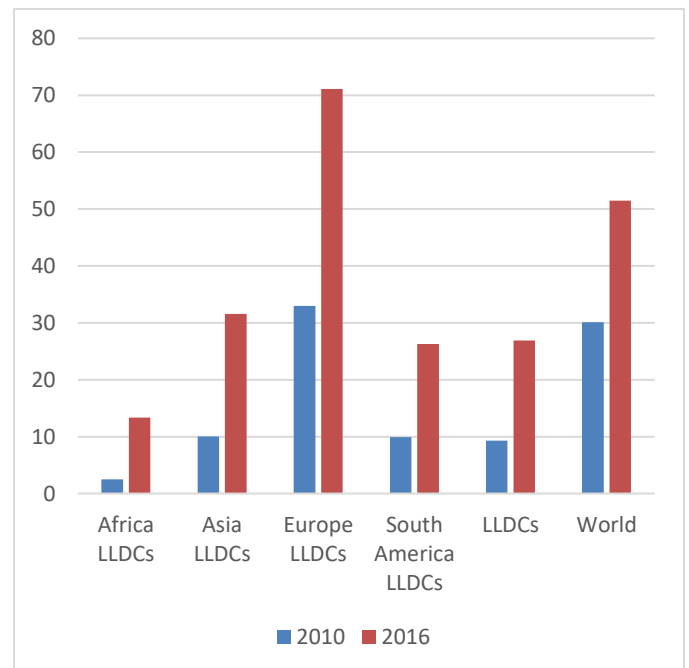
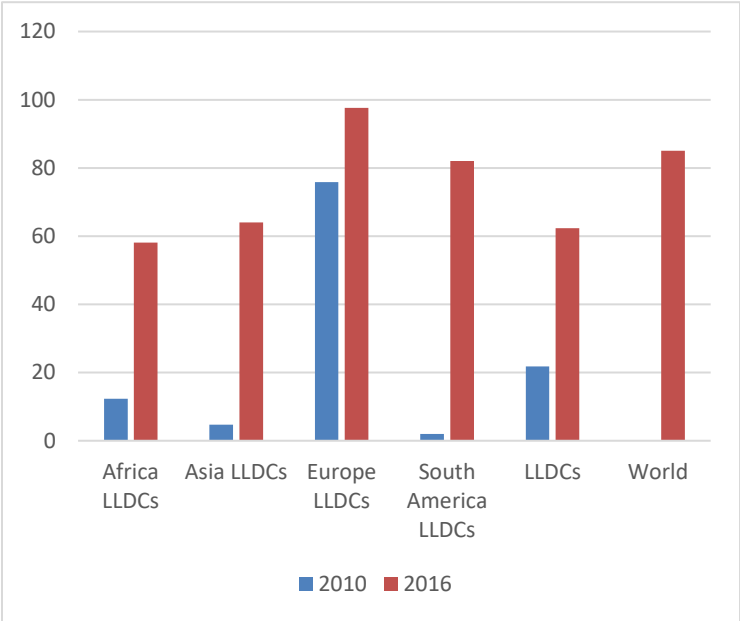


Figure 5.12: Population covered by at least 3G mobile network (%)



Source: ITU

6. EVIDENCE OF STI AS AN ENABLER OF STRUCTURAL ECONOMIC TRANSFORMATION

This section presents evidence of how STI has stimulated or supported structural economic transformation in LLDCs since the launch of VPoA in 2014. A few cases where STI has encouraged value chain development and steered the economy towards diversification are highlighted. The role of digitalization and its potential for enabling structural economic transformation and trade facilitation is discussed so that LLDCs can learn to explore the opportunities presented by digitalization as a new technology that powers the emerging global digital economy.

6.1. Technology Upgrading, Digitalization and Value Chains in LLDCs

6.1.1. Technology upgrading and value chains

As demonstrated in section 3 of this paper, the economies of LLDCs are largely commodity based and primary agriculture and extractive industry are the dominant economic sectors. Technology upgrading and value chain development are very important for economic diversification and structural change in LLDCs because technology upgrading improves productivity of labour and capital while value chains result in superior products. The superior products from value chains and the associated technologies bring returns that are far more attractive than what could be obtained when investments are constrained or limited by commodity exports or marketing. It is however pertinent to note that the technological and market vulnerabilities of LLDCs (especially low income LLDCs) require concerted efforts from development partners to make technology upgrading and value chain development beneficial to LLDCs. The case of honey production and processing in Zambia presented in Box 6.1 provides an illustrative case of how local and international development partners in cooperation with the private sector agents can support technology upgrading and value chain development for economic diversification and remarkable participation of LLDCs in global market.

Box 6.1: Zambia's honey trade

Honey processing generates more income

- The government of Zambia identified honey as a priority sector to diversify an economy largely dependent on copper exports. This created SMEs in honey processing and marketing.
- Honey exports increased by 700% over the last period 2013-2018.
- Zambian beekeepers were not producing as much as they could because they were less connected to buyers, and local processors needed support with food safety requirements and access to export markets.
- Enhanced Integrated Framework (EIF)²¹ and the International Trade Centre (ITC) provided technical support that increased beekeeper productivity and improved honey quality. Food safety certifications (HAACP) were obtained and new international buyers were secured. ITC manages the marketing side, which is complemented by EIF on the supply end. This enhanced the entire honey value chain for best results.

New technology in honey production and processing

- Over five years the Government of Zambia, EIF and SNV, a Dutch non-governmental organization, worked around 6,000 beekeepers, or approximately 20% of the estimated total beekeepers in the country.

²¹The EIF is a partnership of 51 countries, 24 donors and eight partner agencies working closely with governments, development organizations and civil society to assist Least Developed Countries (LDCs) use trade as an engine for development and poverty reduction. <https://www.enhancedif.org/en/who-we-are> (ACCESSED 04 April 2019).

- One crucial goal was to increase the amount of honey being produced. To do so, 5,000 harvesting buckets were distributed to address a collection challenge.
- 1,139 modern hives were supplied to beekeepers together with training programmes, resulting in improved honey quality and quantity.
- Armed with modern hives that don't require an arduous climb to harvest them, women were able to fully participate in beekeeping activities.
- The partnership supported the creation of the Kabule Women's Group, a cooperative of female beekeepers that are now discussing the creation of their own honey products, having been inspired by the new technology and training received.

Intervention in logistics of honey trade

- The intervention addressed the trifold issues of storage, transportation and sales.
- ITC focused on standards and creating market linkages so processors were exposed to international buyers.
- 18 collection centres were constructed across Zambia to house freshly collected honey, offer a point of purchase between beekeepers and processors, and alleviate the prohibitive cost of getting honey from rural areas to those who want to buy it.
- New connections were forged between honey sellers and buyers. For the Kabule women, that translated into their entire harvest selling to Lusaka-based Luano Honey, which gained high-quality honey directly from the source. Another processor, Adcom Investments, is now connected to 4,000 honey suppliers throughout Zambia as a result of its work with ITC. Once production increases, markets can be found more easily, which results in greater income and profits for processors and the suppliers.

Global reach of Zambian honey

- Adhering to strict requirements on storage and handling, six small businesses in Zambia have received HAACP food-safety certification as a result of ITC's efforts. Some have new buyers in the European Union and South Korea because of it.
- They also have contemporary packaging materials and links to the patent office to register trademarks so their honey brands reach supermarket shelves in Europe.

Source: ITC, 2018

6.1.2. Digitalization and value chains²²

Digitalization in the manufacturing process

Most of the debate on digitalization has focussed on the use of industrial robots in the production segment of the manufacturing process. In the context of value chains, industrial robots may have two major effects. First, countries that produce within already robotized value chains may need to robotize their production as well. This may apply especially for the inputs from their firms to meet the quality and product standards that the lead firm in that value chain sets in accordance to the needs of the lead firm's customers in developed countries. Second, industrial robots may adversely affect developing countries' employment and income opportunities by the reshoring of manufacturing activities back to developed countries. However, while offshoring might have slowed down, there is yet no systematic evidence that would point to large-scale reshoring from developing to developed countries (ILO, 2018). Nevertheless, the economic case for reshoring may be strong particularly where firms produce for developed country markets and expect that geographic co-location of production and R&D positively affects innovation (De Backer *et al.*,

²²This section draws largely from the work of Mayer, J. (2018). Digitalization and industrialization: friends or foes? UNCTAD Research Paper No. 25 UNCTAD/SER.RP/2018/7. Division on Globalization and Development Strategies, UNCTAD.

2018). Furthermore, the use of new digital technologies with a view to harnessing market intelligence on the functionalities and features of goods and services that appeal to customers for design and production decisions may allow developing countries to engage in the higher value-added activities in the value chain and benefit from the income-generating potential of digitalization. This potential will increase with the weight of developing countries in global demand and control over market-related data.

Pre-production activities

Mayer (2018) demonstrates that the new digital technologies tend to make design more flexible and reduce its cost. While requiring digital capabilities, digital design simulation reduces the number of work hours required to create new goods. It may also reduce the number of expertise needed to design goods. The latter may arise particularly to the extent that digitalization allows for the codification of tacit knowledge, i.e., the kind of know-how that comes from experience regarding, for example, how to best design and interlink product definition, detailed design, design for manufacturability, component design and eventual manufacture. Codification of tacit knowledge might result from machine learning that identifies correlations based on voluminous data. Machine learning may eventually even be superior to experience-based knowledge accumulation because it can easily identify correlations that humans would not have deliberately looked for. The rise in flexibility and the decline in cost of pre-production activities may be further enhanced by additive manufacturing. This technology can be used for rapid and less-costly simulation-based iterative prototyping and the production of specialized machinery. It compresses the development cycle of products that may subsequently be mass-produced based on traditional technology and infrastructure (Sturgeon, 2017), or be taken for more customized production based on digital technologies.

Post-production activities

The new digital technologies (especially ICTs associated with the Internet of Things- such as cloud computing and big-data analysis) significantly raise the importance of the post-production segment for the entire manufacturing process (Mayer, 2018). ICTs can optimize business operations by increasing the efficiency of production schedules, logistics, inventory management and equipment maintenance, and especially by integrating the data emanating from separate systems into a coherent picture. Also, access to sales data provides better after-sales services, so that manufactures can broaden their activities to include services using the opportunities provided by e-commerce platforms. Furthermore, from a development perspective, cloud computing and big-data analysis reduces the need for hard digital infrastructure, as well as the cost of computing and using software. Cloud computing and big-data analysis also allow for a drastic increase in the number of interactions between firms and customers. This facilitates more personalized advertising and distribution campaigns that go beyond traditional marketing often targeted at certain groups such as readers of certain publications or residents of certain neighbourhoods. This can drastically reduce marketing costs while reaching out to more potential customers. It may also significantly increase the effectiveness of expenditure used to build brand names and other reputational assets, and make access to both market-related information and its analysis more easily affordable for developing countries.

Two case studies on digitalization in LLDCs

Though the crucial role digitalization could play in structural economic transformation through technology upgrading in manufacturing and value chain development is well known, its application in developing countries is yet to be widespread. According to Sirimanne (2019), the post-production activities which include e-commerce may be constrained by the following factors in LLDCs:

- Limited use of the Internet among businesses and consumers
- Lack of awareness among governments and regulators
- Concerns about possible adverse effects
- Insufficient access to affordable ICT infrastructure
- Inefficient trade logistics and facilitation
- Lack of online payment facilities
- Lack of security and trust in online transactions
- Weak legal and regulatory frameworks
- Limited e-commerce skills among MSMEs
- Absence of statistical data on e-commerce

It is however pleasing to note that anecdotal evidence of ICT applications especially through digitalization exist in LLDCs. Two examples are the case of Rwandan ICT applications in Health and Agriculture, and the Ugandan Data visualization for Disease Control Project presented in Box 6.2 and 6.3 respectively. The health sector applications in Rwanda and Uganda are very important to building human capital that are required for structural economic transformation while the agriculture application in Rwanda promotes women empowerment and economic diversification. The next subsection will provide further evidence on how digitalization encourages trade facilitation in LLDCs with a potential to effectively engender structural economic transformation.

Box 6.2: Rwandan ICT and digital economy plan

Policy background

The key strategy document driving high-speed communications in Rwanda is the 2013 *National Broadband Policy* which aims at transforming Rwanda into an information society driven by universal access through high speed, reliable, affordable and secure broadband infrastructure and services by 2020 (GoR, 2013). The policy specifies a timeline with specific actions to be carried out by various organizations. These include: creating a public private partnership wholesale provider; updating the legal and regulatory framework in terms of relevant licensing, standards and spectrum changes to accelerate broadband rollout; establishing network rollout targets (95% of the country to be covered by June 2017); creating a digital literacy program; programs to provide affordable devices and develop content and applications; and connecting all public institutions to broadband. The broadband policy feeds into the SMART Rwanda Master Plan (SRMP) covering the period 2015-2020 (MYIT, 2015). SRMP builds on the previous plans, with a focus on innovation in order to use ICTs as a transformational enabler to digitize the economy generating growth and job creation. The plan emphasizes three key enablers (ICT capability, ICT Governance and Management, and ICT Shared Infrastructure); and seven strategic pillars (Health, Finance, Trade and industry, Agriculture, Education, Government, and WOY-Tech).

Health sector application

A major achievement in the Rwandan health sector is records digitization and transmission through the Rwanda Health Management Information System (R-HMIS). Over 500 health facilities across the country are connected to R-HMIS through the Internet (around 94% of the total). The system has been

progressively updated adding new tracking features such as child death reporting, tuberculosis and HIV patients. The Ministry of Health has been using a mobile text platform called Rapid SMS to track early child health (“the first 1,000 days”).²³ Community health workers in all of the country’s some 15,000 villages are provided with cell phones to send text messages about the status of child health in order to quickly trace any anomalies and provide rapid treatment. By 2015, some 186,719 children were being monitored through the platform.²⁴ One innovative application recently launched is the use of drones to deliver blood across the country.²⁵ The service is operated by Zipline a US start-up. The blood packages are dropped by parachute and then the drone returns to its base. The first phase involves 15 drones delivering the blood to hospitals in rural western Rwanda. They use GPS navigational data and the cellular network to transmit information to air traffic control and the base station, and for health workers to send text messages when blood is needed. Although the cost is roughly the same as motorbike or ambulance, it is much faster (UN-OHRLLS, 2017b).

Agriculture application

In agriculture, another initiative is “Buy from Women”, introduced by the UN in 2016. The platform is targeted at women farmers, providing weather, pricing and other information to their mobile phones. Some 700 women from two cooperatives have already registered with plans to extend the system to ten more cooperatives. The system also allows farmers to calculate production capacity based on their land size, matching it to cooperative requirements (United Nations Rwanda, 2016).

Box 6.3: Ugandan data visualization and interactive mapping for disease control

In 2015, Uganda had a typhoid outbreak. The Ugandan Ministry of Health’s district office collected data at the health centres where typhoid cases were treated. In order to use this information effectively for a disease response, Pulse Lab Kampala was invited to utilize interactive data visualization tools to help present dynamic information about case data and risk factors in support of managing the outbreak. This, in turn, helped reveal clusters of infection through interactive maps at the district, sub-county and individual health facility levels. Furthermore, interactive mapping tools provide the ability to show infection rate data, along with information about risk factors, and thereby helped understanding of the patterns of transmission. As a result, the visualizations contribute in the assessment for decision-making regarding the allocation of medicine and mobilization of health teams (United Nations Global Pulse, 2015).

Pulse Lab Kampala is the first innovation lab in Africa. It brings together data scientists, data engineers, partnership specialists, academics and technical experts to generate high impact data analysis tools to address development challenges. These innovative tools support UN partners and government in anticipating and responding to poverty, impacts of natural disasters, epidemics and food security by leveraging new sources of digital ‘Big Data’ (such as social media, mobile data, online information) and real-time analytics. Pulse Lab Kampala is established as an inter-agency initiative under the United Nations Resident Coordinator in Uganda, and contributes to the United Nations ‘Delivering as One’ process supporting joint programming, monitoring and evaluation to achieve the SDGs.²⁶

²³Ministry of Health. n.d. “The Use of RapidSMS in Nutrition.”

http://www.moh.gov.rw/fileadmin/templates/Summit3/22_The_Use_of_RapidSMS.pdf.

²⁴http://www.myict.gov.rw/fileadmin/Documents/ICT_Sector_Profile_2015/ICT_Sector_Profile_2015.pdf

²⁵Simmons, Dan. 2016. “Rwanda begins Zipline commercial drone deliveries.” BBC News, October 14.

<http://www.bbc.com/news/technology-37646474>.

²⁶See <https://www.unglobalpulse.org/kampala> (ACCESSED, 14 May 2019)

6.2. STI and Trade Facilitation

Trade facilitation is critical to initiatives aimed at addressing the challenge of landlockedness and STI are important enablers of trade facilitation. This is because Science and technology are essential for the development of efficient transportation networks required for LLDCs to connect each other and global markets more effectively and less expensively. This subsection therefore provides evidence on how STI, and particularly digitization, facilitate trade and help overcome geographical barriers to trade by reducing cross-border transaction costs in LLDCs. For example, a recent report by the World Bank on Technology Gains in Trade Facilitation demonstrates that countries that support electronic submission of trade documents have shorter border compliance times compared to paper only or hybrid systems.²⁷

Trade facilitation is also vitally important in promoting economic diversification and bringing about structural economic change. Recognizing the importance of trade facilitation, LLDCs have adopted a wide range of measures at simplifying trade regulations, documents and procedures with support from their development partners and transit countries. According to UN-OHRLLS and UN-ESCAP (2019), some of the trade facilitation measures and tools that LLDCs have adopted include:

- cross-border paperless trade,
- e-based transit and transport facilitation tools,
- single-stop inspections,
- single windows for documentation,
- electronic payment, and
- modernization of border posts and customs services.

Trade facilitation has significantly been strengthened with the introduction of ICT solutions to trade, transport and business transactions which have opened up new opportunities for the LLDCs. As reported by Internet Society (2018), several of the LLDCs have adopted ICT solutions in streamlining customs clearance procedures and formalities, reducing the number of documents, and improving vehicle movements speedily and less expensively. E-banking has been adopted in making payments of taxes and customs duties at border crossing points. A number of LLDCs have adopted the Single Window facilitation tools and Automated System of Customs Data (ASYCUDA) which have greatly improved customs clearance and procedures. Using these facilitation tools, they have been able to improve their trade portals, streamline their customs procedures and reduce paper work. Azerbaijan had completed the establishment of single window facilities at the country's customs border check points since 2009. Similarly, Bhutan has instituted the Bhutan Automated Customs System and identified the National Single Window as one of the key initiatives in its 12th Five Year Plan to provide seamless end to end facilitation of cross border trade. Kazakhstan introduced several measures including the system for electronic declaration and modernization of its customs information and management system. Kyrgyzstan set up the Single Window Centre for Foreign Trade to boost trade efficiency, and Lao PDR launched its Trade Facilitation Strategic Plan in 2011 under which it established the E-Customs Automated System

²⁷Ferro, Cécile, Marilyne Youbi, Dorina Georgieva, Valentina Saltane, and Inés Múgica. 2016. "Technology Gains in Trade Facilitation." In *Doing Business 2017*. Washington DC: World Bank. <http://www.doingbusiness.org/reports/global-reports/doing-business-2017>

for Customs Data (ASYCUDA) at its border posts. Nepal has set up the ASYCUDA at its 13 customs offices.

While the trade facilitation initiatives among LLDCs mentioned above are commendable, LLDCs as a group need to do more in improving and harmonizing their customs administrations, streamlining border crossing procedures and applying ICT solutions including introduction of paperless trade and implementation of single window environment. According to Internet Society (2018), there are three key areas where the Internet can assist physically landlocked countries become digitally land linked, via:

- Networked customs systems which have a significant impact on reducing the delays and cost of trading across borders.
- Access to fibre optic submarine cables.
- LLDCs are on a more equivalent footing with non-landlocked countries in services trade, and the Internet can therefore provide a platform for the offshoring of information technology services.

Furthermore, Internet Society (2017) suggests that the Internet can facilitate trade through expansion of ICT infrastructure, fostering skills and entrepreneurship, and supportive governance.

Boosting cross border connectivity through ICT infrastructure

Similar to the transport of goods for trade, landlocked countries are dependent on transit countries for access to submarine cables. National backbones are therefore crucial for LLDCs in order to interconnect with the networks of sea facing nations for access to undersea fibre optic systems. Downstream local access is dependent on upstream backbone networks as well as traffic exchange arrangements in terms of quality and prices. If there is insufficient international bandwidth due to constraints with the backbone network, quality and pricing of Internet access will be high. LLDCs that can successfully deploy cost-effective national backbones that are interconnected with regional transmission networks and submarine cables will reap gains through fast Internet and low prices for consumers. This is however subject to the existence of open domestic traffic exchange mechanisms.

Skills and digital business

Digital skills are essential to leverage the opportunities created by expanded Internet infrastructure. Internet-enabled services could be attractive for LLDCs since unlike goods trade, there is no need to physically cross borders. LLDCs thus compete on a more level playing field with other developing nations for services exports. In terms of Internet-enabled service exports, opportunities include computer services such as software exports and data processing as well as business services (e.g., accounting, call centres, medical transcriptions, etc.) delivered over computer networks.

*ICT governance in a dynamic world*²⁸

²⁸The information/data in this subsection draw largely from Internet Society (2018)

The way the Internet sector is nurtured and encouraged to grow is a function of the effectiveness of policy and regulatory mechanisms as well as high-level government commitment. Most LLDCs have followed the advice of telecommunications sector reform prescribed by the international community. All but two of the LLDCs have opened their mobile market to competition though the depth of the competition varies, with a number of LLDCs exhibiting signs of high market concentration. Twenty-four LLDCs (75 percent) have a sector regulator. True independence is however not always assured because it depends on the regulator's management composition, how they are appointed and whom they report to. With respect to online shopping, 21 LLDCs have an electronic commerce law, but only a few have a thriving online shopping market often for reasons related to trust, payments, or interpretation and implementation of the law.

A key indicator of whether ICT sector reforms will be successful is how committed the government is. The World Economic Forum's Network Readiness Index includes a survey question on the perception of the extent to which governments have a clear implementation plan for using ICTs to improve the country's competitiveness. Rwanda ranks top among LLDCs and fourth in the world. This is not surprising given that President Paul Kagame has been a strong proponent of broadband and its critical role in economic development. This high-level dedication to ICT is reflected in the country's accomplishments. It has among the highest mobile broadband population coverage in the LLDCs and has deployed an innovative public private partnership for 4G/LTE rollout that aimed at covering most of the population by the end of 2017. Another LLDC that ranks high in government commitment is Azerbaijan, ranking second within the group and eighth in the world. One of the areas where the country has achieved impressive results is in the use of ICTs in schools. The People's Computer Initiative resulted in more than 10,000 teachers being provided with computers, 1,200 schools connected to the Internet and digital skills training for 75,000 people. Overall, there are eight LLDCs where the perception of government ICT commitment exceeds the world average.

7. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions provide the key messages from the findings of this paper and the ensuing recommendations drawn from the lessons learnt to provide the way forward for fostering STI investments as major instrument of structural economic transformation and competitiveness of the economies of LLDCs.

7.1. Conclusions

The findings of this paper demonstrate that overcoming the challenges associated with landlockedness is feasible and would require an enduring international partnership that understand how to harness the opportunities created by science, technology and innovation for structural economic transformation of LLDCs. The results reveal that the pace of economic structural change has been very slow among LLDCs in spite of the implementation of VPoA, and the national and international commitments for the realization of the 2030 Agenda. Though it may be argued that the period 2014 to 2017/2018 is too short to measure VPoA impacts on the economies of LLDCs, the fact remains that the changes observed in key economic indicators, especially in the structure of production in LLDCs, are too marginal to suggest that structural economic change is making significant progress or possibly increase in pace of occurrence.

There is evidence that STI policies aimed at fostering knowledge based and innovation driven economies in LLDCs exist at national levels, and development partners have reached a consensus that VPoA and the 2030 Agenda for Sustainable Development cannot be effectively implemented without global support for developing countries' investment in STI. In this respect, the Technology Facilitation Mechanism (TFM) is an international framework from which LLDCs can draw support for technology transfer and deployment in the process of implementation of VPoA.

The analysis of the STI profiles of the LLDCs showed that the effect of the implementation of VPoA on STI actors' competences and capacity to innovate are weak, and would require more action and incentives that would make STI actors pro-active in the drive for generation and use of technological innovation in a functional national system of innovation. More efforts are needed in the three areas of STI profiles analysed in LLDCs: 1) science base and structure of investments in scientific activities should be improved radically through investment in education and training; 2) research and development expenditure as proportion of GDP should be improved across sectors; and 3) technological learning experiences and opportunities should be tapped more aggressively by LLDCs and digitization particularly provide a new window of opportunities for overcoming geographical barriers to trade and for reducing cross-border transaction costs. The analysis of the STI profiles also indicate that though a few LLDCs in Asia performed remarkably well in structural economic transformation in recent years, it is difficult to ascribe their good performance entirely to the implementation of VPoA because industrial policies in these countries predate VPoA. It is also important to state that African LLDCs generally lag behind other LLDCs in economic performance and in their capacity to learn and harness the opportunities provided by new and emerging technologies.

7.2. Recommendations

Based on the findings of this paper, the following recommendations are aimed at providing practical solutions that would foster the employment of STI for structural economic transformation in LLDCs. The recommendations are:

1) Embark on reform for structural economic change

It appears from the findings that most of the LLDCs have no economic reform measures that aggressively tackle the challenge of weak productivity especially in the agricultural and manufacturing sectors. The share of agriculture and industry in total output remains relatively unchanged for most LLDCs since the adoption of VPoA in 2014. A few LLDCs showing remarkable improvement in share of industry in GDP are those that have aggressive economic reform measures before the adoption of VPoA. LLDCs should therefore embark on economic and industrial policies that aggressively pursue structural economic transformation. As amply demonstrated by the findings of this paper, the reform measures should foster the employment of STI for production activities to ensure that economic transformation is real and sustainable. The reform measures require the support of international development partners in order to encourage technology transfer and create opportunities to learn from other countries that have successfully achieved structural economic transformation. LLDCs need to establish clear and consistent national policies on research and knowledge generation with effective mechanisms for incentivizing private sector creativity and innovation, rewarding excellence in science and technology and protecting scientific and technological rights.

2) Build human capital, technological capability and skills

The findings of this paper indicate that LLDCs especially in Africa lack local technological capability required for assimilating foreign technology and keeping pace with technological advances. To respond to rapid technological change, LLDCs will need to build human capital by investing more in education of its citizenry through reforms in education and training systems, and promote lifelong learning so they could acquire requisite skills for transforming the economies of LLDCs. The results of the analysis in this paper indicate that LLDCs must establish science, technology and innovation as the cornerstone of their human capital development strategy by significantly improving the level of investments in education and training. Increasing the share of budgetary allocation to science, technology, engineering and mathematics (STEM) in the formal education system budget will particularly help improve the quality and reach of infrastructure required for STEM education, and consequently boost enrolment in STEM and related disciplines. It is also critical for public investments in education to support close interactions between the generation of science and technology in knowledge institutions and their application in the real sectors such as agriculture and manufacturing. Investment in education and skills should be particularly focussed on building the capacity of LLDCs to harness the opportunities being created by new and emerging technologies (e.g., biotechnology, nanotechnology, artificial intelligence, machine learning, big data, cloud computing, 3D printing, etc) for economic development and competitiveness.

3) Improve R&D expenditure

International support for technology transfer and knowledge creation would not result in structural economic transformation as long as domestic investment in R&D is very low. National R&D expenditure in LLDCs should be significantly improved to raise local capacity for technology acquisition. If local capacity to adapt, absorb and assimilate foreign technology is low, structural economic transformation would remain highly constrained because the economy would be incapable of delivering the skills and knowledge platform for foreign and superior technology to thrive.

4) Support for STI investments

Support for STI investments is very crucial for strengthening the national system of innovation and increasing the capacity of STI actors to innovate and participate effectively in global value chains. Support for STI investments in LLDCs must be global with full commitment of developed countries and international development partners. The support for STI investments should not be dictated by donors but be delivered by consensus or on agreed STI initiatives that directly promote manufacturing competitiveness of LLDCs, strengthen their capacity to diversify their economy and integrate into global value chains. If support for STI investments in LLDCs is so sincere, structural economic transformation will take place at remarkable speed in LLDCs. Notable areas of specific STI investment support include ICT infrastructure (e.g., broadband Internet access and mobile devices, eLibraries in educational institutions, digitalization of cross-border transaction facilities, etc.), and clean energy technologies (e.g., renewable energy systems).

5) Improve support for LLDCs in international STI initiatives

International development partners should improve support for LLDCs in international STI initiatives by focusing international STI policies on:

- Strengthening of institutions for STI in LLDCs;
- Supporting research and development (R&D) in LLDCs;
- Building STI infrastructure for trade facilitation in LLDCs; and
- Advising LLDCs governments on STI policies.

Technology transfer does not happen by default, but rather by building local technological capability that is strong enough to adopt and assimilate foreign and superior technologies. Development partners should thus improve support for building technological capabilities in LLDCs in order to acquire knowledge and innovation for the achievement of the structural economic transformation priority of VPoA.

6) Promote digitalization of the economy through investments in ICT infrastructure

The findings of this paper amply demonstrate that trade and regional integration between LLDCs and transit countries would benefit immensely from local and international efforts aimed at promoting digitalization of the economies of LLDCs and cross-border activities between LLDCs and transit countries. The scaling up of ICT investments would enhance digitalization of LLDC economies. The global economic competition is increasingly determined by digitalization, and LLDCs cannot afford to be left behind like it happened in the previous waves of technological

change. Promoting digitalization of LLDC economies through massive ICT investments and appropriate uses would transform every sector of the economy and provide opportunities for micro, small and medium enterprises (MSMEs) to thrive, become competitive and integrated into global value chains. The participation of LLDCs in global trade would thus be significantly improved and structural economic transformation of LLDCs would consequently be effectively stimulated.

7) Pursue innovation policies as strategic instruments of economic diversification and competitiveness

The findings of the paper revealed that only 11 of the 32 LLDCs have a policy document specially dedicated for the promotion of investments in STI, 18 LLDCs have STI policies embedded in broader development plan or economic policy frameworks, and there is no evidence that three LLDCs have STI policy. Industrial economies and newly industrializing countries have a history of ardent pursuit of innovation policies as instruments of economic diversification and competitiveness. In this respect, innovation policy is an integration of STI and economic policies in a strategic policy framework that aims at fostering economic growth, creating new processes and products with sufficiently superior value that change market dynamics in favour of the economy. LLDCs should learn from this established economic development paradigm by pursuing innovation policies that effectively integrate STI policies with economic policies. The findings also revealed that STI policies in most LLDCs have in recent years shifted in focus to a more realistic problem-solving approach to STI. It should however be noted that the effectiveness of the STI policies depend on the STI regulatory environment which is determined by the governing rules and regulation, existence of modern transparent institutions, functional infrastructure and good judicial system. A clear understanding of the peculiarities of sectoral systems is also necessary for identifying sources of innovation and the applicable innovation policies.

8) Special support mechanism for African LLDCs

African LLDCs generally lag behind in most of the indicators of structural economic transformation analysed in this paper. They are also relatively weak in the performance of STI actors and capacity to innovate in a national system of innovation. These findings suggest that LLDCs in Africa would need a more specialized support to ensure they overcome current challenges associated with landlockedness and remove the inertia restricting innovative and knowledge generating activities. The special support mechanism should be initiated and packaged by the UN in collaboration with African Union after adequate sensitization that achieve the support of international development partners, civil societies and national governments. The organized private sector in each of the LLDCs should also be actively involved because creativity and innovation are products of interactions among actors often driven by the imperatives of the market.

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ANNEXES

Annex A: SELECTION OF VPoA IMPLEMENTATION STRATEGIES AND ACHIEVEMENTS IN LLDCs, 2014 – 2018

Country	Implementation Strategy	Achievement
AFRICA		
Botswana	<ul style="list-style-type: none"> • Improving intermodal connectivity through regional cooperation and integration • Development of infrastructure such as road, rail, and air routes, ICT, internet connectivity etc. • Promoting trade and trade facilitation • Economic diversification drive initiative • Good governance and rule of law. • Adoption of national climate change strategy and action plan in 2013. 	<ul style="list-style-type: none"> • Increase in market access and share under the free trade area. • Upgrading unified revenue services to customs management system • Formation of vision 2036 • Tripartite free trade area agreement • Real GDP grows at 2.3% in 2017 • Improvement in access to the internet • Regional collaboration on STI
Burkina Faso	<ul style="list-style-type: none"> • Trade facilitation and export promotion. • Adoption of national policy for scientific and technical research in 2012 • Promotion of agriculture and environmental science to ensure food security • Regional collaboration and integration. • Infrastructural development in energy, transport, ICTs, education etc. • Adoption of national strategy to popularize technologies, inventions and innovations in 2012 • Adoption of national innovation strategy in 2014 	<ul style="list-style-type: none"> • Real GDP grows by 6.3% in 2017 • Creation of national fund for education and research • Creation of national fund for research and innovation for development • Export trade accounted for 24.4% of real GDP in 2017 • Improvement in standard of living. • Improvement in national system of innovation.
Burundi	<ul style="list-style-type: none"> • Promoting agriculture • Formulation of vision 2025 • Regional collaboration on STI and economic integration • Trade and trade facilitation policies • Improving education • Infrastructural and ICT development • Promoting ease of doing business 	<ul style="list-style-type: none"> • Creation of centre for excellence • Exports trade rose by 10% in 2017. • Policy is now research driven at regional level • Real GDP grows by 0.5% in 2017 • One of the top World Bank's rank on ease of doing business • Greater access to internet facilities

Central African Republic	<ul style="list-style-type: none"> • Resuscitating education and getting refugee children back to school • Promoting STI • Stimulating Agricultural production • Export promotion and trade facilitation policies • Maintaining national and regional political stability • Rehabilitating infrastructure such as roads, ICT, energy, etc. 	<ul style="list-style-type: none"> • Real GDP grew by 4.3% in 2017 • Export trade rose by 12.0% in 2017 • Improve national and regional political stability • Greater access to internet facilities • Increase in school enrolment and educational standard • Improved bilateral and multilateral cooperation
Chad	<ul style="list-style-type: none"> • Diversification of production • Promotion of agriculture and efficient use of natural resources (oil and gas) • Improving regional and national cooperation and integration • Trade and trade facilitation policies • Maintaining political stability with neighboring countries • Infrastructural development such as energy, ICTs transportation etc. 	<ul style="list-style-type: none"> • Real GDP decreased by -2.9% in 2017 • Export increased by 40.2% of the real GDP in 2017 • Increase in school attendance • Greater access to water and sanitation • Improved regional cooperation and peace • Greater access to internet facilities • Strengthened cease fire agreements
Eswatini	<ul style="list-style-type: none"> • Promoting agricultural productivity • Improving education • Infrastructural development such as ICT, energy, road, railways and air routes etc. • Regional cooperation and integration 	<ul style="list-style-type: none"> • Export trade accounted for 53.7% of real GDP in 2017 • Real GDP grew by 1.8% in 2017 • Improvement in the use of internet • Marginal improvement in school enrolment
Ethiopia	<ul style="list-style-type: none"> • Promoting agriculture and efficient use of natural resources • Focuses on modernization and industrialization • Adoption of growth and transformational plan 2011-2015 • Development of infrastructures such as energy, ICT, Road rail, and air routes, etc. • Sustainable technology transfer • Trade and trade facilitation policies • Climate resilient green economy vision and strategy • Reforming education • Regional cooperation and integration 	<ul style="list-style-type: none"> • Real GDP grows by 10.2% in 2017 • Exports rose by 10.7% of real GDP in 2017 • Upgrading of science and technology commission to ministerial level. • Improved infrastructures such as energy, ICT, Road rail, and air routes, etc. • Greater access to internet facilities • Greater regional and international cooperation and integration • Enhance school enrolment and educational quality. • Improved standard of living.

Lesotho	<ul style="list-style-type: none"> • Adoption of national strategic development plan I 2012-2017 • Implementation of national strategic development plan II 2018-2023 • Strengthening governance and accountability systems • Building enabling infrastructures like energy, ICT, roads, railways etc. • Development of human capital (health, education and skills development) • Enhancing inclusive and sustainable growth. • Regional cooperation and integration. 	<ul style="list-style-type: none"> • GDP grew at 2.3% in 2017 • Poverty rate reduces to 57% between 2014 and 2017. • Automation of revenue collection system • Increased accessibility of internet services of about 27% in 2018 • Tripartite free trade agreements at regional level • Improvement in the provision of infrastructures
Malawi	<ul style="list-style-type: none"> • Diversification of the economy through agriculture, manufacturing, energy, tourism and infrastructures. • Adoption of national export strategy in 2013 • Promoting agriculture which account for 27% of the GDP • Use of incentives to attract FDI • Development of infrastructural facilities. 	<ul style="list-style-type: none"> • Real GDP grew by 4.0% in 2017 • Creation of investment and trade centre in 2013 • Improvement STI research and biomedical research capacity • Export trade rose by 101% of the real GDP in 2017 • Greater access to the internet • Improve agricultural productivity.
Mali	<ul style="list-style-type: none"> • Promoting agriculture • Educational reforms • Establishment of trade facilitation policies • Development of infrastructures like roads, ICT, energy etc. • Regional cooperation and integration. 	<ul style="list-style-type: none"> • Export trade accounted for 22.7% of real GDP in 2017. • Real GDP rose by 5.4% in 2017 • Improvement in infrastructural development • Improved access to internet facilities • Improvement in school enrolment rate
Niger	<ul style="list-style-type: none"> • Adoption of national policy on STI in 2015 • Implementation of a programme for the education and training sector 2014-204. • Trade and trade facilitation measures or policies • Promotion of regional collaboration and integration • Development of infrastructures such as energy, ICT, transportation etc. 	<ul style="list-style-type: none"> • Real GDP grew by 4.8% in 2017 • Export trade contributed 16.5% of real GDP in 2017 • Creation of support fund for scientific research and technological innovation • Improved infrastructures and regional cooperation with transit countries • Greater access to internet facilities.
Rwanda	<ul style="list-style-type: none"> • Promotion of regional cooperation and integration 	<ul style="list-style-type: none"> • Real GDP grows by 6.1% in 2017

	<ul style="list-style-type: none"> • Adoption of Rwanda’s vision 2020 • Adoption of Rwanda’s first and second economic development for poverty reduction strategy 2013-2018 • Investment hard and soft infrastructures as energy, ICT, green innovation • Trade facilitation policies and foreign trade • Promoting FDI • Promotion of education and STI. 	<ul style="list-style-type: none"> • Creation of climate change and environment innovation centre • Export trade increased by 19.4% of real GDP in 2017 • Establishment of national industrial research and development agency in 2013 • Creation of ICTs Centre (KLab) and ICT park • Construction of national data centre for data hosting facility • Establishment of knowledge transfer partnership programme • Establishment of regional centre of excellence in ICT • National fund for environment and climate change was set up.
South Sudan	<ul style="list-style-type: none"> • Government prioritizing education • Efficient use of resources (oil and gas) • Promotion of agriculture • Development of infrastructures such as energy, ICTs, transport routes, etc. • Regional cooperation and integration • Trade and trade facilitation policies 	<ul style="list-style-type: none"> • Increase in the number of children attending school • Improved infrastructural facilities • Greater access to internet facilities • Improved regional cooperation and stability. • Improved foreign trade with transit countries and development partners.
Uganda	<ul style="list-style-type: none"> • Adoption of Uganda’s vision 2040 in 2013 • Launching of the business process outsourcing incubation centre • Development of infrastructures such as energy, ICTs, transport routes etc. • Regional cooperation and integration • Foreign trade and trade facilitation policies • Promotion of agriculture • Improving education and STI. 	<ul style="list-style-type: none"> • Real GDP increase by 3.8% in 2017 • Greater access to internet facilities • Development of infrastructural facilities • Export trade accounted for about 15.1% of the real GDP in 2017 • Enhancement of education and school enrolment • Improved private sector participation in the business environment. • Regional collaboration and integration.
Zambia	<ul style="list-style-type: none"> • Efficient use of natural resources • Stimulating agricultural production 	<ul style="list-style-type: none"> • Real GDP increase by 3.4% in 2017 • Export rose by 32.6% of the real GDP in 2017

	<ul style="list-style-type: none"> • Improving education • Promoting research and development • Infrastructural development in the area of energy, ICT, roads, railways and air routes • Trade and trade facilitation policies 	<ul style="list-style-type: none"> • Improvement in educational enrolment • Greater access to internet facilities. • Diversification of export base.
Zimbabwe	<ul style="list-style-type: none"> • Adoption of second science and technology policy in 2012 • Fostering international collaboration on trade, research and development and STI • Trade and trade facilitation policies • Development of infrastructures such as energy, ICT, transport routes etc. 	<ul style="list-style-type: none"> • Real GDP rose by 4.7% in 2017 • Export rose by 34.6% of the real GDP in 2017 • Upgrading of existing infrastructures into modern day infrastructures • Improvement in educational enrolment • Greater access to internet facilities
ASIA		
Afghanistan	<p>The strategy is regional economic cooperation and integration on Afghanistan (RECCA) in the following areas:</p> <ul style="list-style-type: none"> • Energy, • Transport networks, • Trade and transit facilitation • B2B and labour support • Research monitoring and evaluation • Women empowerment initiatives • Chambers of commerce and industry. 	<ul style="list-style-type: none"> • Construction of transmission lines in Afghanistan in 2018 • Establishment of TAPI gas pipeline project. • Establishment of the lapis-lazuli route agreement • Regional cooperation through the five nation's railway corridor. • The belt and road initiatives in Afghanistan • The Chabahar corridor that facilitates access to foreign markets.
Bhutan	<ul style="list-style-type: none"> • Implementing automated custom system • Intergovernmental agreement on dry ports • Framework for trade and trade facilitation agreements • Regional cooperation and integration • Development of infrastructures like energy, ICT, Transportation, etc. • Diversifying the economy in order to achieve VPoA. 	<ul style="list-style-type: none"> • Reduction of poverty rate from 12% in 2012 to 8.2% in 2017 • Improvement in access to education and health • GDP grows at 4.6% in 2017 • Improvement in standard of living at 11% as GDP per capita rises. • Formulation of economic development policy of 2016 • Enhanced private sector development.
Kazakhstan	<ul style="list-style-type: none"> • Development of transport infrastructures • Development of multimodal transportation • Regional integration and cooperation 	<ul style="list-style-type: none"> • GDP grows by 4.1% in 2017 • Construction of 10 seaports • Construction of 10,00Km of Rail way network • Building of 2,000,000 sq. m of storage facilities

	<ul style="list-style-type: none"> • Creation and complex development of FEZ Khorgos gate way • Establishment of dry port 	<ul style="list-style-type: none"> • First dry port was commissioned in 2015 • Commissioning auto-park terminal in 2018 • Formation of the FEZ infrastructures. • More regional collaboration on STI system.
Kyrgyzstan	<ul style="list-style-type: none"> • Efficient use of natural resources and agriculture • Building bilateral and multilateral transport links • Building infrastructures like roads, railways and air routes, energy, ICTs, education etc. • Building digital economy • Foreign trade and trade facilitation policies • Regional collaboration and integration. • Promoting inflow of FDI. 	<ul style="list-style-type: none"> • Real GDP grows by 4.5% in 2017 • Formulation of the national strategy for sustainable development 2013-2017 • Services contributed about 48.08% of the GDP in 2017 • Export trade improved by 10% in 2017. • Improvement in the development of infrastructural facilities
Lao	<ul style="list-style-type: none"> • Trade facilitation policy plan for 2017-2022. • Efficient use of natural resources (forestry, hydropower, minerals etc.) • Adoption of duty and value added tax incentives in 2019 • Automation of customs procedures 	<ul style="list-style-type: none"> • Establishment of Lao trade portal in 2012 • Ratification of trade facilitation agreement in 2015 • Accession to reversed Kyoto convention in 2016. • GDP grows at 7.5% in 2017 • Poverty rate reduced to 23% in 2017
Mongolia	<ul style="list-style-type: none"> • Support foreign trade to ensure sustainable development • Support non-oil exports • Support industrial capacities to produce export-oriented products • Improving infrastructures for trade, services, transportation and logistics networks • Trade facilitation and investment support. • ICT, energy, and solid mineral processing. 	<ul style="list-style-type: none"> • GDP grows at 5.3% in 2017. • Formulation of a five-year national export strategy • Formulation of the plan industrialization 21:100 in 2018 • Foreign trade turnover rate grows by about 22% in 2018 • Exports grows by about 13% in 2018 • Asia Pacific Trade Agreement • Regional and world trade facilitation agreements
Nepal	<ul style="list-style-type: none"> • Development cooperation policy of 2014 • Foreign investment policy of 2015 in the area of energy, manufacturing services, tourism, ICT, SMEs and construction. • Emphasis on innovation through STI • Gender inclusiveness in national policy 	<ul style="list-style-type: none"> • GDP grows at 7.9% in 2017 • Establishment Nepal investment board • Attraction of more FDI • Improved competitiveness through technology and skill transfer in sectors like energy, telecommunication etc.

		<ul style="list-style-type: none"> • Remittances contributed about 30% of the GDP in 2018. • Improvement in the energy sector • Upgrading of ICT facilities
Tajikistan	<ul style="list-style-type: none"> • Effective use of agriculture and natural resources • Focuses on institutional and economic reform of the education system • Promoting gender equality policies • Regional collaboration and integration • Trade facilitation and export promotion • Infrastructural development like energy, ICT, transport facilities etc. 	<ul style="list-style-type: none"> • Real GDP grew by 7.6% in 2017. • Exports trade contributed about 15.7% of the GDP in 2017 • The share of manufactured exports in total exports rose by 13.8% in 2017. • Greater access to education and scientific data base • Marginal improvement in access to internet facilities • Reducing gender disparities in the country.
Turkmenistan	<ul style="list-style-type: none"> • Enhancing agricultural production. • Encouraging tourism in the country • Building of infrastructures like roads, hospitals, schools, ICT, etc. • Promoting diversified economy through energy, ICT, extraction and refining of oil and gas, transportation and seismology. • Automation of production • Promotion of STI 	<ul style="list-style-type: none"> • Real GDP increase by 6.5% in 2017. • Exports trade contributed about 20.0% of the real GDP in 2017 • Increase in standard of living due to improve infrastructure. • Creation of industrial and technology park • Development of renewable energy use and ICTs • Strengthening governance and the rule of law. • Improvement in STI
Uzbekistan	<ul style="list-style-type: none"> • Establishment of free industrial zone • The committee for the coordination of STI identified its priorities to include rule of law, energy, ICTs, agriculture, and environmental protection etc. • Reforming education • Development of infrastructures such as roads, railways, ICTs, etc. • Regional cooperation and integration • Trade facilitation and export trade. 	<ul style="list-style-type: none"> • Real GDP grew by 5.3% in 2017. • Exports trade contributed about 28.5% of the GDP in 2017 • Creation of new research institutes • Enhancement in gender equality • Improvement in educational quality • Marginal improvement in internet accessibility. • Industrial development.

EUROPE		
Armenia	<ul style="list-style-type: none"> • Road, Communication and Construction, • Information and high technology, • Energy system • Nature and environmental protection • Mining Industry, • Poverty reduction and sustainable development • Regional and international economic integration and cooperation • Improving STI • Promoting FDI 	<ul style="list-style-type: none"> • Reduction in poverty rate to 25.7% in 2017. • GDP grows at about 7.5% in 2017 • ICT sector recorded about 38.2% growth in 2017 • Over 18,000 jobs created in 2017 • Lanching of the engineering city in 2018 • Adoption of new law on free economic zones in 2018. • Establishment of Armenia tourism development foundation. • Number of visiting tourists increased by 37% in 2014
Azerbaijan	<ul style="list-style-type: none"> • Creation of state fund for the development of information technology in 2012. • Adoption of Azerbaijan 2020: look into the future • Infrastructural development in the area of ICTs, energy, environment, STI facilities, education etc. • Regional cooperation and integration • Trade facilitation and export promotion • Promoting non-oil exports 	<ul style="list-style-type: none"> • Real GDP grows at 0.09% in 2017. • Foreign trade turnover increased by 12.3% in 2017 • Non-oil GDP rise by 2.7% in 2017. • Poverty rate drop to 5.4% in 2017 • Establishment of high industrial and technology park • Creation of knowledge fund in 2014
Moldova	<ul style="list-style-type: none"> • The innovation strategy: innovation for competitiveness 2013-2020 • Promoting entrepreneurship and skill development • Accelerating technology transfer • Encouraging partnership with the private sector • Establishment of incentive schemes 	<ul style="list-style-type: none"> • Adoption of open model for research and innovation • GDP grows by 4.5% in 2017 • Total exports contributed about 42.5% of the GDP in 2017 • Updating research equipment and the country's technical base • Greater participation in regional European research area and networks.
Macedonia	<ul style="list-style-type: none"> • Adoption of national innovation strategy, 2012- 2020 • Creative subsidies and tax incentives • National programme for scientific research and development 2012-2016 • Sustainable management of natural resources 	<ul style="list-style-type: none"> • GDP grew by 0.2% in 2017. • Exports trade contributed about 55.1% of the GDP in 2017 • Greater access to internet facilities • Improvement in infrastructural facilities

	<ul style="list-style-type: none"> • Promoting competitive economy • Reforming education and national innovation system • Regional cooperation and integration • Trade and trade facilitation policies • Infrastructural development in energy, ICT and transportation 	<ul style="list-style-type: none"> • High school enrolment rate • Public-Private partnership • Regional collaboration on STI and trade
SOUTH AMERICA		
Bolivia	<ul style="list-style-type: none"> • Efficient use of natural resources • Adoption of institutional strategic plan 2010-2014 • Adoption of system of scientific and technological information • Enactment of investment promotion act in 2014 • Automated revenue system for custom. • Infrastructural development like energy, ICT, etc. 	<ul style="list-style-type: none"> • Export trade of accounted for more than 80% of total export value. • Real GDP increase by 4.1% in 2017 • Improvement in ICT coverage and connectivity. • Creation of STI fund • Creation of center for research and for research and innovation in textile, leather, food production, biodiversity, wood and camelid • Industrialization of the hydrocarbon sector.
Paraguay	<ul style="list-style-type: none"> • Efficient use of natural resources for exports. • Infrastructural development like ICT, energy, education, etc. • Automated revenue system for custom data 	<ul style="list-style-type: none"> • Real GDP increase by 5.2% in 2017 • Export trade accounted for more than 80% of total export value. • Improvement infrastructural facilities • Greater access to internet facilities.

Sources:

1. Statistical Annex to accompany the 2019 Report of the Secretary-General on the Implementation of the Vienna Programme of Action for Landlocked Developing Countries for the Decade 2014-2024 (A/74/113)
2. World Bank World Development Indicator, 2018
3. National LLDCs Reports on Implementation of the Vienna Programme of Action: Various Issues

Annex B: EASE OF DOING BUSINESS PERFORMANCES FOR LLDCs, 2014 and 2018**Table B1: Ease of Doing Business Rankings and Scores**

	Ranking		Score	
	2014	2018	2014	2018
AFRICA				
Botswana	74	86	64.87	65.40
Burkina Faso	167	151	48.36	51.57
Burundi	152	168	51.07	47.41
Central African Republic	187	183	34.47	36.90
Chad	185	181	37.25	39.36
Eswatini	110	117	59.77	58.95
Ethiopia	132	159	56.31	49.06
Lesotho	128	106	56.64	60.60
Malawi	164	111	49.20	59.59
Mali	146	145	52.59	53.50
Niger	168	143	47.63	53.72
Rwanda	46	29	70.47	77.88
South Sudan	186	185	35.72	35.34
Uganda	150	127	51.11	57.06
Zambia	111	87	59.65	65.08
Zimbabwe	171	155	46.95	50.44
ASIA				
Afghanistan	183	167	41.16	47.77
Bhutan	125	81	57.47	66.08
Kazakhstan	77	28	64.59	77.89
Kyrgyzstan	102	70	60.74	68.33
Lao	148	154	51.45	51.26
Mongolia	72	74	65.02	67.74
Nepal	108	110	60.33	59.63
Tajikistan	166	126	48.57	57.11

Turkmenistan	na	na	na	na
Uzbekistan	141	76	54.26	67.40
EUROPE				
Armenia	45	41	70.60	75.37
Azerbaijan	80	25	64.08	78.64
Moldova	63	47	66.60	73.54
Macedonia	30	10	74.11	81.55
SOUTH AMERICA				
Bolivia	157	156	49.95	50.32
Paraguay	92	113	62.50	59.40

Sources: World Bank, Ease of Doing Business (2015) and (2019).

Annex C: BASIC ECONOMIC PERFORMANCE DATA FOR LLDCS IN 2012 AND 2017

Table C1: LLDCs Basic Economic Statistics in 2017

Country	Population (Million)	Real GDP (constant 2010 US\$ billion)	Real GDP per capita (US\$)	Real GDP growth rate	Level of income class	Export (US\$ billion)	Import (US\$ billion)	Export commodities/ products	FDI net inflow (US\$ billion)
AFRICA									
Botswana	2.3	17.2	7,523.2	2.3	Upper- Middle	9.1	8.4	diamonds, copper, nickel, soda ash, beef and textiles	0.40
Burkina Faso	19.1	13.1	685.7	6.3	Low- Income	3.2	32.4	gold, cotton, livestock, Sesame seeds	0.48
Burundi	10.8	2.3	213.4	0.5	Low- Income	0.23	0.85	coffee, tea, sugar, cotton, hides	0.31
Central African Republic	4.6	1.5	335	4.3	Low- Income	0.18	0.63	diamonds, timber, cotton, coffee, tobacco	0.017
Chad	14.8	12.2	823.4	-2.9	Low- Income	4.9	3.5	oil, cattle, cotton, gum Arabic	0.33
Eswatini	1.3	5.4	3,980.6	1.8	Lower- Middle	2.9	3.4	soft-drink concentrates, confectionery, canned fruit and other food products, especially those based on sugar and fruit; clothing and textiles; and wood pulp, timber and paper/board products.	-0.059
Ethiopia	104.9	57.7	549.8	10.2	Low- Income	6.2	19.1	coffee, oily seeds, gold, dried legumes, and cut flowers among other commodities.	4.1

Lesotho	2.2	2.9	1,303.8	-2.2	Lower-Middle	1.0	2.1	Clothing, diamonds, road vehicles, water, wool and tobacco.	0.043
Malawi	18	9,5	486.4	4.0	Low-Income	9.6	11.6	Tobacco, uranium, sugar, tea and coffee	0.27
Mali	18.5	14.1	762.9	5.4	Low-Income	3.2	11.3	Pearls, precious stones, metals, coins, cotton	0.26
Niger	21.4	8.5	395.9	4.8	Low-Income	1.4	2.8	Uranium ore, gold, onions, beans and meat.	0.33
Rwanda	12.2	9.3	764.8	6.05	Low-Income	1.8	4.4	coffee, tea and minerals like tin, coltan, wolfram and cassiterite	0.29
South Sudan	12.5	..	..	..	Lower-middle	..	..	..	0.0014
Uganda	42.8	28.5	666.7	3.8	Low-Income	4.3	5.8	Coffee, fish and products, maize, tobacco, tea, hides and skins, cocoa beans, other livestock/dairy, sim sim, flowers, beans, and cotton.	0.69
Zambia	17.9	27.9	1,635.4	3.4	Lower-Middle	9.09	9.3	Copper, sugar, tobacco, gemstones, cotton and electricity	0.86
Zimbabwe	16.5	17.9	1,088.06	4.7	Low-Income	6.2	9.6	platinum, cotton, tobacco, gold, ferroalloys, textiles/clothing	0.24
ASIA									
Afghanistan	35.5	20.7	583.8	2.6	Low-Income	1.1	8.8	opium, fruits and nuts, hand woven carpets, wool, cotton, hides and pelts, precious and semi-precious gems	0.053
Bhutan	0.80	2.3	2,897.3	4.6	Lower-Middle	0.64	1.1	electricity (to India), cardamom, gypsum, timber, handicrafts, cement, fruit, precious stones, spices	-0.016
Kazakhstan	18,3	196.02	10,867.8	4.1	Upper-Middle	67.2	56.7	oil and oil products 59%, ferrous metals 19%,	4.65

								chemicals 5%, machinery 3%, grain, wool, meat, coal	
Kyrgyzstan	6.2	6.6	1,070.3	4.5	Lower-Middle	2.6	5.9	gold, cotton, wool, garments, meat, tobacco mercury, uranium, electricity; machinery; shoes	-0.10
Lao	6.8	11.1	1,730.4	7.02	Lower-Middle	4.9	7.1	wood, clothing, coffee, electricity, metals, corn and rubber	0.93
Mongolia	3.07	12.4	4,045.6	5.3	Lower-Middle	9.6	10.06	copper, coal, molybdenum, tin, tungsten, and gold), natural or cultured stones, jewellery, textiles, animal origin products, hides and skins	1.4
Nepal	29.3	21.4	732.4	7.9	Low-Income	2.1	11.6	carpets, beverage, textile, tea and plastic	0.19
Tajikistan	8.9	9.1	1,020.1	7.6	Low-Middle	1.1	2.9	aluminium, electricity, cotton, fruits, vegetable oil, textiles	0.10
Turkmenistan	5.7	42.1	7,317.5	6.5	Upper-middle	8.5	11.7	gas, crude oil petrochemicals, textiles, cotton fiber	2.31
Uzbekistan	32.3	65.7	2,031.04	5.3	Lower-Middle	13.7	14.1	oil, natural gas, gold, cotton, natural resources.	0.095
EUROPE									
Armenia	2.9	12.3	4,219.3	7.5	Upper-Middle	4.1	4.4	pig iron, nonferrous metals, unwrought copper, diamonds, mineral products and foodstuff	0.24
Azerbaijan	9.8	57.2	5,805.1	0.09	Upper-Middle	19.8	17.1	oil and gas, machinery, cotton.	2.8
Moldova	3.5	7.6	2,165.1	4.5	Lower-Middle	3.1	5.3	foodstuffs, textiles, machinery	0.16
North Macedonia	2.08	10.9	5,253.7	0.2	Upper-Middle	7.0	9.6	food, beverages, tobacco; textiles, miscellaneous	0.38

								manufactures, iron, steel, automotive parts, buses	
SOUTH AMERICA									
Bolivia	11.05	27.8	2,522.8	4.1	Lower-Middle	9.3	9.8	Soybeans, cotton, coffee, and sugarcane	0.72
Paraguay	6.81	36.2	5,328.5	5.2	Upper-Middle	13.8	12.2	soybeans, feed, cotton, meat, edible oils, electricity, wood, leather	0.50

Source: World Bank, World Development Indicators

Table C2: LLDCs Basic Economic Statistics in 2012

Country	Population (million)	Real GDP (constant 2010 US\$ billion)	Real GDP per capita (US\$)	Real GDP growth rate	Level of income class	Export (US\$ billion)	Import (US\$ billion)	Export commodities/ products	FDI net inflow (US\$ billion)
AFRICA									
Botswana	2.09	14.16	6,779.4	2.6	Upper-Middle	8.39	8.85	Diamonds, copper, nickel, soda ash, beef and textiles	0.54
Burkina Faso	16.57	10.19	615.1	3.3	Low-Income	2.27	4.15	Gold, cotton, livestock, Sesame seeds	0.33
Burundi	9.32	2.21	236.9	1.4	Low-Income	0.27	0.79	Coffee, tea, sugar, cotton, hides	0.001
Central African Republic	4.49	2.14	475.7	3.8	Low-Income	0.26	0.47	Diamonds, timber, cotton, coffee, tobacco	0.070
Chad	12.71	11.61	914.1	5.3	Low-Income	..	5.21	Oil, cattle, cotton, gum Arabic	0.58

Eswatini (Swaziland)	1.25	4.75	3,807.7		Lower-Middle	2.24	2.65	Soft-drink concentrates, confectionery, canned fruit and other food products, especially those based on sugar and fruit; clothing and textiles; and wood pulp, timber and paper/board products.	0.026
Ethiopia	92.44	36.16	391.1	5.8	Low-Income	..	13.70	Coffee, oily seeds, gold, dried legumes, and cut flowers among other commodities.	0.28
Lesotho	2.09	2.68	1,280.4	4.7	Lower-Middle	1.05	2.69	Clothing, diamonds, road vehicles, water, wool and tobacco.	0.057
Malawi	16.10	7.44	461.9	-1.1	Low-Income	2.45	2.51	Tobacco, uranium, sugar, tea and coffee	-0.009
Mali	16.01	10.93	683.0	-3.7	Low-Income	2.82	3.95	Pearls, precious stones, metals, coins, cotton	0.40
Niger	17.73	6.54	369.0	7.6	Low-Income	1.50	2.73	Uranium ore, gold, onions, beans and meat.	0.84
Rwanda	10.79	6.77	627.6	6.1	Low-Income	0.26	..	Coffee, tea and minerals like tin, coltan, wolfram and cassiterite	0.26
South Sudan	10.82	..	..	-54.1	Lower-middle	..	3.85	..	0.161

Uganda	36.31	22.93	631.6	0.4	Low-Income	4.16	7.66	Coffee, fish and products, maize, tobacco, tea, hides and skins, cocoa beans, other livestock/dairy, sim, flowers, beans, and cotton.	1.21
Zambia	14.70	23.02	1,565.9	4.4	Lower-Middle	..	9.95	Copper, sugar, tobacco, gemstones, cotton and electricity	1.73
Zimbabwe	14.71	16.04	1,090.5	14.1	Low-Income	3.63	8.39	Platinum, cotton, tobacco, gold, ferroalloys, textiles/clothing	0.35
ASIA									
Afghanistan	30.70	17.95	584.9	9.1	Low-Income	..	12.47	Opium, fruits and nuts, hand woven carpets, wool, cotton, hides and pelts, precious and semi-precious gems	0.057
Bhutan	0.75	1.80	2,387.0	3.3	Lower-Middle	0.68	1.15	Electricity (to India), cardamom, gypsum, timber, handicrafts, cement, fruit, precious stones, spices	0.024
Kazakhstan	16.79	166.63	9,923.4	3.3	Upper-Middle	68.92	61.60	Oil and oil products 59%, ferrous metals 19%, chemicals 5%, machinery 3%, grain, wool, meat, coal	13.65
Kyrgyzstan	5.61	5.08	905.2	..	Lower-Middle	3.45	6.29	Gold, cotton, wool, garments, meat, tobacco mercury, uranium, electricity; machinery; shoes	0.26
Lao	6.42	8.32	1,296.8	6.7	Lower-Middle	3.29	6.15	Wood, clothing, coffee, electricity, metals, corn and rubber	0.62

Mongolia	2.81	9.47	3,365.6	10.2	Lower-Middle	4.30	8.12	Copper, coal, molybdenum, tin, tungsten, and gold), natural or cultured stones, jewellery, textiles, animal origin products, hides and skins	4.27
Nepal	27.65	17.34	627.2	3.6	Low-Income	1.53	6.33	Carpets, beverage, textile, tea and plastic	0.092
Tajikistan	8.00	6.51	814.7	5.1	Low-Middle	0.86	5.03	Aluminium, electricity, cotton, fruits, vegetable oil, textiles	0.24
Turkmenistan	5.27	28.78	5,463.0	9.1	Upper-middle	..	17.76	Gas, crude oil petrochemicals, textiles, cotton fiber	3.13
Uzbekistan	29.77	46.09	1,548.0	6.6	Lower-Middle	13.99	..	Oil, natural gas, gold, cotton, natural resources.	0.56
EUROPE									
Armenia	2.88	10.39	3,606.5	7.0	Upper-Middle	2.42	5.14	Pig iron, nonferrous metals, unwrought copper, diamonds, mineral products and foodstuff	0.50
Azerbaijan	9.30	54.10	5,820.1	0.9	Upper-Middle	30.42	17.62	Oil and gas, machinery, cotton.	5.29
Moldova	3.56	6.16	1,731.5	..	Lower-Middle	2.95	6.11	Foodstuffs, textiles, machinery	0.25
North Macedonia	2.07	9.58	4,620.7	-0.5	Upper-Middle	4.43	6.51	Food, beverages, tobacco; textiles, miscellaneous	0.34

								manufactures, iron, steel, automotive parts, buses	
SOUTH AMERICA									
Bolivia	10.24	21.73	2,122.4	3.5	Lower-Middle	9.59	10.23	Soybeans, cotton, coffee, and sugarcane	1.06
Paraguay	6.38	28.22	4,423.7	-1.9	Upper-Middle	10.48	11.88	Soybeans, feed, cotton, meat, edible oils, electricity, wood, leather	0.73

Annex D: STRUCTURE OF PRODUCTION OF LLDCs IN 2014 AND 2017

Table D1: LLDCs Structure of Production in 2014 and 2017

Country	Agriculture value-added (% of GDP)		Agriculture value-added (growth rate)		Manufacturing value-added (% of GDP)		Manufacturing value-added (growth rate)		Services value-added (% of GDP)		Services value-added (growth rate)		Share of manufacturing export in total merchandise export	
	2014	2017	2014	2017	2014	2017	2014	2017	2014	2017	2014	2017	2014	2017
AFRICA														
Botswana	2.09	1.7	-0.35	2.1	5.31	5.1	0.506	1.9	55.7	58.3	6.69	4.9	89.92	95.3
Burkina Faso	31.36	25	2.73	-2.9	6.27	5.4	27.13	4.7	40.33	55.1	3.23	8.9	10.65	8.8
Burundi	34.96	..	-3.58	-3.8	..	..	..	..	39.13	45.8	8.78	4	24.18	12.2
Central African Republic	40.59	40.7	-6.16	3.2	7.77	7	5.12	3.7	39.66	39.3	15.98	4.1	0.66	65.1
Chad	50.65	51.7	6.4	3.1	2.69	2.8	13.2	-2.3	31.09	33.8	6.96	-10	..	
Eswatini	9.46	..	-7.48	..	30.79	..	4.31	..	49.8	..	5.16	..	67.18	68.5
Ethiopia	38.52	32.3	5.45	6.7	3.99	5.5	16.64	17.4	39.89	36.9	12.87	10.3	6.77	..
Lesotho	5.62	6.4	3.57	3.1	11.99	13.7	-8.41	-6.3	54.44	52.5	5.78	-2.6	41.64	89.3
Malawi	28.7	26.8	5.88	4.9	9.55	9.3	5.53	2.6	49.8	52.4	5.96	3.9	18.72	8.3
Mali	37.46	34.1	8.75	4.8	..	..	..	..	37.31	37.5	5.2	5.3	..	37.4
Niger	36.71	39.5	8.31	5.6	6.3	5.7	1.33	5.8	36.93	38.3	9.52	4.3	11.52	..
Rwanda	28.75	24.8	6.67	6.5	5.89	5.9	7.84	6.4	47.16	46.3	6.98	7.9	12.34	..
South Sudan	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Uganda	25.07	21.5	2.69	1.61	8.51	8.5	2.16	2.2	47.13	47.1	5.42	5.4	25.6	19.8
Zambia	6.78	7.7	1.06	9.7	6.82	7.5	6.54	4.3	53.51	52.2	5.62	1.6	11.67	10.4
Zimbabwe	8.75	8.4	22.99	9.9	12.59	11	-5.09	1.3	57.59	60.5	1.68	5	27.01	16.7
ASIA														
Afghanistan	22.14	5	-0.1	3.8	11.49	11.1	-1.84	0.7	52.99	52.6	4.53	2.4	14.72	..
Bhutan	16.77	14	2.36	3.3	8.12	7.2	9.16	5.5	37.22	37.1	8.24	6.7	..	..
Kazakhstan	4.33	4.5	1.3	3.2	10.32	11.1	1.6	6.1	54.84	57.4	5.7	2.4	11.28	16.1
Kyrgyzstan	14.72	..	-0.55	..	13.68	..	-2.86	..	50.61	..	4.56	..	..	47.9
Lao	17.85	16.4	4.15	2.8	8.42	7.4	9.75	4.4	44.16	41.5	8.11	4.4	25.29	..

Mongolia	13.34	13.2	13.67	1.8	8.78	9	4.18	20	45.82	42.2	7.78	7.9	3.21	2
Nepal	30.27	30.4	4.55	5.2	5.75	5	6.28	9.7	48.65	51.6	6.22	7.4	67.86	68.3
Tajikistan	23.46	18.8	4.5	6.8	7.52	8.9	..	..	40.56	42.5	10.1	2.9	..	..
Turkmenistan	8.3	..	..	..	..	..	..	..	..	..	..	..	..	..
Uzbekistan	17.27	16.2	6.9	2	..	..	8.26	4	44.34	39.8	8.98	6.9	..	..
EUROPE														
Armenia	18.07	..	6.1	-5.3	9.67	10.2	6	5.9	47.41	51.3	6.79	12.5	23.98	20.1
Azerbaijan	5.32	6.7	-2.6	4.6	4.71	4.7	4.1	-1.8	33.62	37.4	11.86	6.2	2.14	3.4
Moldova	13.05		8.5	15.2	11.63	11.6	8.1	3.2	54.49	55.8	3.56	2.6	32.5	34
North Macedonia	10.18	7.3	3.12	-13.4	10.95	12.6	21.53	1.5	53.83	54.6	3.77	2.9	79.92	82.3
SOUTH AMERICA														
Bolivia	9.74	9.9	3.82	7.5	9.74	10.4	4.03	3.2	41.47	48.7	5.32	4.8	3.57	4.8
Paraguay	11.68	12.2	4.05	7.4	18.81	19.9	6.99	8.3	47.1	48	4.72	5.7	9.49	11.2

Source: World Bank, World Bank World Development Indicators

Table D2: Industry Value Added in 2012, 2014 and 2017

	2012		2014		2017	
Country	Industry value-added (% of GDP)	Industry value-added (growth rate)	Industry value-added (% of GDP)	Industry value-added (growth rate)	Industry value-added (% of GDP)	Industry value-added (growth rate)
AFRICA						
Botswana	29.72	0.301	33.08	-0.23	30.26	-4.16
Burkina Faso	22.37	-7.99	19.80	14.97	18.32	8.25
Burundi	15.75	5.27	15.49	6.20	..	..
Central African Republic	12.98	4.09	16.02	1.19	15.42	7.19
Chad	12.93	8.49	14.51	8.10	14.78	-1.71
Eswatini	37.24	5.32	35.80	0.92	33.90	3.14
Ethiopia	9.48	19.64	13.47	17.04	22.90	18.68
Lesotho	29.16	5.11	30.88	-1.92	31.95	-3.70
Malawi	15.03	-0.55	14.65	4.69	14.35	2.19
Mali	19.87	-9.37	18.38	12.76	14.12	6.3
Niger	21.07	49.54	19.38	0.81	15.86	5.62

Rwanda	16.53	8.32	17.18	11.01	15.77	4.24
South Sudan	..	..	..	..	..	..
Uganda	21.31	3.07	20.41	6.34	20.34	3.39
Zambia	32.01	2.01	32.94	3.89	35.62	5.41
Zimbabwe	25.33	6.75	23.72	-2.48	21.41	2.46
ASIA						
Afghanistan	21.16	6.39	21.23	2.77	22.13	0.42
Bhutan	41.62	6.77	41.48	3.71	40.57	2.41
Kazakhstan	36.30	1.89	33.21	1.76	32.22	6.30
Kyrgyzstan	22.26	-11.71	23.89	5.72	26.46	9.32
Lao	32.44	12.95	28.82	7.31	30.91	11.61
Mongolia	30.77	14.84	31.50	12.65	38.27	0.35
Nepal	14.10	3.00	13.83	7.05	13.40	12.41
Tajikistan	22.04	8.74	22.30	5.85	..	20.45
Turkmenistan	66.58	..	60.67	..	..	..

Uzbekistan	29.73	11.47	29.82	8.31	29.47	4.83
EUROPE						
Armenia	27.83	4.99	25.27	-2.11	25.29	6.45
Azerbaijan	59.46	18.60	53.59	-1.70	49.58	-3.81
Moldova	17.81	0.80	18.66	7.50	..	..
Macedonia	21.08	-5.07	22.82	8.59	24.13	-0.97
SOUTH AMERICA						
Bolivia	29.33	5.20	27.63	5.24	26.37	2.25
Paraguay	34.50	3.18	33.69	4.02	34.51	3.68

Source: World Bank, World Development Indicators