

R&D, Innovation and Competitiveness: Global Evidences on Conceptual and Practical Connectedness

Freddy Jirabi

Gamba

Institute of Finance

Management (IFM)

P. O. Box 3918 Dar es Salaam,
Tanzania

Abstract

Analyzing the role of research and development (R&D) innovation and competitiveness in economic development is important for determining country's entrepreneurial stance, global economic and business positioning and competitiveness. The empirical synthesis of the connective relationship of R&D, innovation and competitiveness confirms their significance and indispensable role for entrepreneurial and sustainable developmental outcomes. This study isolates other development influencing factors such as good governance, effective public administration, law enforcement, protection of intellectual rights and other contextual-factors and only considers the outcomes of R&D, innovation and competitiveness in the analysis. The study aligns the outcome of investment in R&D, innovation activities and competitiveness of countries. Based on literature and examples from developed and developing economies, international benchmark statistics on GERD and GERD percentage of GDP, innovation (GII) and competitiveness (GCI) are used for comparison between countries. The findings show that countries that invest more in R&D tend to be more innovative and competitive in both regional and global phenomena. Increased investment in R&D is recommended as policy and strategic priority for enhancing innovation and subsequently competitiveness of the national economy in a global playground. The implication is that countries that invest more in R&D can develop faster, have speedier promotion of prioritized sectors, tend to attract partnerships globally, and can enable public private partnership (PPP) and improve people's standard of living. The outcomes are enabled by the accessible to research based depository resources and references.

Correspondence:

capacitybuilding.gamba@gmail.com

<https://dx.doi.org/10.4314/ajmr.v32i1.6>

Key words: R&D, Innovation, Competitiveness, GERD, GDP.

Introduction

Globalization and regionalization have expanded markets and dictated actors' entrepreneurial performance for accelerating value delivery and improving standard of living to mankind (Wu, Thomas, & Wright, 2020; Schwab & Sala-i-Martin, 2013; WIPO, 2013; Link & Scott, 2013). Policymakers and corporate leaders found to adjust direction, speed and priorities for enhancing development of their countries and the private sector to cope with globalization potentials (Chepurensko, 2015). For exploiting these potentials, countries compete to outperform each other by being more entrepreneurial, innovative and competitive (Misala & Siek, 2012; Lorca & Andres, 2018; Siudek & Zawojnska, 2014). Johnson and Lundval (2003) and further massive support succeeded by Hung & Lu (2010) and WIPO (2013) analyzed the role of R&D in system of innovation and economic development and proposed that, R&D is important for determining country's global economic positioning and competitiveness. The connection of R&D, innovation and competitiveness can explore their significance and confirm their outcome and return on investment (Oviatt and McDougall, 2005). It is linear in a sense that other influencing factors such as good governance, effective public administration, law enforcement, protection of intellectual property rights and others are isolated and only R&D, innovation and competitiveness are considered in the analysis.

The base is the 40 top spenders on R&D and their position in the top 30 countries in innovations and competitiveness. The main question is, how many countries who are top R&D spenders are also top innovators and top global competitive? The objective of this paper is to elevate the role of R&D for enhancing innovation and subsequently

competitiveness in the economy. There are gaps this paper contributes in bridging: (1) there are no explicit efforts of explaining differences in national development from R&D perspective; (2) R&D, innovation and competitiveness indices are developed by different institutions and using different criteria, so much theoretically, they have been largely addressed separately and the connections between this trinity are rarely explicitly documented especially for developing countries; (3) explanations of causal-effect relationships of important developmental factors has been much done in sophisticated mathematical and econometrical modeling denying the access, exploration, comprehension and utilization by ordinary men and women and sidelining other professions (Lorca & Andres, 2018; Rabiei, 2011; Samimi & Alerasoul, 2009). This paper attempted to explain the same in a friendlier and consumable style so as to enlarge involvement and participation of common people in comparative development dialogue and policies.

Literature Review

The Global Position: R&D, Innovation and Competitiveness

Studies show that long term economic growth is largely based on innovation (Aghion et al., 2015), which, among others, is dependent on research and development (R&D), skills, as well as on expansion to new markets, which enables to gain specific advantages. Evolutionary economics research on economic growth emphasizes also the importance of institutions in the growth process. This is reflected in the evolution of technology and production structure (Nelson, Winter, 2002). Competitiveness is shaped not only by technological changes, but also by institutional innovations, such as new regulations, as well as improvements of

existing law (Freeman, 1996). This is also confirmed by an analysis of the technological gap and its change over time (Gomulka, 1998; Kubiela, 2009). The transfer of innovation and organizational progress from countries with a higher technological level may promote the acceleration of economic growth, but the use of new technology requires investing in human and physical capital, as well as introducing necessary institutional changes (Gomulka, 1998; Romer, 2010). Competitiveness is not, however, limited to economic growth, but is also determined by a given country's position on the international market. Furthermore, the concept of sustainable competitiveness adds environmental protection and social sustainability issues to this economic dimension of competitiveness (Corrigan et al., 2014; Weresa, 2016). Theory, as well as empirical studies theory confirm that a nation's competitive advantages arise from implementing innovation (Peneder, 2017; Dole, Perez-Alaniz, 2017).

OECD (2012) argues that substantial R&D efforts are determinant to providing innovative, sustainable and competitive developmental solutions. Some authors declare that R&D especially in terms of the country's GERD is a major determinant for innovation (Edquist, 2005; Brahim & Abdelaziz, 2019). Edquist (2005) argues that the differences in social and economic development, participation in global economy and enterprise competitiveness between countries have been mainly a result of whether there is a functional innovation system and investment in R&D. The determination of levels of innovation and competitiveness are comparatively gauged between countries and regions based on selected benchmark depending on the purpose of comparison (Lundvall, 2005; DBIS, 2014). The global budget on R&D increased by 56% in 2014. The actual

spending on R&D in 2014 amounted to US \$ 105,757.0 billion (PPP); where 87% of global R&D investment were spend by top 40 countries. The rest of the world (155 countries) spends 13% of the global spending (ibid.). The global R&D statistics of 2016 through 2023 show that in top 40 countries only two African countries namely, South Africa (ranking 33) and Egypt (ranking 38) are included in the list though having low percentage share of GERD in their country's GDP (IRI, 2016; IRI, 2023). It is also observed that there is lack of R&D statistics in many least developed countries (LDCs). In terms of innovation, in the regional context, the sub-Saharan African countries take low ranks globally (global/Africa rank in blankets); Mauritius (53/1), South Africa (54/2), Kenya (80/3), Rwanda (83/4), and Mozambique (84/5) (GII, 2016). On the side of competitiveness, those countries spending less or negligible on R&D and innovation activities tended to be uncompetitive. Based on the GCI (2016), African countries rank in global competitiveness were (global/Africa rank in blankets); Mauritius (46/1), South Africa (49/2), Rwanda (58/3), and Kenya (99/4). Tanzania was ranked 120, and Uganda 115.

Research and Development (R&D)

R&D is a systematic activity, where R (Research) is combining both basic and applied research, and D (Development) aims at drawing on research results and discovering solutions to problems or creating new goods, services and knowledge (Cohen and Levinthal, 1990; Fiol, 1996). R&D may result in ownership of intellectual property such as patents and copyrights (OECD, 2003; Wu, et al., 2020; Greeve, 2003). According to OECD (2003), more than two-thirds of R&D spending by firms or countries is directed to development rather than research. While

in most developing countries there is insignificant spending on R&D, its intensities in developed countries show that basic research is less than one fifth of total R&D spending (OECD Scoreboard, 2003). Hall (2006) noted that: “...total spending on R&D activities is also one of the most widely used indicators of the innovative performance of firms, industries and countries”.

R&D incorporates investigative activities conducted to improve existing products and procedures or to lead to the development of new products and procedures. Frascati Manual of OECD (2002) defines R&D as “creative work undertaken on a systematic basis in order to increase the stock of knowledge of man, culture and society, and the use of this stock of knowledge to device new applications”. According to IRI (2016), R&D is defined as “the process of creating new products, processes and technologies that can be used and marketed for mankind’s benefit in the future”.

R&D theoretical models such as the Development Theory (Fiol, 1996; Nonaka and Takeuchi, 1995) and the Decision-Making Theory (Tabak and Barr, 1998; Dougherty and Hardy, 1996) are used in this paper. While the former informs how the acquisition and management of knowledge, innovative people and infrastructure affect innovativeness and innovation processes in terms of R&D, the later, examines how organizations handle opposition between new thinking of innovations in terms of R&D off-springs and organization stability, legitimacy and risk bearing as a departure ground to commercialization circles (Greeve, 2003). The theoretical spheres of R&D choices and investment are mostly leaning on Arrow-Debreu general equilibrium model (Arrow, 1962) backed by massive literature

such as Griliches (1979, 1992), Aghion & Howitt (1998) and Hall (2002, 2006). Arrow argues that;

“because the R&D output can be imitated at the cost lower than the original cost of making them, the incentives for undertaking R&D are inevitably weaker than society would like. The performance of R&D therefore generates positive externalities or spillovers that benefit others”

Arrow-Debreu general equilibrium model (ADGEM) informs that the allocation of resources for R&D was non-optimal because the created information about R&D results failed the three model assumptions required for perfect competition in achieving Pareto Optimum namely, (1) information be infinitely divisible; (2) be tradable on the market for fully appropriable returns to the true owner; and (3) there be no associated uncertainty. These assumptions according to Arrow and other theorists like Reinganum (1989) are commendable for decisions on R&D investment. Hence R&D can bear results in the environment that provides protection of their information and deliverables.

Empirical studies show that R&D has been associated to variables such as firms’ growth, investment in R&D, Cooperation in R&D, R&D expenditure, economic growth, firm productivity growth, R&D intensity, patenting, technological progress, number of professionals and employees in R&D (Wu, et al., 2020; Rabiei, 2011; Bayarcelik & Tasel, 2012 Table 1 shows empirical evidences from various studies.).

Investment in R&D

IRI (2016) indicates that investment in R&D budgets have been taking incremental stance since 2012 globally. More than 75% of the researchers indicated budgets

Table 1: Empirical studies on R&D and related Variables

Source	Study Variables	Study Description and Empirical Conclusion
Aghion & Howitt (1998)	Firms' Growth and investment in R&D	Investment in R&D is positively correlated with firms' productivity and also produces a relatively high private rate of return.
Sadraoui & Zina (2009)	Cooperation in R&D and economic growth	Sample from 23 countries between 1992 and 2004. There is a positive and significant relation between R&D cooperation and economic growth.
Griffin <i>et al.</i> (2004)	R&D, Innovation and imitation	Study in 12 OECD countries. R&D stimulates innovation and imitation. Is statistically and economically vital in technological catch up and innovation.
Wakelin (2001) Brahim & Abdelaziz (2019)	Firm Productivity growth and R&D costs	Sampled 170 firms quoted on the UK Stock Market. A firm's R&D spending has a positive and significant role in influencing its productivity growth.
Samimi & Aler a- soul (2009)	R&D and economic growth (developing countries)	Sampled 30 developing countries for 2000 to 2006. Low R&D expenditures of developing countries have no significant effect on economic growth.
Zachariadis (2003)	R&D intensity, patenting, Productivity.	Done in developed countries. There is a positive impact between R&D expenditure, patenting and productivity
Griffin <i>et al.</i> (2004)	# of R&D employees, growth rate.	There is a positive correlation between the number of employees in R&D and the growth rate of output in most developed countries.
Ulku (2004)	Innovation effects on per capita outputs in non- OECD and OECD	Analysis of patent and R&D data for 10 non- OECD and 20 OECD countries for a period of 16 years. There is positive relationship between per capita GDP and innovation in both countries and the effect of R&D on innovation is significant only in OECD countries with large markets.

Source: Author compiled and Bayarcelik & Tasel (2012)

improvement over the years. The global budget on R&D increased by 56% in 2014. The global statistics show that R&D investments increased by 3.5% in 2016 to a total of \$1.948 trillion in PPP values for more than 110 countries having significant R&D investments (*ibid.*). The Asian countries led by China, Japan, India and South Korea account for more than 40% of the global R&D investments. North America including USA account for more

than 28%, Europe account for more than 21%. The rest of the world (155 countries) including, Russia, Africa, South America and the Middle East countries account for a combined 8.8% of the global R&D investments with combined average growth of 1.5% per year (*ibid.*).

Drivers for Investment on R&D

The drivers for investment on R&D are also debatable. These includes the country's economic growth, maintaining competitive position in the global markets, filling seen demand gaps by producing new products, political intent and security and protection (Chepurensko, 2015; Hessels, 2008; Oviatt and McDougall, 2005). On the economic growth determined by country's GDP growth, has been rather controversial though recommended strongly in literature as a major driving factor of R&D (Samimi & Alerasoul, 2009; Ebru & Fulya, 2012; Wakelin, 2001; Sadraoui & Zina, 2009). In contrary, it is observed that countries with low GDP growth having high engagement in R&D in terms of GERD percentage and vice versa experience more innovations (R&D Magazine, 2016). For example, Japan's GDP growth is 1.2% but having 3.4% GERD share of GDP, India with GDP growth of 7.5% though ranked sixth in global R&D absolute spending; its GERD share of GDP is only 0.85%

(OECD, 2003; R&D Magazine, 2016). Other many developing countries such as Bangladesh have GDP growth of 6.7%, has 0.7% GERD share of GDP. R&D's investment trends show that striving developing countries tend to have high GDP growth but less involvement in R&D, whereas, developed economies invest much in R&D to protect their global market positions and competitiveness (Misala and Siek, 2012; Siudek and Zawojnska, 2014). The global data show that Israel is the global leader in spending the biggest share of its GDP in R&D despite the fact that its GDP growth rate is always as small as 3.2%. In 2014, Israel spent 4.15% of GDP on R&D, in 2015 and 2016 spent 3.93% of GDP respectively. This triggers more discussion on the results of such investments. In fact, Israel being ranked 22nd in the world in terms of GERD, it is ranked 1st innovator in Western Asia, 21st innovator and 26th competitive economy globally in 2016.

Table 2: Share of Total Global R&D Spending

COUNTRY/ REGION	2014	2015	2016	2016 (by Block)
North America	29.1%	28.5%	28.4%	28.5%
U.S.	26.9%	26.4%	26.4%	
Caribbean	0.1%	0.1%	0.1%	
All North America	29.2%	28.5%	28.5%	
Asia	40.2%	41.2%	41.8%	41.8%
China	19.1%	19.8%	20.4%	
Europe	21.5% %	21.3%	21.0%	21%
Russia	3.1%	2.9%	2.8%	8.8%
South America	2.8%	2.6%	2.6%	
Middle East	2.2%	2.3%	2.3%	
Africa (all countries)	1.0%	1.1%	1.1%	

Source: Global R&D Magazine, 2016

The R&D processes and their costs vary depending on number of factors such as (1)

the level of regional or national development or economic growth, where

the tendency has shown that developed economies spend more on R&D than developing economies. Though, this has been the tendency over years, today emerging economies such as China, Estonia, India and South Korea are protruding highly in R&D investment (R&D Magazine, 2016). (2) Political intent and commitment in facilitating the spending of significant part of GDP for R&D, and (3) stakeholders' collective efforts towards providing infrastructure for cultural and socio- economic solutions (Karol, 2013).

Innovation

Innovation is defined differently depending on the background, industry orientation and author's experience (Karol, 2013). According to Ernst *et al.*, (1998), innovation is the process by which firms master and implement the design and production of goods and services that are new to them, irrespective of whether or not they are new to their competitors' domestic or foreign markets. Kaplinsky & Readman (2000) define innovation as "an introduction of improvements and upgrading, when innovation is faster than competition". Further Kaplinsky & Morris (2000) urge that if the rate of innovation is lower than that of competition; will result in declining value added and firms' market share. Thus, both definitions show that innovation has to be placed in a relative term; how fast compared to competitions. Innovation as explained by Kaplinsky *et al.*, (2000) goes in line with Schumpeterian concept that corporate profit in long run cannot be sustained by control over the market but through the development of dynamic capabilities as a result of "learning and innovation" as furthered by Kaplan and Norton (1992). Furrer *et al* (2008) asserted

that the main feature of an innovation is being market driven, having the ability to accrue competitive advantages

The definitions and typologies or classifications of innovation have been naturally multidimensional due to the inherent complexities of the concept. Such dimensions are: (1) multi-type classifications (EOCD, 2005; Bethant & Tidd, 2007); (2) degree of strength and power of innovation or innovation intensity (Garcia & Calantone, 2002); (3) multilayer classification (Jones & Johnson, 1957; Zawislak; 2011); (4) dichotomical and dually-dichotomical classification (Abernathy & Clark, 1985; Brahim & Abdelaziz, 2019); and (5) classification linked to the innovation process (Moore, 2005). Table 3 presents sources, definitions and classification of innovation.

Innovation produces various innovator's perceived benefits to the organizations and the market such as improved method, re-organization of production, improved internal functions, improved distribution arrangements, improved support to users, substitution of cheaper material, new process of production, new product/service (Thompson, 2004; Salavou *et al.*, 2004; Zawislak, 2011). The aggregation of government institutions and firms' innovations in a country account for the country's innovations (GII, 2012; 2013, 2014). Table 4 presents countries which are top 5 innovations performers by region.

Table 3: Sources, Definitions and classification of Innovation

Source of Definition	Definition	Innovation Typology Placement	Sources of aligned Typology/ Class.
Schumpeter, J. (1930)	Introducing a new product or modifications to an existing product, A discovery of new process, new market, new source of raw materials and other changes in the organization.	Process, Product, Organizational, paradigm & Incremental, transaction, technological, marketization innovation	Zawislak (2011), Walker, Avellaneda & Berry (2011)
Howard & Sheth(1969)	Any new element brought to the buyer, whether or not new to the organization.	Incremental innovation	Leonard & Rayport (1997), EOCD (2005)
Mohr (1969) Eur. Comm. Green(1999)	The degree to which specific new changes are implemented in an organization Successful production, assimilation and exploitation of novelty.	Creative and radical innovation	Tushman & Nadler (1986), Kimberly & Evanisko (1981),
Damanpour & Evan (1984)	utility concept defined in various ways to reflect a specific requirement and characteristic of a study	Radical & Position innovation, Marketing, transaction innovation	Markides (1998), Bethan & Tidd (2007)
Kenneth (1986)	New ideas that consist of: new products and services, new uses, new markets or new marketing methods.	Creative, Position Innovation, Marketing, transaction innovation	Utterback & Abernathy (1975) Thompson (2004),
Damanpour (1991)	Development and adoption of new ideas by a firm	Adoptive innovation	Thompson (2004)
Davenport (1991)	Complete task development in a radically new way	Radical innovation	Tushman & Nadler (1986)
Evans (1991) Boer & During (2001) Drucker (1954)	-The ability to discover new relationships, of seeing things in different perspectives and to form new combinations from existing concepts. -Creating a new association (combination): product-market- technology-organization. -One of the basic functions of an organization	Organizational & Management innovation, operational innovation, administrative and architectural innovation	Salavou et al., (2004), Wolfe (1994), Kim (1980), Zawislak (2011)
Knox (2002)	A process that provides a degree of novelty to the organization, suppliers and customers, new procedure, solutions, products and services and marketing ways.	Process, Product, Organizational innovation	Salavou et al (2004), Damanpour & Evan (1984)
Bus. Council Australia (1993)	Adoption of new or significantly improved elements to create added value to the firm directly or indirectly.	Incremental, administrative innovation,	Knight (1967), Leonard & Rayport (1997)
Rogers (1998)	Involves both knowledge creation and diffusion of existing knowledge.	Technical, technological and radical innovation	Damanpour and Evan (1984), Knight (1967)

Source: Author compiled from Popa et al (2014) and Kotsemir & Abroskin (2013) and others

Table 4: Top Innovations Performers by Region

Rank	America	Europe	Sub-Saharan Africa (Global)	Central And Southern Asia	South East Asia	Western Asia
1	USA	Switzerland	Mauritius (53)	India	S. Korea	Israel
2	Canada	Sweden	S. Africa (54)	Kazakhstan	Japan	Cyprus
3	Chile	Finland	Kenya (80)	Iran	Singapore	UAE
4	Costa Rica	Germany	Rwanda (83)	Tajikistan	Hong Kong	Turkey
5	Mexico	UK	Mozambique (84)	Sri Lanka	China	Armenia

Source: The Global Innovation Index 2016, WIPO

Table 5: Focus of Competitiveness Definitions and Sources

Determinants	Source	Definitions of Competitiveness
Productivity, growth of GDP per capita, high employment	Swab, Sala-i-Martin (2013), Scott & Lodge (1985), Krugman (1994)	- The ability of a country to achieve sustained high rates of growth in GDP per capita. - The set of institutions, policies, and factors that determine the level of productivity of a country. - Is a country's ability to create, produce, distribute products and/or service in international trade while earning rising returns on its resources.
Designing, producing, promote and selling at price, superior quality and benefits	Frejterski (1984)3Chao & Chang (2010), Buckley et al. (1988), Scott & Lodge (1985)	The firm's economic strength against its rivals in international marketplace where products, services, people and innovations move freely despite the geographical boundaries.
		Is the capacity of the sector, industry or branch to design, and sell its goods at prices, quality, and others more attractive than competitors.
Free and fair market conditions	Barker & Koehler (1998), Porter et al. (2008), Chao & Chang (2010)	The degree to which it can, under free and fair market conditions, produce goods or services meeting the test of international markets, while simultaneously maintaining and expanding the real incomes of its population over the longer term.
Market share	Porter et al. (2008)	- Competitiveness of a firm is its share in a competitive market. - A country's share of world markets for its products. This makes competitiveness a zero- sum game because one country's gain comes at the expense of others.

Source: Adapted from Siudek and Zawojka (2014)

Competitiveness

There are actually a number of definitions of competitiveness. Some definitions concur in terms of focus and determinants covering the spectrum of competitiveness multi-dimensions as indicated in table 5. Porter and Rivkin (2012) noted that: *“... the wide misunderstanding of the concept of competitiveness has dangerous consequences for political discourse as well as policy and corporate choices that are all also evident today...”* pp. 58.

One of the common definitions of competitiveness is the “ability of a firm or a nation to offer products and services that meet the quality standards of the local and world markets at prices that are competitive and provide adequate returns on the resources employed or consumed in producing them” (Scott & Lodge, 1985). The World Economic Forum (1979) defined it as “the set of institutions, policies and factors that determine the level of productivity of a country”. Globally, competitiveness includes basic requirements for factor driven economies, efficiency enhancers for efficiency driven economies and innovation and sophistication factors for innovation driven economies (GCI, 2016). Therefore, competitiveness is the favourable market position as a result of perceived benefits of market innovation offers by the service or product provider to the customer. It is displayed by the presence of competitive advantages, which are obtained when an organization develops or acquires a set of attributes (or executes actions) that allow it to outperform its competitors.

From table 5, this paper suggests a comprehensive definition of competitiveness that covers (1) Productivity, growth of GDP per capita, high employment; (2) Designing, producing, promote and selling at price, superior quality and benefits; (3) Free and fair market conditions; and (4) Market

share. Theoretical explanation of competitiveness has tended to be multi-dimensional and circumventing the market mechanism. The classical theories include the concept of invisible hand (Smith, 1776), comparative advantage (Ricardo, 1817) and natural resources abundance theory (Heckscher, 1919); these old theories inform about absolute advantage, comparative advantage and locally abundance factors of production respectively as factors of competitiveness. The neo-classical theories such as the theory of effective competition (Clark, 1961), and the theory of entrepreneurship and innovation (Schumpeter, 1950); these theories inform about the sources of competitive advantage being innovation and six market related factors namely, supply, demand, threat of new entrants, threat of substitutes, bargaining power of customers, bargaining power of suppliers, industry rivalry. Firms through innovation seek competitive advantages by reducing costs, improving quality and/or branding their products. The contemporary theories are mostly leaning on Krugman (1996) and Porter (1998); they portray competitiveness in terms of productivity, improved standard of living, growth of GDP per capita and high employment.

The metrics of competitiveness has been studied on different levels such as macro and mega, meso and micro levels. At macro and mega level, national, regional and global competitiveness is addressed; where the policy issues tend to be prominent for measuring competitiveness such as productivity, economic growth, exchange rates, R&D, GCI, productive efficiency and technological innovation (Barrell et al., 2005; Easty & Porter, 2002;). At meso level, sector competitiveness metrics include R&D, varied environmental assessments, sector policies and regulations for creation of free and fair market conditions (Misala

& Siek, 2012; Leiter et al., 2011; Copeland & Taylor, 2004). At micro level, firm competitiveness measures related to marketization innovations (Altomonte et al, 2012; Helleiner, 1991). Conclusively, competitiveness is the offspring of innovation and R&D at all levels. Factors enabling competitiveness depend on how developed is the economy (Armbruster *et al.*, 2008). First, for the *factor-driven* economies, competitiveness can be observed in the set institutional arrangements, availability of infrastructure, macroeconomic environment, health and primary education. According to Armbruster et al (2008), these factors can be enabled through organizational innovation that can demand restructuring and reforms. Moreover, they can be possible by the use of increment innovation. The procedural innovation and structural innovation are key for enabling intra-organizational and inter-organizational relations and innovation diffusion (Gamba. 2017; Oishi, 2013). Second, in the *efficiency-driven* economies, competitiveness is manifested by efficiency in goods and services in markets, higher education and training, labour and financial market development, technology and market size. Countries striving for the *efficiency-driven* economy need to choose the right form of innovation. Suchanek, Spalek & Sedlacek (2011) underscores incremental and transformational innovation as useful for the situation. Transformation innovation, for example, is done when there is uncertainty of the problem and usefulness new initiatives (Zawislak, 2011); innovations of this type are mostly undertaken in collaboration with other actors such as universities because of the risks involved. Third, the innovation driven economies are engaging much in radical innovations where problem are well defined, but the path to the solution is missing (ibid.). This involves intensive

research and technological deepening. In a whole, any level of competitiveness required, the kind of relevant innovation is important to get to the desired competitive destination. Such innovation needs to provide a better solution than others or the past. The literature shows that at any level and scale of competitiveness aspired in a developed or developing country, the enablers of such competitiveness is the right set of innovation mix (Gamba, 2017; Oishi, 2013).

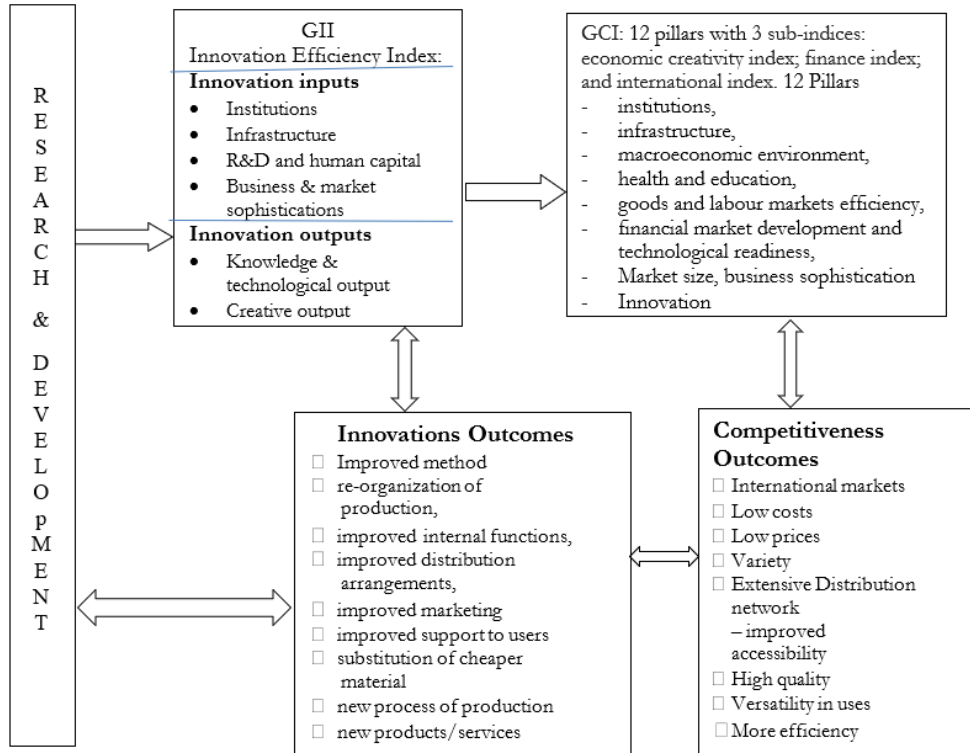
Conceptual Framework

Fargerberg (1988) asserts that the relationship between R&D, innovation and competitiveness is vicious, cross-cutting and multi-dimensional in conceptualization, operationalization and strategization. GII (2016) as well as EOCD (2012), Mwamila (2004) and Mytelka (2004) assert that though there are many enhancers for innovation such as social capital, effective system of innovation, collective system of knowledge and learning and macro-economic policies: R&D play a major role. The protrusion of R&D is also in line with the arguments of Oyeyinka (2004), Wang (2014) and Cornel University et al., (2019). Further, Lall and Pietrobelli (2003) argue that there are many pillars for national, regional or global competitiveness but innovation plays a prominent role and also influences other factors at all levels. Indeed, competitiveness in all states of economy depends on varied elements of innovation (GCI, 2016; Wang, 2014). Competitiveness being an outcome from strategic investment manifests itself in institutional performance and financial productivity which allows more R&D and consequently massive and quality innovations. It is noted that output of R&D is the input of innovation and the output of innovation is the competitiveness: this causes varied time

span of variables. It is seen that some variables have spans over seven (7) years while the other is over four (4) years. Figure

1 shows the conceptual framework of this study.

Figure 1: Conceptual Framework



Source: Author conceptualization based on Cornel University et al., (2019), Oyeyinka (2004) and Wang (2014)

Methodology

The desk study was conducted by reviewing various documents on R&D, innovation and competitiveness using secondary data from both developing and developed countries. Authenticated global statistics and data from International comparative benchmarks such as Global Competitiveness Indices (GCI) and Global Innovation Indices (GII) are used and referred to for comparison purposes. The base is the 40 top spenders on R&D and their position in the top 30 countries in innovations and competitiveness. Global documents from benchmarking institutions dealing with publishing and dissemination of R&D results, innovation activities and competitiveness comparative figures were explored including International Research & Development Institute (IRI), (GII and GCI). Further the criteria used for comparison were also looked at. Statistics on global spending on R&D from 2011 through 2017 were categorically analyzed covering how much is spent in R&D between countries: such as spending on natural against applied research; in research opposed to development; how is the acquisition and management of knowledge, human capital and infrastructure; new thinking of R&D off-springs; and organization stability, legitimacy and risk bearing for commercialization circles. Statistics on global innovation and competitiveness indices from 2015 to 2018 were analyzed. The developed, emerging economies and developing countries, particularly sub-Saharan African countries were involved in the comparative analysis by accounting for R&D budgets, innovation efficiency, innovation outcomes and competitiveness outcomes (Cornel University et al., 2019; Oyeyinka, 2004 and Wang, 2014). Then comparison was done using criteria such as regional and global ranking of R&D spending, innovators and

those who were ranked more competitive to determine if they are the same actors or there were positional intrusions: meaning the tendency of actors to shift from one position to another and enabling unexpected and new entrants of innovation and competitiveness in the top global ranks. The global innovation index (GII) considers the innovation efficiency which is composed of the innovation inputs and innovation outputs. Both have the same weight in calculating the overall GII scores for countries (Dutta et al., 2020). The former consist of institutions, human capital and research, infrastructure and market and business sophistications. Whereas, the later consists of knowledge, technological and creative outputs (Iqbar & Rahman, 2020; WIPO, 2016).

The computation of competitiveness integrates a set of 12 pillars with three sub-indices making up GCI: the economic creativity index, the finance index and the international index. (EOCD, 2005). The creativity index consists of variables for current technological effort and technology imports. The finance index has variables for financial market sophistication and accessibility, interest rates, financial supervision and the current state of the capital market. The international index measures import barriers, exchange rate issues. 1st pillar is institutions to portray that the institutional environment of a country depends on the efficiency and the behavior of both public and private sectors. The second pillar is infrastructure for ensuring the effective functioning of the economy. The third pillar is macroeconomic environment for economic stability. Fourth and fifth pillars are on health and education. The sixth and seventh pillars are goods and labour markets efficiency which are necessary for supply-and-demand conditions in the economy. The eighth and ninth pillars are

financial market development and technological readiness respectively. Market size is the 10th pillar as it affects productivity since large markets allow firms to exploit economies of scale while business sophistication (11th pillar) embodies the quality of a country's overall business networks and the quality of individual firms' operations and strategies. The 12th pillar is innovation (mainly the output side) being important for economies as they approach the frontiers of knowledge, and the possibility of generating more value by merely integrating and adapting exogenous technologies (Iqbar & Rahman, 2020).

Synthesis of the Findings

The synthesized findings presented are observations from the authenticated institutions and statistics and general trend of development politics and economics related to R&D, innovation and competitiveness. This synthesis would instigate some explicit efforts of explaining differences in national development from R&D-innovation-competitiveness perspective for all stakeholders rather than addressing biased development partners skewed issues of interest such as reforms, governance, environment etc. The synthesis gives a thorough snapshot for development thought and policy concerns especially for developing countries. The participation of countries in the GII over years has been 132 (in 2023), 130 (in 2020), 129 (in 2019), 126 (in 2018), 127 (in 2017) and 128 (in 2016).

Based on the alignment of recent and historical GCI and GII tables and global R&D results from 2015 to 2023 it is portrayed that: first, the findings show that 70% of 40 top R&D spending countries (in terms of GERD) are also top innovators and competitive regionally and globally. This displays that the GERD value is an

indicator that R&D activities are going on and show that the innovation activities are possible. On the other hand, the percentage of GDP spent on R&D depending on country's GDP value, can give indicative impact on innovation and subsequently competitiveness. It informs about the pivot role of political will and corporate strategic intent on competitiveness value chain for revolutionizing sustainable national development and sovereignty upgrading in countries. This confirms that competitiveness begins with intentional efforts on research and development and is embedded in national political processes and corporate strategies. Second, it has been revealed that many developing countries have higher GDP growth rate than developed countries. This study shows that in developing countries there is no relationship between high GDP growth rate and high level of development. This concurs with Samimi & Alerasoul (2009) whose analysis indicated that the low R&D expenditures of developing countries have no significant effect on economic growth. The developing countries' figures on economic growth have little to address on private sector prosperity and people-centred development in terms of choices, income per capita, standard of living and competitiveness from grass-root to global level (Sala-i-Martin, 2013; Porter *et al.*, 2008).

Fourth, according to OECD (2003), more than two-thirds of R&D spending by firms or countries is directed to development rather than research. While in most developing countries there is insignificant spending on R&D, its intensities in developed countries show that basic research is less than one fifth of total R&D spending (OECD Scoreboard, 2003). Researchers in developing countries engage much more on basic research for the consumption by international development

and cooperation agencies sponsored by developed countries. There is insignificant work on development in developing countries, thus it can be miraculous to improve innovativeness and competitiveness (OECD, 2012; OECD, 2003; Ulku, 2004; Samimi & Alerasoul, 2009). Fifth, the developing countries spending relatively high in R&D in both GERD and GERD percentage of GDP are hardly appearing in the top global innovative and competitive countries but they take a good regional ranking. The examples are Mauritius, Bangladesh, Kenya, India, and Rwanda. India for instance, GII (2016) indicates that it was the top innovator in the Central and Southern Asia region, followed by Kazakhstan. Though it cannot protrude as one of the competitive and innovative country, India is within 40 top R&D spending countries globally. The same apply to Mauritius, Kenya and Rwanda in sub-Saharan Africa, who spend relatively more on R&D as compared to other countries are holding good innovation and competitiveness rank regionally.

Sixth, the findings show that 98% of 40 top R&D spending countries (in terms of GERD percentage of GDP) are also top innovators and competitive regionally and globally. the top R&D spenders were established based on absolute spending of GERD. When the R&D percentage of GDP was considered, the findings indicate that those with high R&D percentage of GDP made more innovations than those spent small R&D percentage of GDP. The findings further reveal that countries such as Switzerland, Sweden, UK, USA, Finland, Denmark, Germany, Singapore, South Korea, Ireland and others led by Israel had high percentage of GDP spent on R&D. Despite the fact that their creation of innovations was significant, these countries were also maintaining with consistent and

sustainable high global competitiveness (GII,2016; GCI, 2016; R&D Magazine, 2016). Seventh, some countries ranking high in the top GERD spenders were not good innovators as their R&D percentage of GDP was low. For example (R&D % of GDP in blanket), Turkey (0.88%), India (0.85%), Poland (0.80%), Egypt (0.24%), Indonesia (0.22%), Mexico (0.45%), Bangladesh (0.70%), Argentina (0.62%) and Saudi Arabia (0.32%), had spent small R&D as percentage of GDP and therefore did not innovate much though they are among 40 R&D top spenders in terms of absolute GERD. All African countries fall in this category due to negligible R&D spending both in GERD and R&D percentage of GDP, though South Africa, Mauritius, Kenya and Rwanda are far beyond others in terms of both innovation and competitiveness.

Eighth, it was further found that 100% of top innovators are also competitive regionally and globally. This indicates and justifies the interwoven connection between innovation and competitiveness; the former being researched and developed offering or product for strategization, operationalization and/or commercialization, and the later explains the market judgment and acceptance about the offering in the market playground. This concurs with Wang (2014) arguments that competitive advantages are by-products of innovations and deployment of resources and dynamic capabilities. The results are also in line with EOCED (2012) argument that substantial R&D efforts are determinants to providing innovative, sustainable and competitive socio-economic developmental solutions. The results negate the assertion that R&D especially in terms of the country's GERD is a major determinant for innovation (OECD, 2012), conversely, it is confirming that the major factor is the GERD

percentage of the country's GDP and not GERD itself. Ninth, from year 2014 to 2018 All Countries in the top 40 R&D Spending in terms of both GERD percentage of the country's GDP and not GERD itself are the ones that are top innovators and with the highest competitiveness globally (GII, 2015-2018; GCI, 2015-2018).

Conclusion and Implication

The need to invest more in R&D is fundamental, crucial and critical especially in developing countries. The shortage of research staff, lack research and development funding, lack of innovations and experience of countries' inadequate competitiveness, need to be proactively addressed and positively enhanced. Regardless of the country's level of development, innovation and competitiveness need to be enhanced and investment in R&D is the major and most impacting and enhancing tool. The understanding that innovation is market triggered, and that, it can be tailored and contextualized depending on country's level of development; whether the country economy is factor-driven, efficiency-driven or innovation-driven, is of policy and economic relevance. Indeed, innovation amplifies strategic focus by analyzing the

country GDP growth, identifying and filling market gaps timely, determining and sustaining desired market position and upholding competitiveness. Interestingly, investing in R&D requires political will and strategic intent. That is why some countries with low GDP growth have been allocating a big percentage for R&D while those with high GDP growth providing less for R&D.

The implication is that the countries allocating small budgets to R&D will develop slowly. Developing countries, especially sub-Saharan African countries, should not ignore the preconditions for sustainable socio-economic performance by not embracing R&D. Many countries instead are embracing sure poverty enhancing and liability embodied initiatives. This paper throws silent questions to policy makers and resource allocators particularly in developing countries on what are the optimal factors they usually consider when allocating resources for development? Conclusively, it is historically revealed, theoretically propounded and empirically proven that R&D, innovation and competitiveness are interwoven inputs for developmental outcomes in firms, sectors and countries: recommended and worth for policy and strategic considerations and practice.

REFERENCES

- Aghion P., Bloom N., Blundell R., Griffith R., Howitt P. [2005], Competition and Innovation: An Inverted U Relationship, "Oxford Journals, *Quarterly Journal of Economics*", no. 120 (2), pp. 701–728.
- Aghion, P. & P. Howitt (1998). *Endogenous growth theory*. Cambridge, MA: MIT Press. ISBN 0-262 01166-2
- Altomonte, C., Aquilante T., Békés G. & G. P. Ottaviano (2012). *Internationalization and innovation of firms: Evidence and policy*. Presented at Economic Policy Fifty-seventh Panel Meeting Hosted by Trinity College Dublin and supported by the Central Bank of Ireland Dublin, 19-20 April 2013.
- Barrell R., Choy A., Holland D., Riley R., (2005). The sterling effective exchange rate and other measures of UK competitiveness. *National Institute Economic Review* 191(1), 54–63.
- Bayarcelik, E. B., Tasel, F. (2012). Research and development: Source of economic growth. *Procedia. Social and Behavioral Sciences*, 58, 744-753.
- Becker, B. (2015). Public R&D policies and private R&D investment: A survey of the empirical evidence. *Journal of Economic Surveys*, 29(5), 855–1010.
- Biswas, R. K., Kabir, E., & Rafi, R. B. R. (2019). Investment in research and development compared to military expenditure: Is research worthwhile? *Defence and Peace Economics*, 30(7), 846–857.
- Brahim, M. B., & Abdelaziz, F. B. (2019). Multilevel, multiplayer R&D investment decisions: Cooperation or competition? *Journal of Multi-Criteria Decision Analysis*, 26(5–6), 329–340.
- Broekel, T., Brachert, M., Duschl, M., & Brenner, T. (2015). Joint R&D subsidies, related variety, and regional innovation. *International Regional Science Review*, 40(3), 297–326.
- Cantwell J. (2006), *Innovation and Competitiveness*, in: J. Fagerberg, D. C. Mowery and R. R. Nelson (Eds.), *Handbook of Innovation*, Oxford University Press, Oxford, pp. 543–567.
- Chepurensko, A. (2015). *Entrepreneurship theory: New challenges and future prospects*, 2015. Vol. 9. No.2, pp. 44-57
- Cimoli, M. (2000), *Developing innovation systems: Mexico in a global context*. London, New York: Continuum.
- Cohen, W. M. & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly* 35(1): 128-152.
- Dougherty, D. & Hardy, C. (1996). Sustained production innovation in large, mature organizations: Overcoming innovation-to-organization problems. *Academy of Management Journal*, 39(5): 1120–1153.
- Doyle E., Perez-Alanis M. (2017), From the Concept to the Measurement of Sustainable Competitiveness: Social and Environmental Aspects, "Entrepreneurial Business and Economics Review", no. 5 (4), pp. 35–59, <http://doi.org/10.15678/EBER.2017.050402> (access: 12.05.2024).
- Drucker, P.F. (1985). *Innovation and entrepreneurship: Practice and principles*. New York: Harper and Row, Publishers.
- Durand, M. & C. Giorno (1987). Indicators of international competitiveness: Conceptual aspects and evaluation. OECD at <http://www.oecd.org/economy/outlook/33841783.pdf> (accessed 5th November, 2023).
- DST (2004). National survey of research and experimental development (R&D) 2001/02: High Level Key Results. Pretoria: Department of Science and Technology.
- EC (2017a), European Innovation Scoreboard 2017, Methodology Report,

- European Commission, <http://ec.europa.eu/DocsRoom/documents/25101> (access: 12.06.2024).
- Edquist, C (1997). *System of innovation technologies, institutions and organizations*. London and Washington: W.W. Norton.
- Edquist, C. (2005). Systems of innovation: perspectives and challenges. In Fagerberg, J., Mowery, D.C., Nelson, R. R. (Eds.). *The Oxford Handbook of Innovation*. Oxford University Press, New York, 181–208.
- Ernst, D, T. Ganiatsos & L. Mytelka (1998). *Technological capability and export success in Asia*. London: Routledge.
- Fagerberg, J. (1988). International competitiveness. *Economic Journal*, Vol. 98, No. 391, June 1988, pp. 355 -374
- Fiol, C.M. (1996). Squeezing Harder doesn't always work: Continuing the search for consistency in innovation research. *Academy of Management Review*, 21(4), pp.1012- 1021.
- Freeman, C & L. Soete (1997). *The economic and industrial innovation*. London and Washington: Pinter.
- Furrer, O., Thomas, H & Goussevskaja, (2008). The structure and evolution of the strategic management field: A content analysis of 26 years of strategic management research. *International Journal of Management Reviews*, Vol.10(1) 1–23.
- Gamba J. F (2017). Facilitating innovation in developing countries: Challenges and choices. *African Journal of Finance and Management Vol 26(1)* 40-51.
- Global R&D Magazine (2016), at www.rdmag.com winter 2016 (accessed on 8th March, 2024)
- GII, (2011 - 2018). Global innovation indices at <http://www.wipo.int/publications/en> (accessed on 2nd Jan, 2024)
- Greeve, H. R (2003). A behavioural theory of R&D expenditure and innovation. Evidence from ship building. *The Academy of Management Journal*, Vol. 46 No. 6 pp.685-702
- Griliches, Z. (1992). The search for R&D spillovers. <http://www.nber.org/chapters/c8349> (p. 251 - 268)
- GU, Shulia (1999). *Implication of national innovation systems for developing countries: Managing change and complexity in economic development*. Maastricht: UNUINTECH.
- Gumus, E., & Celikay, F. (2015). R&D expenditure and economic growth: New empirical evidence. Margin: *The Journal of Applied Economic Research*, 9(3), 205–217.
- Hall, B. H. (2006). “R&D, Productivity and Market Value” Available at <http://www.econ.berkeley.edu/~bhhall/bhpapers.html> (Accessed on 25 Feb, 2022)
- Heckscher, E. F. [1919] (1991). *The effect of foreign trade on the distribution of income*. In Flam, H. & M. J. Flanders (Eds.). *Heckscher-Ohlin trade theory*. Cambridge, Mass.: MIT Press.
- Hessels, J. (2008), International entrepreneurship: An introduction, framework and research agenda. *SCALES Scientific Analysis of Entrepreneurship and SMEs*. Available at <https://core.ac.uk/download/pdf/7074486.pdf> (accessed on 20 February, 2024)
- Hung S.V. & Lu W.M. (2010). DEA performance measurement of the national innovation system in Asia and Europe. *Asia-Pacific Journal of Operational Research*, Vol. 27, No. 3, pp. 369–392.
- Jaffe B. & K. Palmer (1997). Environmental regulation and innovation: A panel data study. *The Review of Economics and Statistics* Vol. 79, No. 4 (Nov., 1997), pp. 610-619
- Johnson, B. & B. Lundval (2003). The national innovation system and economic development. In Muchic, M., Gammeltoft, P., Lundval, B. (eds). *Putting Africa first. The making of Africa innovation systems*. Aalborg: Aalborg University Press.

- Kaplinsky, R. & J. Readman (2000). Globalization and upgrading: What can (and cannot) be learnt from international trade statistics in the wood furniture sector? Mimeo, Brighton, Centre for Research in Innovation Management, University of Brighton and Institute of Development Studies, University of Sussex., www.centrim.bus.brighton.ac.uk/go/global/.
- Kaplinsky, R. & Morris, M. (2001). *A handbook for value chain research*. www.ids.ac/global and www.nu.ac.za/csds, *IDS Research Report* (Accessed on 16 December 2023)
- Kaplinsky, R., M. Morris & J. Readman, (2001). *Globalization and upgrading: Innovation and learning in the wood furniture value chain*. Background Paper for UNIDO World Industrial Development Report, 1992, Brighton: Institute of Development Studies, University of Sussex.
- Karol Śledzik (2013), Schumpeter's view on innovation and entrepreneurship. In Stefan Hittmar (ed.) *University of Gdańsk - Faculty of management: Management trends in theory and practice*. Faculty of Management Science and Informatics, University of Zilina & Institute of Management by University of Zilina.
- Kim, L. (1997). Initiation to innovation: The dynamic of Korea's technological learning. Boston: Harvard Business School Press.
- Kotsemir, M. & Abroskin, A. (2013). Innovation concepts and typology - An evolutionary discussion. *Working Paper: Science, Technology and Innovation* WP BRP 05/STI/2013.
- Kuchta, D., & Skowron, D. (2016). Classification of R&D projects and selection of R&D project management concept. *R&D Management*, 46(5), 831–841.
- Leiter, M., Osatuke, K., Belton L., Dyrenforth, S. & Ramsel, D. (2011). Civility, respect and engagement at the workplace (CREW). *Journal of Management Policies and Practices*, Vol. 1 No. 2, pp 24–34.
- Link, A. N., & Scott, J. T. (2013). Market failure and public support of R&D. In *Bending the arc of innovation: Public support of R&D in small, entrepreneurial firms*. New York, NY: Springer.
- Lorca, P., & Andr' es, J. (2018). The importance of cultural factors in R&D intensity. *Cross-Cultural Research*, 53(5), 483–507.
- Lundvall, B. (1992). National innovation system: Towards a theory of innovation and interactive learning. London: Frances Printers.
- Herfert, K. F., & Arbige, M. V. (2015). Aligning an R&D portfolio with corporate strategy. *Research-Technology Management*, 51(5), 39–46.
- Maidique, M. (1980). Entrepreneurs, champions, and technological innovation. *Sloan Management Review*, Vol.21, No. 2, pp. 59–76.
- Maroto, A., Gallego, J., & Rubalcaba, L. (2016). Publicly funded R&D for public sector performance and efficiency: Evidence from Europe. *R&D Management*, 46(S2), 564–578.
- Misala J. & Siek, E. (2012). *International competitive ability of the silesia economy during the transformation*. Katowice Economic University Press, Katowice, pp.35–52.
- Navdi, Khalid & Hurbert Schmitz (1994). Industrial cluster in less developed countries: In *Review of experiences and research agenda*. Brighton: Brighton Institute of Development Studies.
- Nelson, R. (1993). *National innovation systems: A comparative analysis*. New York and Oxford: Oxford University Press.
- Nonaka, I., Takeuchi, H. (1995) *The knowledge-creating company. How Japanese companies create the dynamics of innovation*, Oxford University Press, Oxford.

- OECD (1997), *The measurement of scientific and technological activities; proposed guidelines for collecting and interpreting technological innovations* (Oslo Manual), Paris: OECD
- OECD (2012). *Frascati Manual: Proposed Standard Practice for Survey on Research and Experimental Development*. Paris, France: OECD.
- OECD (2005). *Oslo Manuals. Guidelines for Collecting and Interpreting Innovation Data*, 3rd edition., Paris, France:
- OECD (2007). *Science, Technology and Innovation Indicators in a Changing World: Responding to Policy Needs*. Paris.
- OECD (2005). *The measurement of scientific and technological activities: Guidelines for collecting and interpreting innovation data*. Oslo Manual, Third Edition. www.oecd.org/. (accessed on 7th December, 2023)
- OECD (2007). Innovation and growth: Rationale for an innovation strategy. www.oecd.org/. (accessed on 7th December, 2023).
- OECD (2012). Innovation for development: A discussion of the issues and an overview of work of the OECD directorate for science, technology and industry. www.oecd.org/. (accessed on 7th December, 2023).
- OECD & Eurostat (2005). *Oslo Manual—guidelines for collecting and interpreting innovation data*. Paris: OECD, www.oecd.org/sti/frascatimanual/. (accessed on 5th December, 2023)
- Oishi, S., Diener, E. & L. Tay (2013). Rising income and the subjective well-being of nations. *Journal of Personality and Social Psychology*, Vol. 104, No. 2, 267–276
- O'Sullivan, D., Dooley, L. (2009). *Applying innovation*. Sage Publications, Inc. Pan.
- Oviatt, B. & McDougall, P. (2005). Defining international entrepreneurship and modelling the speed of internationalization. *Entrepreneurship Theory and Practice* (USA), Vol. 29 No. 5, pp 537-553. www.emeraldinsight.com/doi/full/10.1108/sd.2006.05622 (accessed on 21/2/2024).
- Peneder M. (2017), Competitiveness and Industrial Policy: From Rationalities of Failure Towards the Ability to Evolve, “*Cambridge Journal of Economics*”, no. 41, pp. 829–858.
- Perrot, R., Mosaka, D., Nokaneng, L., & Sikhondze, R. (2013). Government R&D impact on the South African macroeconomy. *African Journal of Science, Technology, Innovation & Development*, 5(6), 531–540.
- Popa, Preda & Boldea (2014). Theoretical Approach of the Concept of Innovation. www.repec.org/conference.ubbcluj.ro/mccs/RePEc/bbu/wpaper/151-156.pdf (accessed 6 Nov, 2023)
- Porter, M. & Rivkin, J. (2012). *Restoring U.S. competitiveness: The looming challenge to U.S. competitiveness*. Havard Business Review: HBR Press. Harvard.
- Rogers, E. M. (2003). *Diffusion of innovation* (5th Ed.). New York, NY 10020: The Free Press.
- Salavou, H., Baltas, G. & San. Y. (2004). Organisational innovation in SMEs: The importance of strategic orientation and competitive structure. *European Journal of Marketing*. 38 (9/10): 1091-1112.
- Samimi, A. & Alerasoul, A. (2009). R & D and economic growth: New evidence from some developing countries. *Australian Journal of Basic and Applied Sciences*, 3(4): 3464- 3469. ISSN 1991-8178.
- Schumpeter, J. A. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interests and the business cycle*. London: Oxford University Press
- Siudek, T & Zawojaska, A. (2014). Competitiveness in the economic concepts, theories and empirical research. *ACTA Oeconomica* 13 (1) 2014, 91–108
- Smith, M.T. (2001). Eco-innovation and market transformation. *Journal of*

- Sustainable Product Design*, Vol. 1, No.1. 19–26.
- Sohn, S.Y., Kim, D., & S.Y. Jeon (2016b). Re-evaluation of global innovation index based on a structural equation model. *Technology Analysis and Strategic Management*, 28 (4), pp. 49
- Stewart, J. & Hyysalo, S. (2008). Intermediaries, users and social learning in technological innovation. *International Journal of Innovation Management*, Vol. 12, No. 3, pp 295– 325
- Suchanek, P., Spalek, J. & M. Sedlacek (2011). Competitiveness factors in post transformation period: The case of Czech enterprises. *European Research Studies Journal*, RePEc:ers:journl:v:xiv:y:2011:i:1:p:121-146 (accessed on 20 June, 2024)
- Tabak, F. & Barr, S. (1998). Innovation attributes and category membership: Explaining intention to adopt technological innovations in strategic decision-making contexts. *Journal of High Technology Management Research*, Vol.9, p.17-33.
- Ulku, H. (2004). R&D, innovation, and economic growth: An empirical analysis. *IMF Working Paper*, WP/04/185
- UNCTAD (1999). *The science, technology and innovation policy review*. Geneva: United Nations.
- Vukoszavlyev, S. (2019). The connection between global innovation index and economic well-being indexes. *Applied Studies in Agribusiness and Commerce*, 13 (3–4) (2019), pp. 87-92.
- Wakelin, K. (2001). Productivity growth and R&D expenditure in UK manufacturing firms. *Research Policy*, vol. 30, issue 7, 1079-1090
- Wang, H. (2014). *Theories for competitive advantage*. In Hasan, H. (Eds.) *Being practical with theory: A window into business research* (pp. 33-43). Wollongong, Australia: THEORI.
- Wang, J. (2017). Structuring innovation funnels for R&D projects under uncertainty. *R&D Management*, 47(1), 127–140.
- Wu, H., Thomas, A. M., & Wright, S. (2020). Using the R&D capitalization choice to explain the scale benefits of R&D investment. *Australian Journal of Management*, 45(4), 579–606
- Zawislak, P., Alves, A., Tello-Gamarra, J., Barbieux, D. & Reichert, F (2012). Innovation capability: From technology development to transaction capability. *Journal of Technology Management & Innovation*. Vol 7, No 2. Pp. 14-28