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Impact of R&D and Human Capital on Economic Growth in Ethiopia's Innovation System

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Abstract

In today's world, national innovation system (NIS) is one way of fostering economic growth especially in developing countries. It is well known that human capital and research and development (R&D) are the fundamental pillars of NIS. The aim of this study is to evaluate the contribution of human capital and R&D on GDP through systematic review and validate theoretical results using empirical analysis. From systematic review result, labor force and research expenditure have positive impact and educational investment has long-term impact on GDP. A validation is required to give comprehensive conclusion about effect of R&D and human capital on GDP. Hence, linear regression analysis was implemented using primary education, secondary education, tertiary education, expenditure in R&D, researchers in R&D, and expenditure on education as independent variables whereas GDP as dependent variable. The world bank data of Ethiopia was used for 23 years data. The model findings depicted that R&D index has only statistically significant. Generally, the overall findings suggest that Ethiopia's government should give attention on enhancing human capital and R&D by allocating enough research funding, creating strong relation among NIS actors, and formulating strategies and policies that increase skilled and educated manpower in various sectors for effective economic growth.

Keywords: Economic growth, Ethiopia, GDP, human capital, national innovation system, R&D
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1. Introduction

The Ethiopia's economy has improved greatly in the last few years, spurred by the Growth and Transformation Plans (GTP I and GTP II). According to National Plan Commission (NPC), Ethiopia will be categorized in the middle-income countries by 2030 through industrial transformation. Accordingly, the National Innovation System (NIS) plays a vital role in achieving the 10 years Homegrown Economic Reform (HGER) plan (Ethiopia, 2020). National Innovation Systems (NIS) are increasingly recognized as pivotal drivers of economic growth and development, especially in developing nations where innovation and technological progress are essential for advancement (R.N. Weerasinghe, 2023).

Many researchers (Freeman, 1987) define NIS as an interconnection of various actors that enhance new technologies and knowledges in the given nation. For a better innovation system, there are key components of NIS namely, infrastructure, institution, research and development, technology transfer, and human capital.

Central to a thriving NIS is research and development (R&D), which facilitates the creation of new technologies, processes, and products for spurring economic activity. New developments in technical know-how are fundamentally driven by research and development (R&D), which facilitates the exploration and application of new knowledge to existing production techniques. R&D is vital for advancing the ability to innovate and enhancing economic performance while it provides various innovations. Hence, nations should give high priority for both direct and indirect R&D investments to foster economic growth.

Human capital refers to the skills, knowledge, and competence of the workforce. (Becker, 1964) defines human capital as the knowledge, skills, and capacities embedded in humans. which are supplemented by research and development. Education and training are instruments that enhancing human capital and increase productivity and economic growth. Human capital is important as it enhances the ability to utilize and build upon innovations

(Muhamad, 2018), thereby boosting GDP and supporting the overall performance of the NIS. Human capital are two essential factors in R&D activities and in applying the new technologies resulting from successful R&D to production. In simple words High-level human resources can promote a company's technology R&D through integrating both internal knowledge and external knowledge.

This integration mainly includes knowledge creation, knowledge dissemination, knowledge diffusion, and companies' internal R&D activities transformation (Xiuli Sun, 2020). Therefore, high-level human capital can directly affect companies' R&D activities, thereby enhancing their innovation level. On the other hand, the new technologies open up new economic opportunities for investment in physical and human capital to take place. If these two can be integrated into one single framework, then it is possible to see the interaction between these two types of forces in pushing economic growth and therefore bring the theory a step closer to the reality.

During the 18th century, the doctrine of economic growth has been at the main focus of macroeconomic research so previous studies focused on how it relates to variables like population and capital. The emergence of endogenous growth theories in the early 1990s marked a dramatic change by emphasizing the contribution of internal elements, especially technology, innovation, and human capital, to long-term economic growth. These ideas emphasize the significance of knowledge generation, human capital development, and research and development (R&D) activities as major drivers of economic performance and technological innovation.

The interaction between human capital, research and development (R&D), and economic growth has been a research interest in economic literatures for decades. Knowledge, mostly produced through research and development, is a non-rivalrous public good that supports long-term economic growth, according to the endogenous growth hypothesis, which was developed by (Romer, 1994). Knowledge spillovers amplify the impact of R&D by extending its benefits beyond the originating firm.

Many researchers studied about the impact of human capital and R&D on economic growth within innovation ecosystem through empirical analysis. Authors in (Ashenafi Eneyew Dinku, 2024) presented the effect of human capital on small and medium enterprise performance using CB-SEM data analysis technique. Formal education and managerial skill were used as an independent variable whereas performance of small and medium enterprises (SMEs) and innovative practices were dependent variables. Even though, the result of the study implicates that human capital has positive significant on the performance of SMEs, extensive work is expected to see its long-term impact on the country's economy, such as formulating innovation strategies and updating educational curriculum that can fit with entrepreneurship. This paper was only focused on the relation between human capital and economic growth without considering R&D.

In contrast, (Araya, 2023) presented an empirical analysis to understand the correlation between R&D and economic growth. The authors used General Structural Equation Model (GSEM) to analyze the relation between them using world bank's enterprise survey dataset. Their empirical result indicates that innovation has strong impact on firm productivity. However, it requires further work to develop innovation capabilities of firms. Since human capital and R&D are highly correlated, it is recommended to evaluate their impact on GDP rather discussing the solely.

Similarly, another work by (Gebrehiwot, 2016) employed to analyze the effect of human capital development on economic growth using ARDL method. The result depicts that human capital and economic growth have long run impact since 1% increase in secondary education has produced 0.5096% change in GDP. Even though the paper tried to present the impact of human capital in both long and short terms, the role of R&D was not considered at all.

Additionally, the authors in (Suhatman, 2024) obtained that human capital and economic growth has unidirectional relation since the human capital has positive influence on economic development but the reverse is not true at all. Such result indicates that investment in human capital is essential for fostering economic growth.

The interplay between R&D and human capital is synergistic. R&D generates new knowledge, while human capital is essential for its creation, dissemination, and application. A skilled workforce is crucial for transforming R&D outputs into innovative products and processes. Conversely, R&D investments contribute to human capital development by creating new job opportunities and stimulating demand for education and training. This dynamic interaction between R&D and human capital is a key driver of economic growth and competitiveness.

Although R&D and human capital are highly correlated in NIS ecosystem, there is a notable gap in existing studies that measure the combined impact on economic growth. Hence, the main objectives of the study are:

- To conduct systematic review on previous studies, focus on impact of R&D, and human capital on economic growth in the context of Ethiopia's NIS.

- To examine the significance of R&D and human capital to measure Ethiopia's economic development

In order to fully comprehend the relation between Ethiopian economic development, R&D, and Human capital, empirical data from many sources must be carefully analyzed using a variety of methodologies in addition to theoretical concepts. The following important questions are addressed in this study.

- How do human capital and R&D contribute to economic growth within Ethiopia's NIS, based on existing literatures?
- Do the human capital and R&D have statistically significance to GDP?

The remaining sections of the paper is organized as follows: the methodology section employed in the study that describing the approach and techniques used to analyze the data. The third section outlines the overall thematic analysis which is obtained from systematic review. In the fourth section, the econometric analysis is presented with mathematical expression of the OLS model. The main findings from empirical analysis are presented and discussed in the result and discussion section. Finally, the paper concludes by presenting implications of these findings, offering insights and recommendations for future work in the concluding section.

2. Methodology

2.1 Systematic Review Procedures

This study utilizes a systematic literature review to evaluate the combined effects of research and development (R&D) and human capital on Ethiopia's GDP, with a focus on the Ethiopia's NIS. The review involved searching academic papers, government reports, and other authoritative sources published between 2010 and 2024. Studies were included if they examined the relationship between R&D, human capital, and economic growth within the context of Ethiopia's NIS. Exclusion criteria encompassed studies not directly relevant to Ethiopia's NIS, those not published in English (unless translated), and studies lacking methodological rigor. Data were extracted from selected studies, focusing on study characteristics, methodologies, and findings related to R&D and human capital.

Forward and backward citation searches were conducted using Connected Papers and Litmaps to uncover additional relevant literature. The databases searched included Google Scholar and CORE. The extracted data were analyzed qualitatively to identify trends and assess the effectiveness and efficacy of Ethiopia's NIS in promoting economic growth. This comprehensive approach ensures a robust examination of the relevant literature and provides insights into the interactions between R&D, human capital, and economic outcomes.

Figure 1 depicts the overall review process by categorizing the research papers and various reports based on the impact of R&D and human capital in the country GDP for the case of NIS. The Figure depicts four main review stages namely, identification, screening, eligibility, and final inclusion. Around 45 studies are included in this systematic review. As it is shown in the figure, there are limited number of studies that implies the combined impact on economic growth. On the other hand, reports which explain the combined effects are large in number.

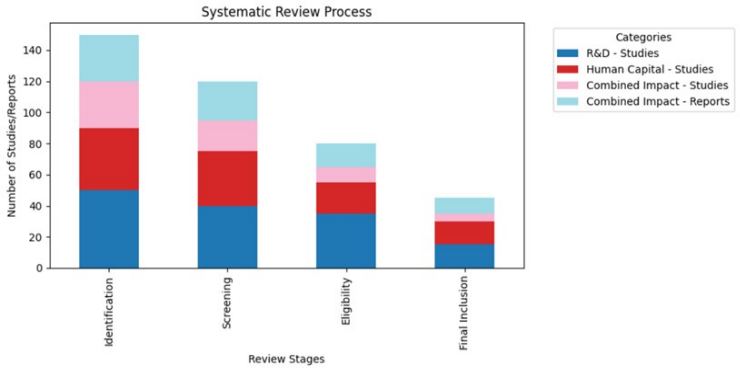

Figure 1. Systematic Review Process

2.2 Review Analysis

The systematic review revealed that human capital and R&D have an impact on national innovation system. The pivotal role of R&D in stimulating economic growth is well-established in the literature. The proportion of those papers is illustrated in the Figure 2.

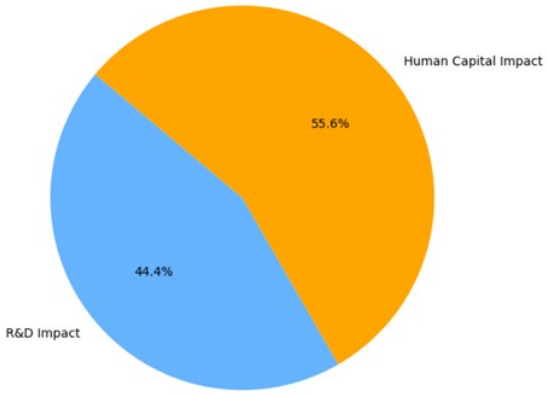

Figure 2. Percentage of Studies Showing Positive Impact on GDP by R&D and Human Capital

Figure 2 illustrates that the percentage of positive impact of R&D and Human Capital on GDP which is obtained from the studies. Specifically, 44.4% of the reviewed papers implies that improving R&D contributes positively on the economic growth. Whereas, 55.6% of the studies explains that enhancing human capital capabilities has large influence on GDP. Generally, this analysis implies the significant role of both pillars to the effectiveness of NIS for the development of country's economy.

The authors in (Belachew Alemayehu, 2021) evaluated the significance of R&D on Ethiopia firms. The R&D fund in various firms has been allocated for capital expenditures instead of actual research. According to a recent survey, 45% of the total expenditure was used for the acquisition of machinery, 25.7% for buildings, and 15.2% for equipment, a mere 7.04% directly allocated to R&D activities. Due to lack of funds, 42.86 percent of firms are unable to innovate. Such a mismatch suggests that the government's R&D strategy may focus more on infrastructure development than on developing the innovative capacity of firms and researchers.

Almost all of the funded researches are ideal rather than practical, that hinders its immediate industry relevance. This problem is made worse by the gap that exists between research institutes and the corporate sector, which leads to little cooperation and a misalignment of research initiatives with business demands (Araya, 2023). Such problems hinder our research capabilities to achieve the country's productivity and economic growth. In order for R&D investments to be more successful in the country's economic development, it is important to conduct research that can directly answer industry questions and design strategies that strengthen the relationship between academia and the corporate sector. Without these adjustments, R&D has little potential to contribute significantly to economic growth.

R&D is the engine of innovation that can be measured through the number of researchers exist in the country within various institutions and the amount of research expenditure (Mekonnen Hailu, 2022). Based on (Tesfa D. B., 2015), the key difficulties encountered by Ethiopian researchers when conducting various researches in their organization or institution have been addressed from government policies and researchers. The paper explained the main challenges of researchers in Ethiopia includes research administration and leadership problems, insufficient research resource and facilities, inadequate national policy and strategies, and limitation on outsourcing of research. The paper also emphasized that there is a relation between R&D expenditure and existence of researchers. Finally, the author recommended possible solution for fostering research in Ethiopia such as creating consistent research funding, enhancing different research councils, and boosting professional associations that can enhance country's economy through innovation.

According to (Habib M, 2019), R&D expenditure and skilled labour have impact on innovation for improving economic growth. The paper links the impact of R&D and human capital on innovation through empirical analysis. The Authors used those metrics as an input variable to observe the change in firm productivity. Using the empirical analysis, the paper described that there is strong relation between firm productivity and innovation through employment size, labour force, and research expenditure.

Although the role of small and medium enterprise on the economic growth is very high for developing countries like Ethiopia, the skills and knowledges of both the owners and their employees are not enough and needs enhancement. According to (Ashenafi Eneyew Dinku, 2024), the relation between SMEs, innovation and human capital was measured using formal education, managerial skills, innovation practice and performance of SMEs.

As a result, the formal education and managerial skills have positive significant on the performance of SMEs. Hence, the Ethiopian government should work on enhancing and updating strategies that include entrepreneurship-oriented curriculum in the formal education system. Also, SMEs should design and build innovative strategies to improve their performance.

(Wegari, 2023) studied the relation of human capital and economic development for the case of Ethiopia by considering GDP as an index of economic growth. Several metrics were used to measure human capital such as labor force, total government expenditure, education expenditure, and secondary school enrollment. ARDL technique was implemented to investigate the co-integration existence among those metrics and human capital. Based on the paper result, such metrics has long term impact on GDP whereas policy change has positive short-term effect on Ethiopia's economic growth.

The key productive resources of any country are its level of human capital and workforce. (Shiferaw, 2017) discussed about the importance of human capital investment to enhance productive capacities of manufacturing sector and economic growth of Ethiopia. The three educational levels of the country namely, primary, secondary, and tertiary educations used as a metrics of country's human capital. Nevertheless, the number of both private and public educational institutes become increase, their educational outcome is very low. This is due to inadequate government expenditure on education, and low quality of education (Annelies van Uden, 2017). Various studies have widely stated that human capital has a strong economic impact on GDP, but one of the significant shortcomings of Ethiopia's NIS is the lack of human capital, making the situation more complicated (CIORA, 2013). According to the (CIORA, 2013), the GDP would boost by 0.0063% for each 1% secondary education expenses. This mainly indicates an upbeat long-term relation among economic growth and educational investment.

Although there are limited number of studies in this area, the available studies tried to evaluate the relation between R&D, human capital, and economic growth. A well-educated and skilled man power have the capability to innovate and adopt new technologies that can enhance the country economy especially in developing countries. Various researchers mentioned many metrics of human capital and R&D which used in measuring GDP such as number of researchers, education expenditure, research expenditure, levels of education, and labour force (Agezew, 2024) (Belete, 2015). In most of the studies, these metrics have significant impact on GDP but more works to be done include formulate compatible innovation policy and strategy, proper research and education funding, building strong collaboration among different innovation actors, and create suitable environment for skilled and educated man powers. An empirical analysis should be implemented to check the validation of the systematic review results. Therefore, the empirical analysis is presented in the following section.

2.3 Empirical Analysis

In addition to systematic review, this paper also used econometric analysis for validating the impact of R&D and human capital on economic growth within NIS ecosystem through empirical test. From the systematic review, various R&D and Human capital metrics are obtained which have an impact on GDP. Hence, their statistical significance is evaluated by implementing this econometric analysis. Since, the study aim to analyze the causal relation among R&D, Human capital and GDP, linear regression analysis model is selected for econometric analysis. According to (Akhmadkhon, 2024), linear regression analysis is used for estimating the causal relationship between various variables.

Data and variables

The study used GDP as an index of economic growth and it also takes into account variables such primary education, secondary education, tertiary education, expenditure in R&D, researchers in R&D, labor force, and expenditure on education as independent variables for human capital and R&D (Habib M, 2019). Within this scope, to carry on with the examination regression model is performed to capture the causal relationship among the variables. As well as to determine the direction of these relationships.

Table 1. Dependent and Independent Variables

Variable	Symbols	Description	Measurement
Independent	RE	Expenditure on R&D	Research and development expenditure (% of GDP)
	RR	Researcher in R&D	Researchers in R&D (per million people)
	PE	Primary Education	School enrollment, primary (% gross)
	SE	Secondary Education	School enrollment, Secondary (% gross)
	TE	Tertiary Education	School enrollment, Tertiary (% gross)
	LF	Human Capital	Labor tax and contributions (% of commercial profits)
	GE	Expenditure on Education	Government expenditure on education, total (% of government expenditure)
Dependent	GDP	Economic Growth	GDP (current US$)

All the data were sourced from world bank economic development indicators from 2000 to 2023 for Ethiopia case only. Table 1 presents the detail description of variables.

In regression analysis, one of the most popular techniques is the ordinary least squares (OLS) method. Reducing the sum of the squared differences, or residuals, between the values predicted by the regression model and the observed values is its main objective (AKHMADKHON, 2024). The relationship between the dependent and independent variables is modeled mathematically using regression method as shown below:

$$GDP_t = \beta_0 + \beta_1 RE_t + \beta_2 RR_t + \beta_3 PE_t + \beta_4 SE_t + \beta_5 TE_t + \beta_6 LF_t + \beta_7 GE_t + \varepsilon_t \quad (1)$$

where, β_0 is constant, β_1, …, β_7 are coefficients used to calculate GDP, ε_t is the error term for unexplained variations in GDP.

Before implementing the regression method, knowing the relation, structure, and distribution throughout the dataset is required to properly prepare it for the analysis. Accordingly, the KNN Imputation technique is used to handle the missing data's (Della Murbarani, 2019). The missing data is handled by identifying the nearest value and applying numerical analysis. In the imputed dataset, exploratory data analysis is implemented for providing suitable data to the econometric model. This includes statistical and correlational analysis. In the statistical analysis, the mean, standard deviation, range, skewness, and kurtosis are measured to explain the variability and data distribution. On the other hand, correlation analysis is carried out to determine the causal relation among variables and detect multicollinearity that potentially bias the result of the OLS.

4. Result and Discussion

3.1 Empirical Analysis Result

As it is explained before, regression method is implemented after preparing the dataset for suitable econometric analysis using explanatory data analysis. Table 2 depicts that the statistics result such as mean, standard deviation, skewness, and kurtosis of both dependent and independent variables.

Table 2. Descriptive Statistics of Variables

Variable / Statistics Parameters	GDP	RE	RR	PE	SE	TE	LF	GE
Mean	52860836504.49	0.28	48.14	87.27	30.26	5.34	8.91	22.44
Std dev.	44008304931.18	0.12	24.76	17.06	7.22	2.44	2.77	4.55
Min.	7850809498.17	0.17	19.98	51.75	13.98	1.17	3.90	14.46
Max.	163697927593.98	0.60	90.24	114.56	37.21	7.74	12.40	30.54
Range	163697927593.98	0.43	70.26	62.81	23.23	6.57	8.50	16.08
Skewness	0.85	1.50	0.39	-0.68	-1.08	-0.54	0.14	-0.39
Kurtosis	-0.18	1.47	-1.21	-0.53	-0.38	-1.46	-1.43	-0.58
Jarque_bera_pval	0.23	0.00	0.35	0.34	0.09	0.19	-0.34	0.62

Table 2 illustrates that the statistic results of each variable help to know their distribution. Based on the above result, GDP varies across the years with a range between 7850809498.17 to 163697927593.98 with average value of 52860836504.49. For all variables, the value of standard deviation is very small as compared to mean, hence the data distribution has low variability.

In addition to statistical analysis, the correlation analysis is also implemented before regression analysis. From the result, it is obtained that GDP has a strong relation with labor tax and contribution, researcher in R&D, and tertiary education as shown in Figure 3. Whereas, there is a negative correlation among government expenditure on education and labor tax and contribution since their correlation value is -0.04.

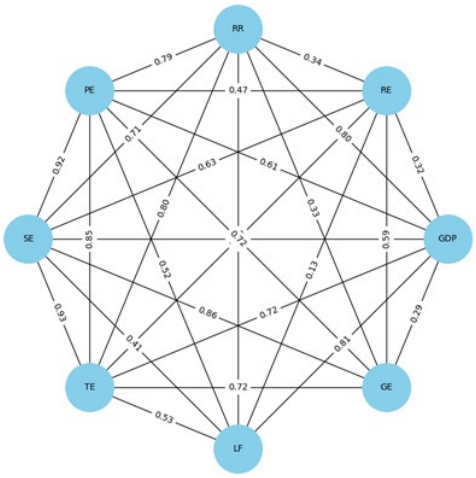

Figure 3. The Correlation Result Among Variables

To decide whether or not all variables are used in the regression model, the multicollinearity should be checked between variables. The existence of multicollinearity among those variables cause difficulty in estimating the impact of each independent variables on GDP. Figure 4 illustrates the variables that have multicollinearity. PE, SE, and TE are highly correlated each other. Also, LF has high correlation with RR (0.83) and GDP (0.81).

Due to this, the Eq (1) should be updated for conducting better regression analysis that contains variables with less correlation among them.

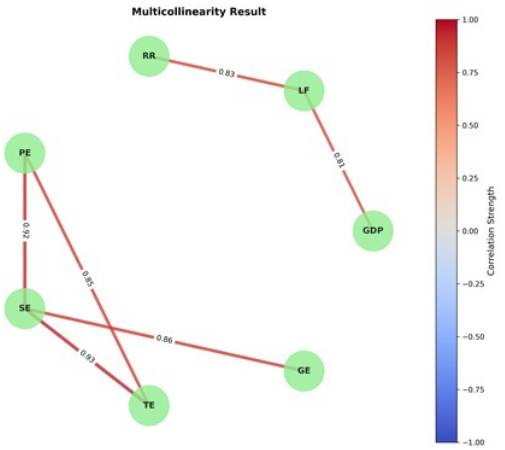

Figure 4. Multicollinearity Result

$$GDP_t = \beta_0 + \beta_1 RE_t + \beta_2 GE_t + \beta_3 EI_t + \beta_4 RDI_t + \varepsilon_t \quad (2)$$

where, EI (index of education) is the average index of PE, SE, and TE and RDI (Index of R&D) is obtained from the average of highly correlated variables namely, LF and RR.

Table 3. OLS Regression Model Coefficient Analysis Result

Variable	Coeff.	Std. Err	t-statistic	p-value
const	21.0315	0.525	40.093	0.000
RE	0.7402	0.877	0.844	0.410
GE	0.0347	0.047	0.744	0.466
EI	0.0223	0.038	0.585	0.566
RDI	0.0475	0.015	3.066	0.007

The OLS method is used to indicate the effect of research and development and human capital in economic growth. Table 3 shows the overall coefficient analysis of OSL method. The result implies that RDI has statistically significant impact on GDP since it has p value ($p = 0.007$) which is less than 0.05 and positive coefficient. Although, the remaining variables indicates positive coefficient that depicts their positive relation with GDP, they are statistically insignificant in this model since their p value is greater than 0.05.

According to the OLS model statistic result, it is observed that around 86.7% of Log GDP variation occurs due to the independent variables. This exhibits that the chosen model is strongly fitted to show the changes on GDP. Furthermore, the value of F-statistic and Prob (F-statistic) reveals that the overall statistical significance of the model since it has very low p value (1.18e-07).

Table 4. OLS Regression Model Statistics Result

Parameters of statistic	Value
No. Observations	23
Df Residuals	18
R-squared	0.867
Adjusted R-squared	0.837
F- statistic	29.21
Prob(F-statistic)	1.18e-07

3.2 Discussions

The study aim was to examine the relation between R&D, human capital, and economic growth and to evaluate the significance of R&D and human capital as determinants of economic growth within the Ethiopia's NIS. A systematic review and empirical analysis were implemented to obtain both theoretical and empirical insights about the essentiality of those NIS pillars in the economy growth. The result of both methods reveals that R&D and human capital are the key pillars of NIS especially in developing countries like Ethiopia.

The systematic review shows that the two pillars are highly interrelated and difficult to see them separately. Similarly, their correlation is also observed in the empirical analysis. For example, researchers in R&D (RR) and labour tax and contribution (LF) are highly correlated with correlation value of 0.83 since they are the metrics of R&D and human capital, respectively. According to (Tesfa, 2015) the major challenges that limit R&Ds of universities are problems on human resources development, availability research facilities, communication of research output, government strategies for research and the motivation for the research. As it is observed on the econometric analysis, the expenditure on R&D (RE) is statistically insignificant with p value of 0.41. Many researchers presented that both NIS pillars have great impact on GDP in various sector of the countries as it is obtained from the systematic analysis. On the other hand, the empirical analysis is also approved that around 86.7% of GDP is varied by its independent variables. The study also found that RDI (combination of LF and RR) has a positive significant on GDP with ($\beta = 0.0475$ and $p = 0.007$). The remaining variables namely, RE, GE, and EI are not statistically significant on GDP with large p value. This result implicates that human capital and R&D have statistically significant on GDP.

Moreover, extensive studies explained that the economic productivity of Ethiopia is highly depend on the knowledge, skill, and innovation capability of manpower. The knowledge produced from research and development can enhance the production level and adoption of technology in several sectors of the country including agricultural and manufacturing sectors. Such NIS pillars improve the ability of competitiveness by supporting firms to yield more innovative products and minimizing the reliance on traditional methods. Although both pillars have a great contribution to the growth of Ethiopia's economy, the government and the relevant bodies have not worked on them properly.

According to many studies, the government has not designed an appropriate strategy for innovation, not allocating enough fund for research and development, lack of educated human resources in various economic sectors, most small and medium firms use traditional work processes, inadequate research infrastructure, less professional development, and lack of collaboration between research and business institutions. To enhance Ethiopia's economy through innovation, the government should formulate a robust innovation framework that define and control the responsibility of each NIS actors. Also, various industries and research institutions must collaborate and work together for the development of Ethiopia's economy.

4. Conclusions

The development of national innovation system is highly influence in the growth of economy especially in developing countries like Ethiopia. However, its enhancement highly depends on proper interaction of its actors and various pillars implementations. Among them, this study tried to explore the impact of human capital and R&D in fostering the economic growth. A systematic review is applied to examine existing literatures of Ethiopia that helps to understand both theoretical and empirical relation among R&D, human capital, and GDP. Although the studies conducted in this regard are limited, their findings revealed that R&D and human capital has an impact on GDP. For instance, some studies found that labour force and research expenditure have positive impact on GDP whereas others obtained formal education such as primary, secondary, tertiary education, and government expenditure have positive long-term effect on GDP. Since many of the studies were conducted in specific sectors like small medium enterprises, an empirical analysis is required for validating the systematic analysis result in a comprehensive manner.

For empirical analysis, a linear regression analysis technique was selected and implemented because it determines the influence of one or more independent variables on dependent variable and used to identify which variables have significant impact on the dependent variable. So, the independent variables namely, primary education, secondary education, tertiary education, expenditure in R&D, researchers in R&D, labor force, and expenditure on education are selected based on systematic review result. The data were obtained from the world bank economic development indicators spanning from 2000 to 2023 for the case of Ethiopia.

A statistical and multi-correlation analysis were performed in the data to make the data more suitable for the selected model. The analysis findings show that there was high correlation among variables. For instance, high

correlation was occurred between primary education, secondary education, tertiary education. Also, Labour force and number of researchers in R&D have high correlation value of 0.83. Therefore, these highly correlated variables should be taken as one variable using average indexing technique. As a result, the independent variables minimized from seven to four particularly, expenditure on R&D, expenditure on education, index of education (PE, SE, and TE), and index of R&D (LF, and RR) with GDP as dependent variable.

The regression analysis findings implicate index of R&D variables has statistically significant on GDP and other variables have insignificant statistical impact on countries economy development. The result illustrates that both human capital and R&D has a combined influence on GDP. In other words, since the number of labour force and researchers in R&D increases, the GDP is also maximized. So, the government, educational institutions, and enterprises should work together for developing countries economy by obtaining a skilled and educated manpower.

On the other hand, the empirical analysis outcome tells us that there is limited number of educated manpower, poor quality of education, and inadequate research and education funding in the country. Hence, the government should formulate innovation strategies and policies that used for enhancing the quality of education with allocating enough education and research funding for boosting the NIS impact on countries economy.

Generally, the chosen model is strongly fitted since around 86.7% of GDP varies due to its independent variables. However, this paper presented both theoretical and empirical analysis for the evaluation of R&D and Human Capital impact on GDP, the study is not included their long term or short-term impact so future researchers can study on this using advanced data analysis techniques. Furthermore, the paper is only use Ethiopia's data hence it is recommended for further research to include other developing countries for a better understanding of NIS influence on economic growth.

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