Does Research and Development Expenditure Incite Quality of Economic Growth? Evidence from China

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Abstract A recent economic and political history has extensively shown that high growth alone does not necessarily lead to better social outcomes. Quality of growth has, therefore, become a popular lemma over the past few years. Most countries are now concentrating on how to improve the quality of growth rather than the quantity. This study, therefore, aimed at assessing the impact of innovation on the quality of economic growth in China, using Research and Development Expenditure as an indicator for innovation, and Human Development Index as an indicator for quality of economic growth. A time series data covering a period from 2000 to 2019, and the Ordinary Least Square method of estimation were used in the regression analysis. The results of the study provide evidence that research and development expenditure is a vital factor for ensuring quality of economic growth. The findings of the study are very essential for policymakers in China, as China in its 14th Five-Year plan, intends to increase its spending on research and development to enhance innovation activities. This provides adequate evidence for the government of China, as well as other emerging economies, that as a country increases its investment in research and development, it stands a better chance for enhancing its quality of growth, and also achieving its Sustainable Development Goals. The study also adds new empirical evidence to the existing literature on innovation and economic growth.

Keywords: R & D expenditure, quality of economic growth, human development Index, China, innovation


1. Introduction

Recently, several researchers and policymakers have been paying attention to innovation and its impact on human capital and the economy as a whole [1,2,3]. Innovation is seen to improve human capital, thereby increasing productivity and consequently enhancing economic growth [4]. In the quest for innovativeness, most policymakers and countries have resorted to investment in Research and Development (R&D). Since human capital is held to be a vital factor to innovativeness, investing in R&D would invigorate the human capital, making it more productive.

Innovation affects an economy in diverse ways such as global competitiveness [5,6], infrastructural development [7,8,9], quality of life [10,11,12], employment [13,14,15,16], and the financial system [17,18] of the country.

A recent economic and political history has extensively shown that high growth alone does not necessarily lead to better social outcomes. Quality of growth has, therefore, become a popular lemma over the past few years. Most countries are now concentrating on how to improve the quality of growth rather than the quantity. Among these countries is China. According to China’s 14th Five-Year Plan (2021-2025) Report, China is shifting its principal growth drivers towards innovation and prioritizing quality of growth over quantity of growth [19]. China, therefore, intends to increase its R&D spending in order to enhance innovativeness.

This paper, therefore, assessed the impact of increase in R&D expenditure on the quality of growth in China. The research findings showed that the increase in China’s spending on R&D is directly proportional to the economic growth quality. As China keeps allocating a percentage of its GDP to investment in R&D, it should expect nothing but a better and sustained economic future.

This study is quite useful as the empirical results provide adequate evidence that investment in R&D is a good driver of a country’s innovativeness, hence enhancement of quality of economic growth. Policymakers and governments can rely on this evidence in making good innovative policies for their countries, especially for developing or emerging economies. Most studies on innovation are limited to growth quantity which ignores the social benefits. This study bridges this gap, and adds to the existing knowledge of literature on economic growth and innovation.

The rest of the paper is structured as follows. The literature review deals with related studies on the subject of study and empirical reviews. The next sections deal
with data and methodology, and empirical results. The last section provides conclusion to the study.

2. Literature Review

2.1 Institutional Background

This section provides a brief discussion about the various institutions of study which include innovation, economic growth and human development index.

2.1.1. Overview of Innovation

Innovation is a concept that is quite difficult to be defined. Despite its difficulty in definition, economists have been able to break it down into three forms which include decreasing costs, quality enhancements, and increasing the variety of goods and services, and its production methods. This definition involves finding new ways of doing things and coming up with new ideas and products and services to meet either the standard of the market or make a difference in the marketplace. It is a concept that has a huge influence on conditions of living of people and also the society as a whole. Innovation may come in the form of technology or social. However, most often, innovation is limited to technology. Technological innovation deals with stock and the knowledge flow underlying science. Technological innovation entails scientific research and the stage of R&D which includes new inventions, registration of patent, prototyping, and consequently leads to either change or making of new products and services to be followed by market entry, marketing and commercialization [20].

2.1.2. Innovation in China

Since 2015 China has been identified as innovation-driven economy [21]. China is one of the countries in Asia that is fast growing in terms of innovation. China boosts of innovative products like high-speed trains, e-commerce, mobile payments, and drones. The country began with imitation and finally arrived at innovation [22,23].

With a strong ambition to become the leading innovative country by 2035 [19], China has prioritized R&D, spending a percentage of its GDP on encouraging and reducing the cost of R&D activities. Since 1996, China has been increasing its rate of spending on R&D from a 0.56% to 2.4% in 2020. According to the country’s 14th Five-Year Plan (2021-2025), China will continue to increase its percentage of GDP spending on R&D yearly by more than 7% [19]. The country intends to make technology as its core focus [24]. For a country to be successful at its cutting edge sectors it should have a strong scientific base [25].

2.2. China’s Economic Growth Trend

The economy of China had experienced poverty, stagnant growth, and inefficiencies for some number of years until the country began to undergo reforms and trade liberalization. Since 1979, China has been identified to be one of the fastest growing economies in the world with an annual GDP growth of 6.75% in 2018 and 5.95% in 2019. China is currently, in terms of purchasing power parity, seen globally to be the largest economy which has a large market for merchandize goods, foreign exchange reserves, and manufacturing.

Despite the maturity in economic growth, China’s real GDP growth began to fall after a rise in 2007. In 2007, China recorded a real GDP growth of 14.23%. Since then, the country has been experiencing significant fall in growth from 9.65% in 2008, 5.95% in 2019, and about 2.3% in 2020. However, according to a forecast from International Monetary Fund (IMF), the real GDP growth rate of China is expected to increase to 8.44% in 2021 but after begin to fall from 5.57% in 2022 to 4.86% in 2026 [26]. According to the Chinese government, the slower rate of growth of the economy is not really a problem as the country is currently considering embracing a new growth model that depends on innovation strategies in order to drive better growth. Moreover, China is no more pay attention to the quantity of growth but the quality of growth. AS such, the country plans to strengthen its domestic economic and social development [27].

The decision by Chinese government considering quality of growth is because political and economic history has shown that growing in terms of quantity does not bring about enhanced social outcomes. Many countries, especially developing economies have been experiencing increase in economic growth, yet the level of poverty, unemployment, and inequality are high. Hence, in order to ensure that economic growth comes with achievement of
social goals, countries are now considering quality of growth. The concept of quality of growth, however, is quite difficult defining since it meaning differs country by country. In measuring quality of growth, Human Development Index (HDI) which was developed by the United Nations (UN), has been proven to be a better indicator [28]. The HDI comprises of life expectancy index, education index, and the income index which is based on Gross National Income per Capita. Since 2000, China has been experiencing increase in the HDI, from 0.59 in 2000 to 0.76 in 2019. According to the 2019 report on global HDI by United Nations Development Program, China is ranked 85th position.

![Figure 3. China’s HDI Trend (Source: Author’s compilation from World Bank data)](image)

### 2.3. Empirical Review of Innovation and Economic growth

Literature postulates that innovative activities, directly and indirectly aid economic growth through other macroeconomic factors [29,30]. On the other hand, other studies have shown innovation does not contribute to economic growth [31,32].

Pece, et al. [29] examined how innovation is able to influence long-term economic growth among CEE countries. Number of patents, R&D expenditures, and number of trademarks were used as proxy for innovation. The results from the multiple regression analysis indicated that a positive relationship exist between innovation and economic growth. Similarly, Maradana, et al. [30] analyzed the long-run relationship between innovation and per capita economic growth, using 19 European countries. Six innovative indicators, including patents for residents, patents for non-residents, expenditure on R&D, researchers in R&D, high-technology exports, and scientific and technical journal articles, were used. The results from the Granger causality test showed that there is a positive relationship between innovation and per capita economic growth. However, there were variations in the results from country to country, due to differences in the type of innovative indicators.

Bilbao-Osorio and Rodriguez-Pose [33] analyzed the impact of innovation on economic growth in peripheral regions of Europe. Their study sort to achieve two objectives; the effect of R&D investment of the private, public, and higher education sectors on economic growth, and how innovation and innovation growth influence the economic growth. The results indicated a positive relationship between investment in R&D as a whole, and investment in peripheral regions of the EU, and economic growth.

Bayarçelik and Taşel [34] studied the link between innovation and economic growth of Turkey. Bayarçelik and Taşel [34] used the number of researchers in R&D, R&D expenditures, and patents as indicators for innovation. For economic growth, GDP was used as a proxy. The findings indicated that R&D expenditure and the number of researchers in R&D are significant and positively related with economic growth.

Technological growth is responsible for long-run economic growth [35]. In [36], digital technology usage was found to be substantial to economic growth for 39 African countries. In countries that have access to better education, the use of internet contributes to economic growth [37]. This means that education facilitates a positive relationship between technology and economic growth. Technological innovation is, therefore, a key factor to economic growth and the development of human capital. The long-term record of success of most developed countries like USA, Germany [38], Singapore [39], and Iceland are attributed to technological innovation.

On the other hand, Gumus and Celikay [31] found a weak relationship between R&D and economic growth among developing countries. [40] also investigated the relationship between R&D and economic growth using 30 developing countries. R &D indicators like government expenditures on research in GDP, the number of researchers in each one million population, and scientific output of the countries were used. The findings indicated that there is no significant positive impact of R&D on economic growth of the countries under the study. Similarly, Burcu and Ayşe [41] analyzed the relationship between R&D and economic growth for 15 OECD countries. The findings showed that R&D positively affect economic growth. However, a negative relationship was found for countries like Germany, Netherland, Spain, and England.

Moreover, Kokko, et al. [42] examined the relationship between R & D spending and economic growth among EU countries and other regions. A negative relationship between R&D and economic growth was found among the 15 EU countries. A similar result was also found in [32]. An investigation was done on how technological innovation affect economic growth in 25 developing countries. Using R&D expenditure and number of researchers in R&D, Pala [32] found a negative impact of R&D on economic growth in countries like China, Iran, Panama, Serbia, Egypt, and Uzbekistan. Also, a negative effect of number of researchers in R&D and economic growth was found among countries like Mexico, Tunisia, Iran, and Uzbekistan.

In this literature, several studies have been conducted on innovation and economic growth. However, these studies focused on quantity of growth, using GDP or GDPPC as a measure of growth. This current study goes beyond the economic impact by including the social benefits of innovation on the adopted country.

### 3. Data and Methodology

This study used the time series data to examine the impact of innovation on the quality of economic growth in
China. The Ordinary Least Square method of estimation was used for the regression analysis. R & D expenditure was used as a measure of innovation whereas human development index was used to measure the quality of economic growth. The table below presents the definition of the variables and their sources.

**Table 1. Summary of Variables Definition and Sources**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of Economic Growth (QEG)</td>
<td>Refers to the level of country’s economic and social achievement. HDI is used as a proxy and it is measured in three dimensions; Life expectancy index, Education index, and Income index.</td>
<td>Knoema, 2020 Statistical Update</td>
</tr>
<tr>
<td>R&amp;D expenditure (RDEXP)</td>
<td>Research and development expenditure as a percentage of GDP. Research and development entails basic research, applied research and experimental development. It is used as a proxy for innovation.</td>
<td>World Development Indicators (WDI -2021)</td>
</tr>
<tr>
<td>GDP growth</td>
<td>It is measured as the annual percentage growth rate of GDP at market prices based on constant local prices.</td>
<td>World Development Indicators (WDI-2021)</td>
</tr>
<tr>
<td>Unemployment (UMPLMT)</td>
<td>Refers to a percentage of the total labor force that are available for work and seeking for employment but have no work.</td>
<td>World Development Indicators (WDI-2021)</td>
</tr>
</tbody>
</table>

Source: Author’s compilation

**Model**

In order to achieve the empirical results, the following model was developed.

\[ QEG_t = \beta_0 + \beta_1 RDEXP_t + \beta_2 GDPG_t + \beta_3 UNPLMT_t + \epsilon_{i,t} \]  
(1)

Where,

- QEG = Quality of Economic Growth
- RDEXP = R&D Expenditure
- GDPG = Gross Domestic Growth Product
- UNPLMT = Unemployment.

4. Empirical Results

Before the regression analysis, a test was conducted to check whether multicollinearity exist amongst the variables of study. Using Variance Inflation Factor, the test shows no multicollinearity in the variables. Test results are presented in **Table 2**.

**Table 2. Variance Inflation Factor**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient Variance</th>
<th>Uncentered VIF</th>
<th>Centered VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDEXP</td>
<td>3.61E-05</td>
<td>31.05477</td>
<td>2.250212</td>
</tr>
<tr>
<td>GDPG</td>
<td>1.39E-06</td>
<td>35.11335</td>
<td>1.762283</td>
</tr>
<tr>
<td>UNPLMT</td>
<td>3.72E-05</td>
<td>183.7920</td>
<td>1.434417</td>
</tr>
<tr>
<td>C</td>
<td>0.000526</td>
<td>155.5512</td>
<td>NA</td>
</tr>
</tbody>
</table>

Source: Author’s computation.

4.1. Regression Analysis

The **Table 3** shows the results of the regression analysis between R & D expenditure and HDI.

**Table 3. Results of the OLS Regression**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDEXP</td>
<td>0.1332</td>
<td>0.0060</td>
<td>22.1582</td>
<td>0.0000</td>
</tr>
<tr>
<td>GDPG</td>
<td>0.0031</td>
<td>0.0012</td>
<td>2.6614</td>
<td>0.0171</td>
</tr>
<tr>
<td>UNPLMT</td>
<td>-0.0176</td>
<td>0.0061</td>
<td>-2.8800</td>
<td>0.0109</td>
</tr>
<tr>
<td>C</td>
<td>0.51059</td>
<td>0.0229</td>
<td>22.2631</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Source: Author’s computation. NB: All values are converted into 4-decimal places.

Table 3 provides the results of the OLS regression analysis of the impact of R & D on quality of economic growth. From the results, RDEXP has a probability value of 0.0000 which indicates a highly significant value with a positive coefficient value of 0.1332. This means that a percentage increase in R&D expenditure will lead to 13.32 percent increase or improvement in growth quality.

Considering the results of the empirical analysis, it is evidenced that R & D expenditure which is used as an indicator of innovation is a vital factor that drives quality of growth. The amount of spending on research and development is directly proportional to quality of growth. The results of this study is in line with the findings of [43]. The findings of this study also affirms the notion that investing in R&D aids in achieving both social and economic goals in the country. This means that countries that set aside a proportion of their GDP for R&D, stand the chance of better economic and social outcomes.

Based on the findings, it is of good essence for countries, especially developing economies which seek to improve their economies to begin to prioritize innovation as a driver for spurring quality growth. More policies such as tax incentives, direct grants for R&D, protecting of intellectual property, and creating cooperative research for government universities and private institutions, could be undertaken to enhance innovation which would consequently empower economic growth.

4.2. Further Analysis

A forecasting analysis was done to check the accuracy of the model. Before the forecasting, serial correlation was checked and from the results in **Table 4**, the Breusch-Godfrey Serial Correlation shows a Chi-Square probability of 0.2154 which is an indication of absence of serial correlation in the data.
Out of the data period, 2000 to 2015 was used to estimate the regression line, whilst data from 2016 to 2019 was used for forecasting. Using Root Mean Squared Error (0.011313) and Theil Inequality Coefficient (0.009843) for evaluating the forecast, the results show that the model is accurate and has no errors. As such, it is good for making future predictions.

Table 4. Breusch-Godfrey Serial Correlation LM Test

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>F-statistic</th>
<th>Prob. (F(2,14))</th>
<th>R-squared</th>
<th>Prob. Chi-Square (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
<td>1.2694</td>
<td>0.3114</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obs*R-squared</td>
<td>3.0701</td>
<td>0.2154</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Author’s computation.

5. Conclusion

The main aim of this study is to examine the relationship between innovation and quality of economic growth. The study used a time series data covering a period from 2000 to 2019. Using R&D expenditure as an indicator for innovation, and human development index, the results of our OLS estimator revealed that increase in research and development expenditure propels increase in quality of economic growth. Also, using the period 2000 to 2015 as a regression line, and period from 2016 to 2019 for a forecast, the results of the Root Mean Squared Error and Theil Inequality Coefficient provide evidence that the model makes correct predictions. As countries continue to invest in research and development, they create avenue for quality growth and also achieving their Sustainable Development Goals. Innovation is, therefore, seen to incite quality of economic growth.

References


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