International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Healthcare Expenditure and It's Relationship with Socio- Economic Indicators

Keya Patel

Student, Narsee Monjee Institute of Management Studies

Abstract

This study focuses on identifying and analysing the relationship between healthcare expenditure and other variables such as Literacy Rate, Gross National Income, Life Expectancy, Infant Mortality Rate and Gross Domestic Product in the BRICS nations. The Pearson's Correlation Coefficient, Augmented Dickey-Fuller test, the Granger's causality test and a multiple linear regression model have been used to assess the data from 1980 to 2020. On examining the trends, we see a positive correlation of healthcare expenditure with Literacy rate, GNI and Life expectancy and a negative correlation with Infant mortality rate and Gross Domestic Product. The paper also looks at causal relationships and gives evidence regarding the indirect causal relationship of healthcare expenditure on the socio-economic variables. On the other hand, the socio-economic variables have a direct causal relationship with healthcare expenditure stating that making changes or improvements in those areas might benefit the health outcomes. These relationships are supported with empirical evidence but there are exceptions from country to country. The reasons and justifications for the same are also determined.

Keyword: BRICS nations, healthcare expenditure, literacy rate, gross national income, life expectancy, infant mortality rate, gross domestic product

Introduction

Human development in both developed and developing countries depends on two key factors: education and health, which constitute human capital. While education has traditionally been the focus of research on economic growth and development, recent studies have also emphasized the importance of health in expanding human capital. Improved health results in increased labor productivity, longer life expectancy, and the accumulation of health capital, all of which contribute to human growth. One way of measuring the importance of health is by looking at government spending on healthcare. Such spending includes health services, family planning activities, emergency assistance, and nutrition programs. Government investment in health improves public health and the building of health capital, and its effects on economic growth and human capital have significant impacts on human progress.

The growing importance of health in the growth model has been attributed to several reasons. Firstly, poor health reduces workers' productivity and efficiency, thereby slowing economic growth. Secondly, health affects education, as children in many underdeveloped nations are unable to attend school due to illnesses like malaria. Thirdly, there is a growing understanding of the connections between health outcomes and other development objectives like eradicating poverty, promoting gender equality, and maintaining the environment.

By prioritizing investments in health, policymakers can promote public health and the building of health

capital, which has positive effects on economic growth and human capital. Therefore, it is crucial for both developed and developing countries to consider health when designing their economies and make investments in health a top priority in order to advance both human and sustainable economic growth.

Objective

The key objectives of this paper are as follows:

1. To analyse the growth, trend and pattern of healthcare expenditure in the BRICS nations
2. To assess the impact of healthcare expenditure on various socio-economic variables
3. To study the cause-and-effect relationships among healthcare and various socio- economic variables.

Rationale

The study aims to investigate the relationship between healthcare spending and various key indicators of development, including literacy rate, GNI, life expectancy, infant mortality rate, and GDP. Understanding this relationship is important as healthcare spending is often a significant portion of government budgets, and can have significant impacts on the overall well-being and productivity of a population. By examining these indicators, the study seeks to determine if there is a causal relationship between healthcare spending and improvements in these measures of development, and if so, to what extent. The findings from this study can inform policymakers on the potential benefits of investing in healthcare and aid in the allocation of resources towards healthcare spending in a more efficient and effective manner.

Literature Review

The paper by Bokhari, Gai, and Gottret explores the complex relationship between government health expenditure and health outcomes. The authors suggest that increased healthcare spending may not always result in improved health outcomes, as several factors such as inadequate infrastructure and corruption can limit the impact. The study recommends that low-income countries require more financial aid from donors to improve their healthcare expenditures. (Bokhari et al., 2006)

Studies by Gangadharan and Valenzuela (2001) and Pritchett and Summers (1996) show a correlation between wealth and health expenditure. Pritchett and Summers (1996) suggest that infant and child health are more dependent on income, with an estimated income elasticity of 0.2 to 0.4 for infant mortality. They conclude that income is more important for infant and child health than overall life expectancy. *(Wealthier Is Healthier, 2022).*

Boyacioglu's study highlights the importance of healthcare expenditure and basic health measures as crucial indicators of sustainable development. Noncommunicable diseases need to be addressed to avoid incurring trillions of dollars in costs. The study also finds a positive correlation between health and socio-economic status. (Boyacioglu, 2020)

Bloom and Canning (2003) suggest that health is crucial for increased productivity and output. Countries should allocate a larger proportion of their GDP to healthcare expenditure. However, Melissa Oney's paper "An analysis of the Relationship between Health Expenditure and Health Outcomes" shows that despite the US spending twice as much as OECD nations on health, improvements in health outcomes are relatively low. After the 2007 financial crisis, countries planned to cut back on various areas, including health (Bloom and Canning,

2003; Oney, 2018).to cut back on various areas, including health. *(Bloom and Canning, 2003; Oney,*

2018)

A study by Lamiraud et al. (2016) found that education is related to infant mortality, while health expenditure correlates positively with life expectancy and potential years of life lost (PYLL). Lifestyle factors like alcohol and cigarette consumption are also essential. The research indicated that a 1% increase in health expenditure resulted in a 0.03% increase in life expectancy and a 0.17% decrease in PYLL. The proportion of the population under 15, income, and health expenditure are positively related to happiness, with a 1% increase in health expenditure leading to a 0.14% increase in happiness.

(Lamiraud et al., 2016)

Guzel's paper "Public Health expenditures and Happiness in OECD countries" explores the relationship between healthcare expenditure and happiness, highlighting the significance of public spending in promoting welfare. The study suggests that health is a crucial factor influencing happiness, and governments must focus on reducing poverty and income inequality to increase welfare levels. The paper notes the growing interest in using the happiness index as a measure of well-being in economics. (Guzel, 2019)

The study examines the relationship between public health spending and happiness in OECD countries. The government has a critical role in providing health services to ensure equality and generate positive externalities. Public health spending is important in determining the priority of health expenditures and is a significant factor in the overall happiness and well- being of societies. The study shows that countries with low levels of public health spending have lower levels of happiness among OECD nations. (Gao et al., 2021)

The study conducted in Iran from 1990 to 2009 shows a positive correlation between government health spending and the human development index. The study recommends allocating more of the government budget to promoting good health and supporting NGOs. Future studies should also examine the private sector's contribution to health care. (Arab- Zozani et al., 2015)

The study analyzed the relationship between healthcare spending, carbon emissions, and human development index (HDI) in 33 OECD countries from 2006 to 2016. The study revealed that healthcare spending and HDI had a positive causal relationship, while healthcare spending and CO2 emissions had a bidirectional causal relationship. It also suggested that carbon emissions had a negative causal relationship with HDI. The study recommended reducing CO2 emissions and investing in clean technology to improve people's health and wellbeing while reducing healthcare costs. The findings align with Fernández et al. (2018). (Fernández et al., 2018)

Mirahsani (n.d.) examined the relationship between health expenditures and human development index using data from Iran's "2025 Horizon" publication from 2000 to 2008. The study found a positive correlation between government health spending and the human development index. Additionally, it was noted that the effectiveness of government health spending decreases as it increases. The results suggest that higher government spending on health can lead to increased human development indices.

The focus on sustainable economic growth has shifted from GDP to Human Development Index (HDI), which considers human physical and intellectual attributes. Research on southwest Asian nations has shown a positive correlation between higher health spending and higher HDI. Iran ranks tenth out of 24 nations in the region for health spending. (Theoretical and Experimental Literature, UN table comparison of southwest Asian nations' health spending)

The United Nations Millennium Declaration aims to tackle issues such as poverty, hunger, education, gender equality, child mortality, maternal health, disease, and environmental sustainability. Edward

Nketiah-Amponsah's study analyzed the impact of health expenditure on health outcomes in 46 sub-Saharan African countries between 2000 and 2015. The study found that healthcare spending has a positive impact on life expectancy, under-five mortality rate, and maternal mortality, but it remains low in the region. The study recommends increasing healthcare spending to improve health outcomes in sub-Saharan Africa. (Nketiah- Amponsah, 2020)

Studies including Arthur and Oaikhenan (2017), Novignon et al. (2012), and Anyanwu and Erhijakpor (2007) have shown a positive relationship between healthcare spending and improved life expectancy in Africa. Anyanwu and Erhijakpor's (n.d.) study on 47 African countries suggests that increased government and total health expenditure, along with policy interventions, are necessary to improve health outcomes. The study emphasizes the role of multilateral development banks in mobilizing resources and implementing policies.

Arthur and Oeikhenan's (2017) study on health expenditure in Sub-Saharan Africa found a strong relationship between public and private spending, with public expenditure being more effective in reducing mortality rates and private expenditure being more effective in improving life expectancy. The study suggests increased public health expenditure, health insurance, and investments in sanitation, clean water, and immunization for better health outcomes. (Arthur and Oeikhenan, 2017)

Novignon et al. (2012) found a positive association between healthcare expenditure and improved health outcomes in Sub-Saharan Africa, including increased life expectancy and decreased infant mortality and death rates. The study suggests that increased public healthcare expenditure is needed to improve health outcomes in the region.

Timofeyev et al. (n.d.) highlight the significance of healthcare expenditure in the BRICS nations and suggest the importance of government spending on healthcare, promoting physical activity and healthy lifestyles. The paper recommends research funding and exchange with medical sciences to improve healthcare outcomes. Carmen and Pilar's (n.d.) paper emphasizes the role of education and socio-economic development in improving healthcare resources and quality of life in Africa and Asia, recommending international cooperation to promote investment and industrial growth in these regions. Overall, both papers highlight the need for increased healthcare expenditure and education to improve health outcomes in developing nations.

Farahani et al. (2009) investigate the impact of state-level public health spending on mortality probability in India. The research suggests that a 10% increase in public health spending reduces the average likelihood of dying by around 2%, with the most significant impacts felt by the young, old, and women. The study highlights a growing socioeconomic divide between high- and low-income households, challenging the social objective of equal health status and access to healthcare.

Nnenna et al.'s paper "Effect of government expenditure on human capital development in Nigeria" examines the relationship between government spending on health and education and human capital development in Nigeria. The study finds that public investment in education and health has a significant impact on the country's human development index (HDI). However, the study also finds that government spending on education and healthcare has no direct impact on HDI. The study emphasizes the importance of public investment in education and health in promoting human capital development in Nigeria. (Nnenna et al., n.d.)

Raghupati and Raghupati (2018) investigate the relationship between healthcare expenditure and economic performance in the US from 2003-2014. They find a positive correlation between healthcare spending and income, GDP, and labor productivity, but a negative correlation with multi-factor

productivity. The study emphasizes the need for more research on universal healthcare access and the current healthcare system's design.

The study finds a positive correlation between healthcare spending and economic metrics like personal income, per capita GDP, and labor productivity. However, personal healthcare expenses negatively impact time spent on purchases, and healthcare spending does not correlate with changes in multi-factor productivity or working hours. The study recommends prioritizing public health spending and economic growth to maximize potential economic benefits. Further research is needed to determine the economic benefits of universal healthcare. (Raghupati and Raghupati, 2018)

Kim and Lane's study found that increased government health spending is associated with improved public health outcomes, particularly a reduction in infant mortality rate and an increase in life expectancy at birth. The study highlights the importance of public investment in healthcare for improving the overall health of the population. The findings have significant policy implications for governments aiming to reduce infant mortality rates and increase life expectancy. The study also contributes to the ongoing healthcare reform debate in the US. (Kim and Lane, n.d.)

Railaite and Ciutiene's study of 28 European Union countries found that public health spending positively influences life expectancy and human capital. The study emphasises the importance of efficient governance and careful resource management given the increasing rate of public health expenditure. The findings suggest that investing in public health can improve health outcomes and promote human capital development. (Railaite and Ciutiene, n.d.)

The paper by Lopez-Casasnovas et al. examines the complexities of comparing healthcare expenditures across nations. The study recommends the need for better understanding of the settings and background in healthcare expenditure, aligning sampling with financial capabilities, and accounting for the political nature of healthcare systems. The paper uses the Spanish case as an example. (Lopez-Casasnovas et al., 2014)

Methodology

The methodology of this paper is primarily based on secondary data for the period 1980 to 2020. The data has been collected from World Bank, International Labour Organisation (ILO), United Nations Development Programme (UNDP), and International Monetary Fund (IMF).

The methodology of this paper has been divided in 3 subsections – Part I has been devoted to the trend analysis and correlation analysis of the variables. Part II tests the data for stationarity and causality using the Augmented Dickey-Fuller and Granger's Causality Test. Part III focuses on the Multilinear Regression Analysis of the data.

The variables used for analysis are as follows:

1. Healthcare Expenditure as a percentage of total expenditure: The proportion of total expenses that a nation or an individual spends on healthcare. It is used to assess how important healthcare is in comparison to other areas of spending.
2. Literacy Rate: A nation's educational level and level of human development are gauged by its literacy rate, which is the proportion of its people that can read and write.
3. Gross National Income: a metric used to assess a nation's economic performance and level of life and is the sum of all the products and services produced within plus any net income the nation receives from abroad.
4. Life Expectancy: Life expectancy is the average number of years a person is expected to live, and it

is used to measure the health and well-being of a population.

5. Infant Mortality Rate: It is calculated as the number of infant deaths under one year of age for every 1,000 live births. It is a key indicator of a population's health and wellbeing, particularly in terms of maternal and child health.
6. Gross Domestic Product: Gross Domestic Product, which is used to gauge a nation's economic growth and production, represents the monetary worth of all finished products and services produced inside its boundaries during a certain time period.

The estimation procedure includes:

1. Pearson's Product-Moment Correlation Coefficient Test: The Pearson's correlation coefficient test is used to evaluate the degree of link between two variables by measuring the strength and direction of the linear relationship between them.
2. Augmented Dickey-Fuller Test: It is a statistical analysis used to check for stationarity in time series data and to see if a time series data has a unit root.
3. Granger's Causality Test: It is a statistical hypothesis test that examines the direction and causality of links between two variables. It is used to check whether time series data may be used to predict one another.
4. Multiple Linear Regression Model: It is used to predict and explain variations in the dependent variable based on the independent factors. It is used to analyse the linear relationship between two or more independent variables and a dependent variable.

In the analysis, we have used time-series data from 4 out of 5 BRICS nations. I have taken the data for Brazil, Russia, India, and China. The reasons for excluding South Africa are as follows - South Africa's economy is smaller and heavily reliant on natural resources compared to the other BRICS countries. Therefore, it is not comparable and is an outlier.

PART I: TREND AND PATTERN ANALYSIS

In this part we have performed the trend analysis and the correlation analysis for the data.

This is done to establish the direction of the relationship between the variables.

DATA AND ANALYSIS

(II) PEARSON'S PRODUCT – MOMENT CORRELATIOIN COEFFICIENT

In this section, we do a basic Pearson correlation analysis to determine the degree and direction of the linear link between two continuous variables. The Pearson product-moment correlation coefficient has a range of -1 to +1, with +1 denoting a perfect positive correlation,
-1 denoting a perfect negative correlation, and 0 denoting no connection between the variables.

(A) BRAZIL:

Taking reference of the figures from the following page we observe that: The plotted graphs show the trends and patterns as well as the correlation between the variables. All variables have been plotted in a line graph with Healthcare Expenditure shown as a bar graph in all. Our inferences are as follows:

(a) Healthcare Expenditure, literacy rate, GNI and life expectancy of Brazil have been increasing over

the years and the GDP and Infant Mortality rate have reduced.

(b) A positive correlation is seen between healthcare expenditure and literacy rate (0.89), GNI (0.87) and Life Expectancy.

(c) A positive correlation is seen between healthcare expenditure and Infant mortality rate (-0.95) and GDP (-0.78)

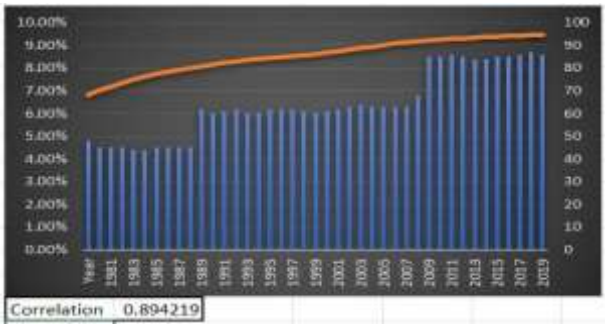


Figure 1: Literacy Rate

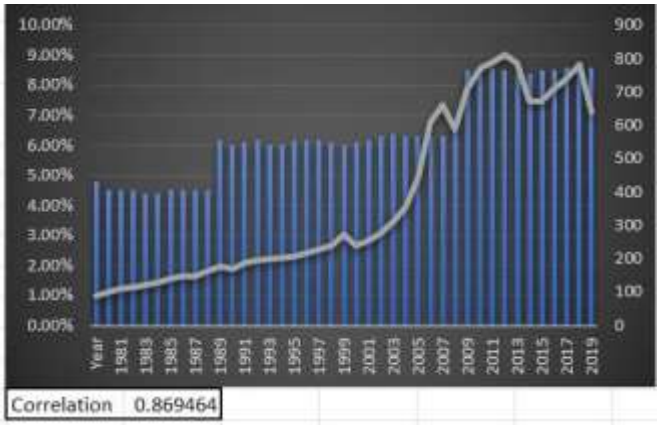


Figure 2: Gross National Income

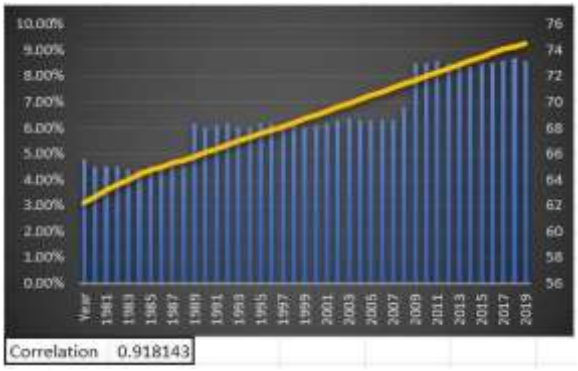


Figure 3: Life Expectancy

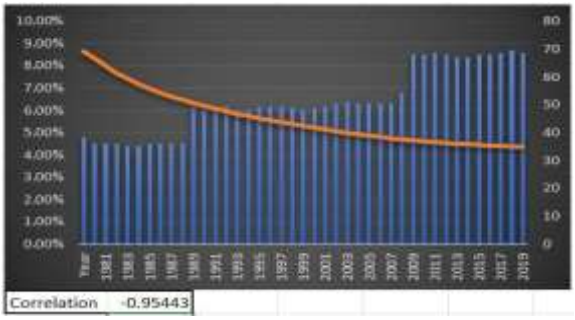


Figure 4: Infant Mortality Rate

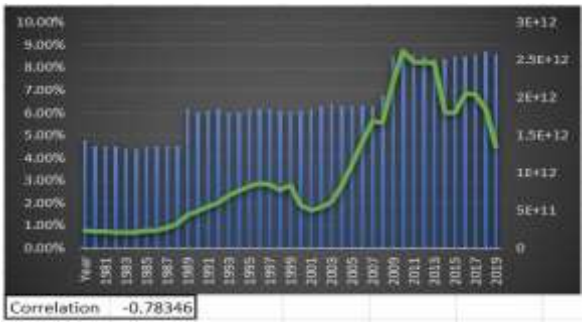


Figure 5: Gross Domestic Product

(Source: all plotted by the author)

(B) RUSSIA

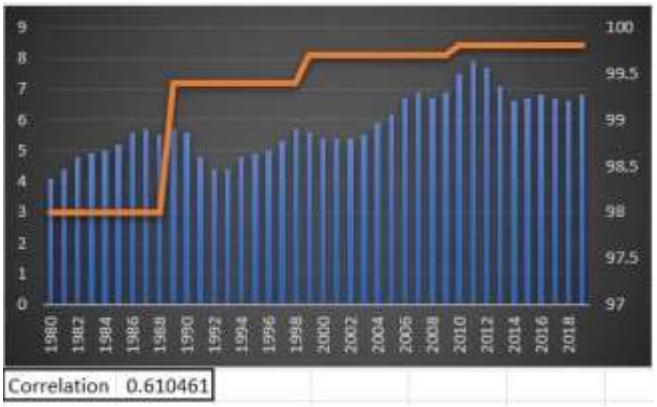


Figure 6: Literacy Rate

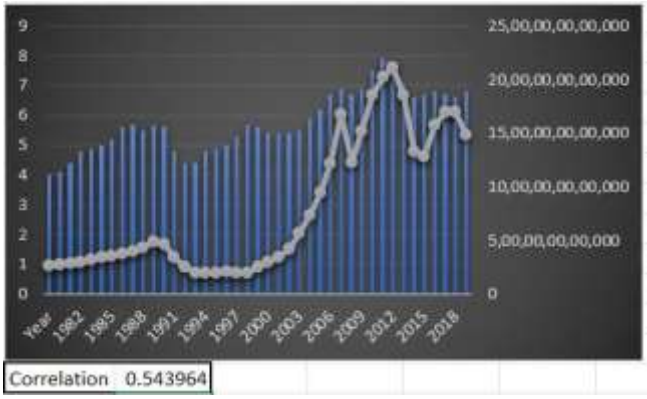


Figure 7: Gross national income

Figure 8: Life Expectancy

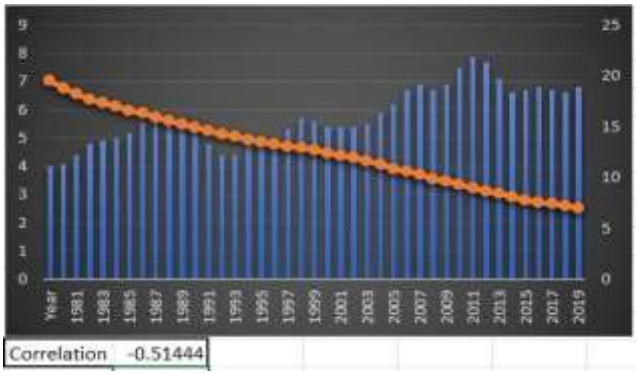


Figure 9: Infant mortality rate

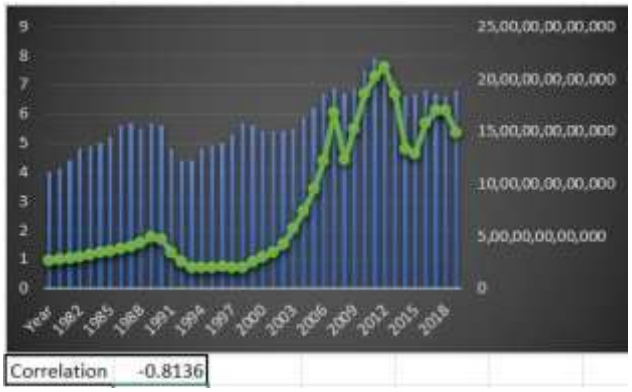


Figure 10: GDP

The plotted graphs show the trends and patterns as well as the correlation between the variables. All variables have been plotted in a line graph with Healthcare Expenditure shown as a bar graph in all. From the above graphs we see a positive correlation between the Healthcare Expenditure and Literacy rate (0.61), GNI (0.54) and Life Expectancy (0.79).

These variables are also increasing over time. A negative correlation is seen between Healthcare Expenditure and Infant mortality rate (-0.51) and GDP (-0.8136) and these variables are decreasing over time.*(Source: all plotted by author)*

(C) INDIA

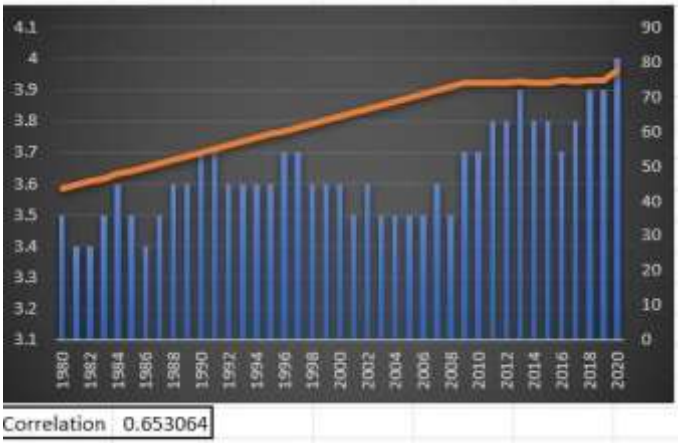


Figure 11: Literacy Rate

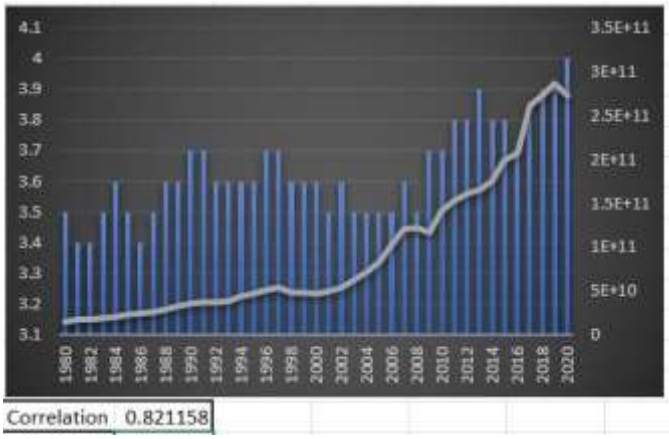


Figure 12: Gross national income

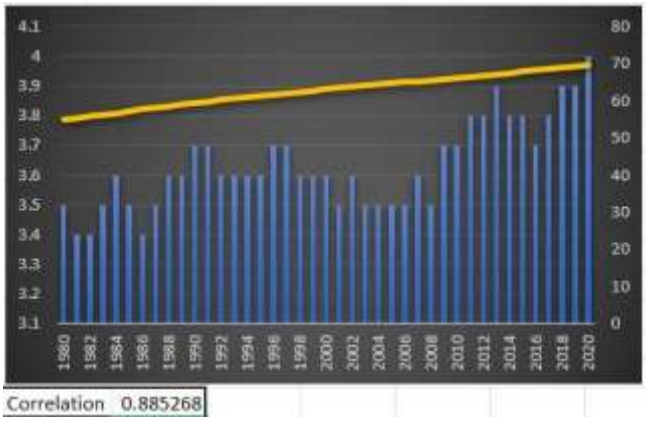


Figure 13: Life Expectancy

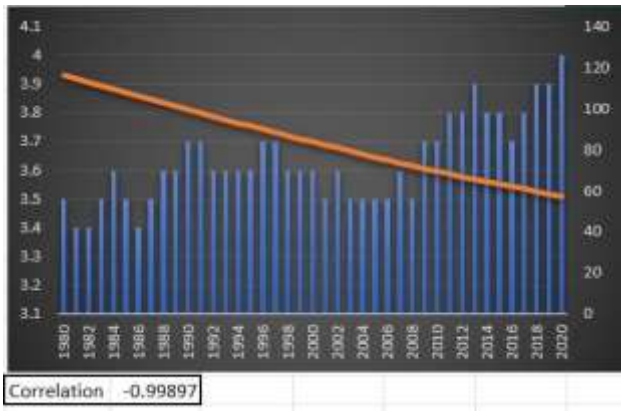


Figure 14: Infant mortality rate

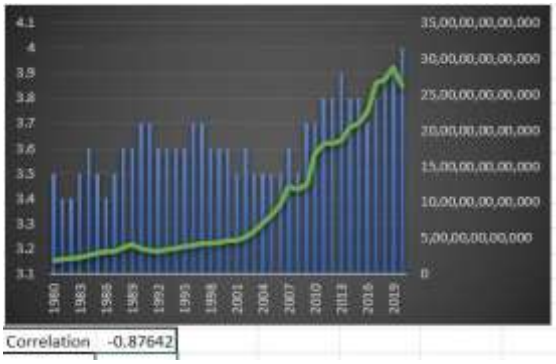


Figure 15: GDP

(Source: all plotted by author)

The plotted graphs show the trends and patterns as well as the correlation between the variables. All variables have been plotted in a line graph with Healthcare Expenditure shown as a bar graph in all. From the above graphs we see a positive correlation between the Healthcare Expenditure and Literacy rate (0.65), GNI (0.82) and Life Expectancy (0.88).

These variables are also increasing over time. A negative correlation is seen between Healthcare Expenditure and Infant mortality rate (-0.99) and GDP (-0.87) and these variables are decreasing over time

(D) CHINA

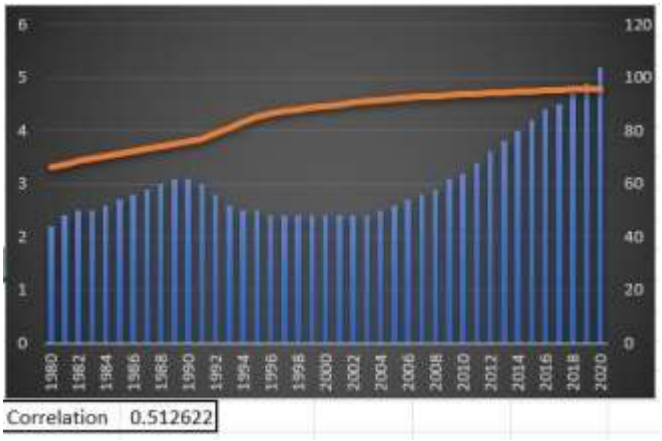


Figure 16: Literacy Rate

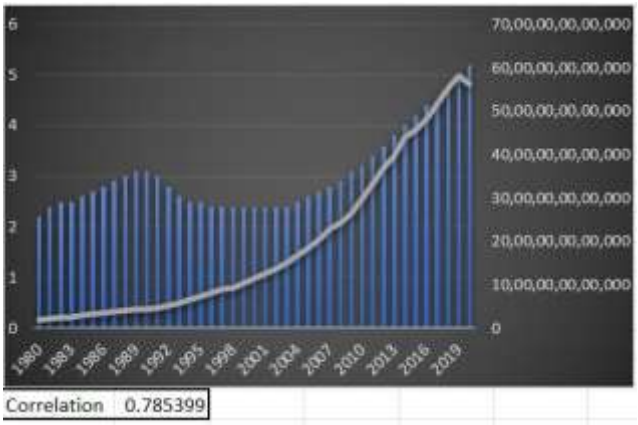


Figure 17: Gross national income

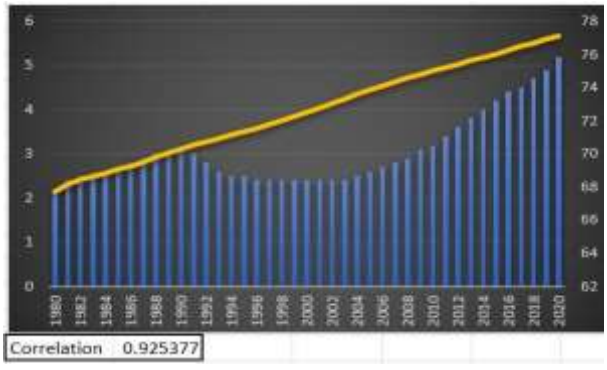


Figure 18: Life Expectancy

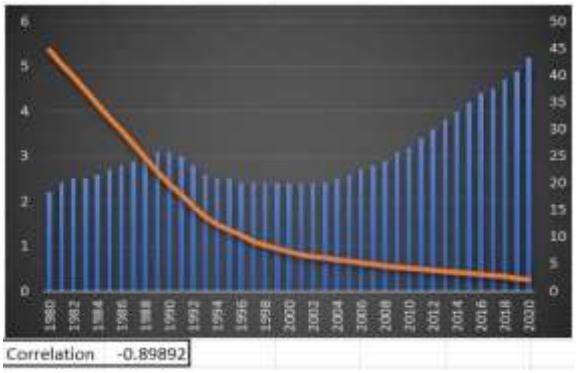


Figure 19: Infant mortality rate

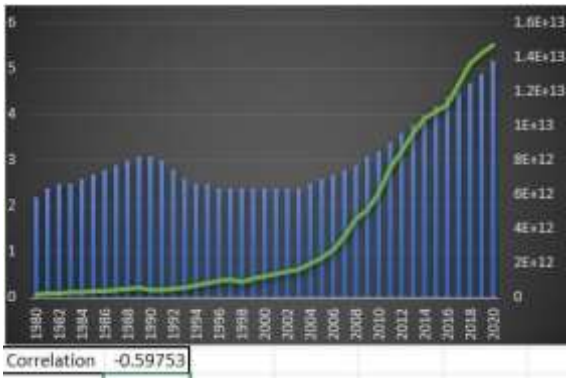


Figure 20: GDP

(Source: all plotted by author)

The plotted graphs show the trends and patterns as well as the correlation between the variables. All variables have been plotted in a line graph with Healthcare Expenditure shown as a bar graph in all. From the above graphs we see a positive correlation between the Healthcare Expenditure and Literacy rate (0.51), GNI (0.78) and Life Expectancy (0.92).

These variables are also increasing over time. A negative correlation is seen between Healthcare Expenditure and Infant mortality rate (-0.89) and GDP (-0.59) and these variables are decreasing over time

DISCUSSIONS:

Healthcare Expenditure has increased over the years in all 4 nations. The Literacy Rate: Increasing over the time with positive correlation with healthcare expenditure in all 4 nations which can be attributed positive health outcomes and therefore lesser absenteeism and better academic performance. Gross National Income (GNI) has increased over time and has shown positive correlation with healthcare expenditure as well which is because of higher investment in human capital which improves productivity. Life Expectancy has been increasing over time in all nations besides Russia where it dipped around 1993-1997. It has a positive correlation with healthcare expenditure as it improves health infrastructure and medical services. Infant Mortality Rate has been decreasing over the years and has shown negative correlation with healthcare expenditure. Increased expenditure ensures better facilities for pre-natal and maternal care which reduces infant mortality rate. Gross Domestic Product has shown an increasing trend over time but a negative correlation with healthcare expenditure. This can be attributed to inefficient use of healthcare budget. Wastage might lead to reduced potential economic benefits.

PART II: STATIONARITY AND CAUSALITY TESTS

In this part we have performed the Stationarity test and the Causality test for the data. This is done to ensure that the data is stationary and establish causal relationships.

(I) AUGMENTED DICKEY-FULLER TEST

In order to proceed with the collected data, and test its stationarity, we have conducted the Augmented Dickey-Fuller Test. Augmented Dickey-Fuller (ADF) test is used to detect whether or not a time series is stationary. Many time series models and procedures include the assumption that the data is stationary. Stationarity is a key notion in time series analysis.

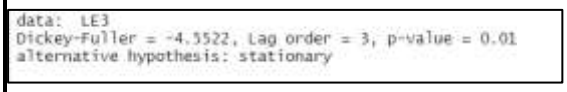
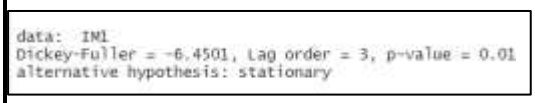
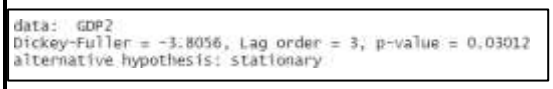
The null hypothesis in the series is that it contains a unit root, meaning the data is non- stationary and the alternate hypothesis suggests that there is no presence of a unit root, meaning the data is stationary. In case of non-stationarity, further differentials are taken to test for stationarity.

(A) BRAZIL

We have checked the stationarity of the data of Brazil for all 6 variables. The results of the stationarity test are as follows:

Stationarity output table

Sr. No.	Variables	Stationarity at difference level	P value	R – Output
1.	Healthcare Expenditure as a % of Total Expenditure	I(2)	0.01	data: HE2 Dickey-Fuller = -4.4124, Lag order = 3, p-value = 0.01 alternative hypothesis: stationary
2.	Literacy Rate	I(2)	0.01	data: LR3 Dickey-Fuller = -4.6026, Lag order = 3, p-value = 0.01 alternative hypothesis: stationary
3.	Gross National Income (GNI)	I(2)	0.01	data: GNI2 Dickey-Fuller = -4.8926, Lag order = 3, p-value = 0.01 alternative hypothesis: stationary

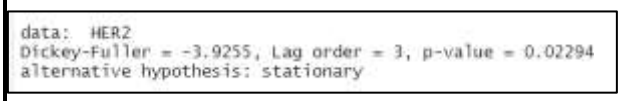
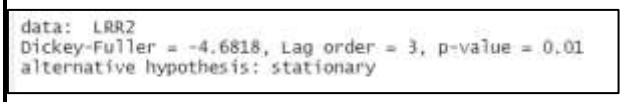
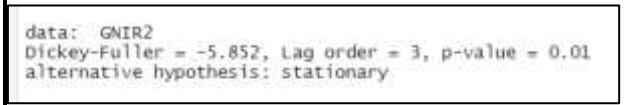
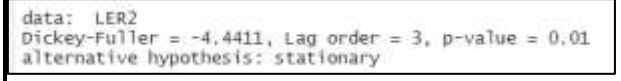
4.	Life Expectancy	I(2)	0.01	
5.	Infant Mortality Rate	I(1)	0.01	
6.	Gross Domestic product	I(2)	0.03012	

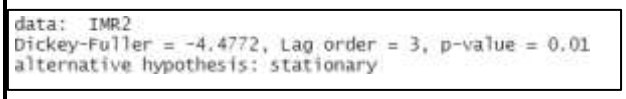
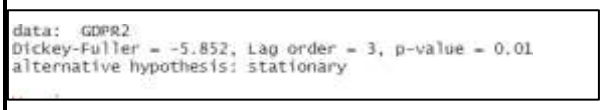
(Source: Calculated by author)

(B) RUSSIA

We have checked the stationarity of the data of Brazil for all 6 variables. The results of the stationarity test are as follows:

Stationarity output table:

Sr. No.	**Variables**	**Stationarity at difference level**	**P value**	**R-outputs**
1.	Healthcare Expenditure as a % of Total Expenditure	I(2)	0.02294	
2.	Literacy Rate	I(2)	0.01	
3.	Gross National Income (GNI)	I(2)	0.01	
4.	Life Expectancy	I(2)	0.01	

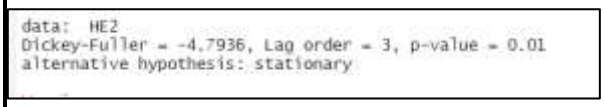
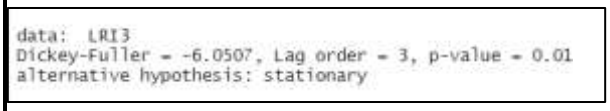
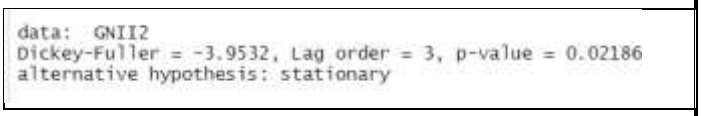
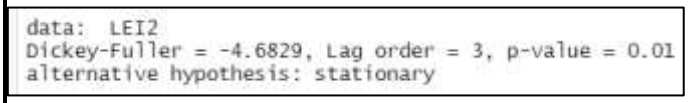
5.	Infant Mortality Rate	I(1)	0.01	
6.	Gross Domestic Product (GDP)	I(2)	0.01	

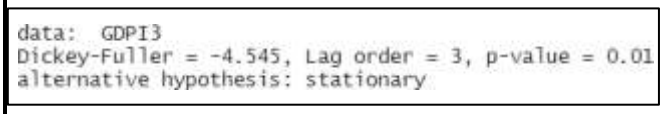
(Source: Calculated by author)

(C) INDIA

We have checked the stationarity of the data of Brazil for all 6 variables. The results of the stationarity test are as follows:

Stationarity output table:

Sr. No.	Variables	Stationarity at difference level	P valu e	R-Outputs
1.	Healthcare Expenditure as a % of Total Expenditure	I(2)	0.01	
2.	Literacy Rate	I(2)	0.01	
3.	Gross National Income (GNI)	I(2)	0.02 186	
4.	Life Expectancy	I(2)	0.01	

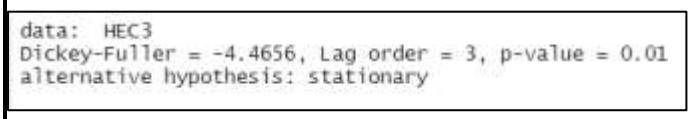
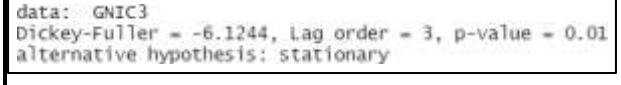
5.	Infant Mortality Rate	I(2)	0.01018	
6.	Gross Domestic Product (GDP)	I(2)	0.01	

(Source: Calculated by author)

(D) CHINA

We have checked the stationarity of the data of Brazil for all 6 variables. The results of the stationarity test are as follows:

Stationarity output table: *(Source: calculated by author)*

Sr. No.	Variables	Stationarity at difference level	P value	R-outputs
1.	Healthcare Expenditure as a % of Total Expenditure	I(2)	0.01	
2.	Literacy Rate	I(2)	0.01882	
3.	Gross National Income (GNI)	I(2)	0.01	

4.	Life Expectancy	I(2)	0.02054	data: LE2 Dickey-Fuller = -3.9875, Lag order = 3, p-value = 0.02054 alternative hypothesis: stationary
5.	Infant Mortality Rate	I(1)	0.01	data: Infant mortality rate per 1000 live Dickey-Fuller = -4.7609, Lag order = 3, p-value = 0.01 alternative hypothesis: stationary
6.	Gross Domestic Product (GDP)	I(2)	0.03611	data: GDPC2 Dickey-Fuller = -3.728, Lag order = 3, p-value = 0.03611 alternative hypothesis: stationary

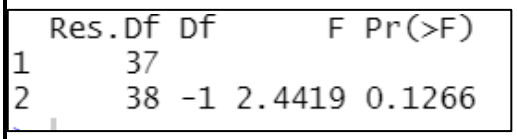
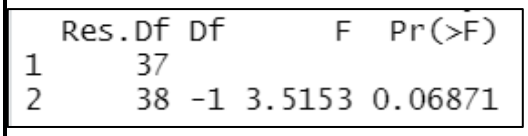
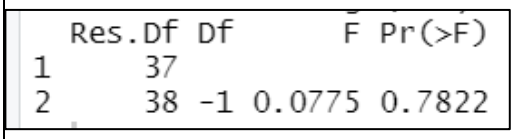
(II) GRANGER'S CAUSALITY TEST

Furthermore, in the last part I have covered the Granger's Causality test to ascertain if one time series may be used to forecast another. It is specifically a statistical hypothesis test that aids in determining the causal relationship between two time series. The test is based on the hypothesis that, if one time series Granger-causes another, then the past values of the first time series should be helpful in forecasting the future values of the second time series, even after accounting for the second time series' previous values.

(A) BRAZIL

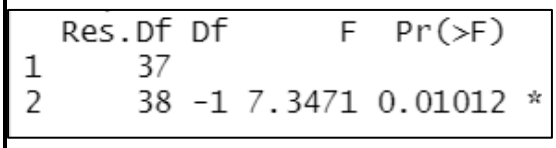
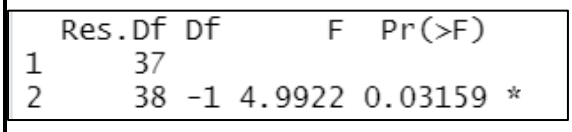
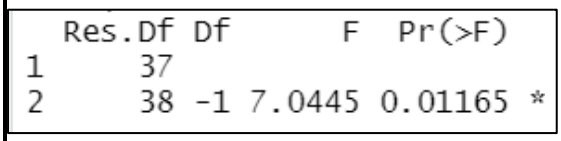
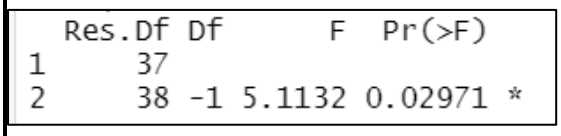
The following table shows whether Healthcare Expenditure Granger-Causes other variables or not. The output is as follows:

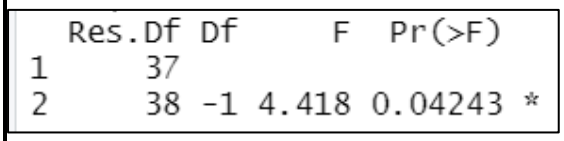
Sr. No.	Variables	Granger Cause or Not?	P value	
1.	Literacy Rate	Does Not	0.4475	Res.Df Df F Pr(>F) 1 37 2 38 -1 0.5895 0.4475
2.	Gross National Income (GNI)	Does Not	0.9561	Res.Df Df F Pr(>F) 1 37 2 38 -1 0.0031 0.9561

3.	Life Expectancy	**Does**	**0.1266**	
4.	Infant Mortality Rate	Does Not	0.06871	
5.	Gross Domestic Product (GDP)	Does Not	0.7822	

Source: calculated by author

Whether Other variables Granger Cause Healthcare expenditure or not

Sr. No.	**Variables**	**Granger Cause or Not?**	**P value**	**R-Outputs**
1.	Literacy Rate	**Does**	**0.01012**	
2.	Gross National Income (GNI)	**Does**	**0.03159**	
3.	Life Expectancy	**Does**	**0.01165**	
4.	Infant Mortality Rate	**Does**	**0.02971**	

5.	Gross Domestic Product (GDP)	**Does**	**0.04243**	

```
  Res.Df Df     F  Pr(>F)
1     37
2     38 -1 4.418 0.04243 *
```

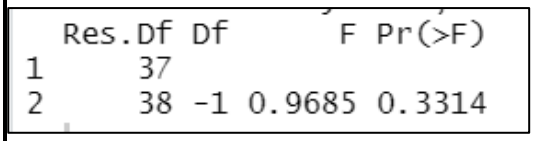
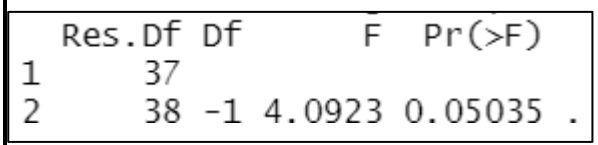
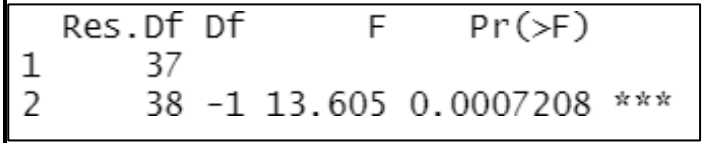
(Source: calculated by author)

Causal relationships seen:

1. Literacy Rate: It has a unidirectional relationship with healthcare expenditure. Literacy Rate Granger causes healthcare expenditure.
2. Gross National Income: It has a unidirectional relationship with healthcare expenditure. GNI Granger causes healthcare expenditure.
3. Life Expectancy: It has a bidirectional relationship with healthcare expenditure. Life expectancy Granger causes healthcare expenditure and healthcare expenditure granger-causes life expectancy.
4. Infant Mortality Rate: It has a unidirectional relationship with healthcare expenditure. Infant Mortality rate Granger causes healthcare expenditure.
5. Gross Domestic Product: It has a unidirectional relationship with healthcare expenditure. GDP Granger causes healthcare expenditure.

(B) RUSSIA

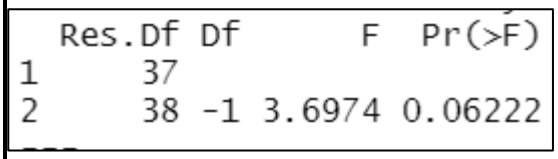
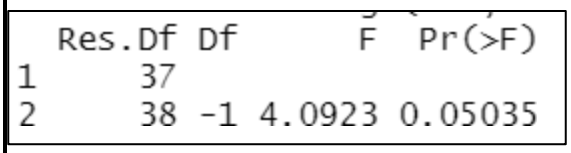
The following table shows whether Healthcare Expenditure Granger-Causes other variables or not. The output is as follows:

Sr. No.	**Variables**	**Granger Cause or Not?**	**P value**	**R-Outputs**
1.	Literacy Rate	Does Not	0.3314	
2.	Gross National Income (GNI)	**Does**	**0.05035**	
3.	Life Expectancy	**Does**	**0.0007**	

```
  Res.Df Df      F Pr(>F)
1     37
2     38 -1 0.9685 0.3314
```

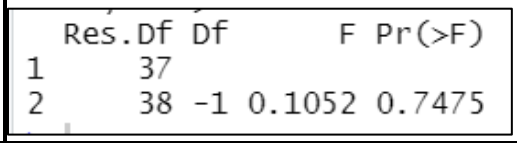
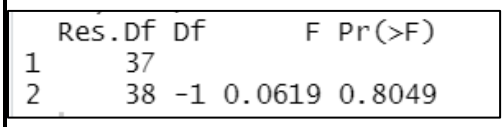
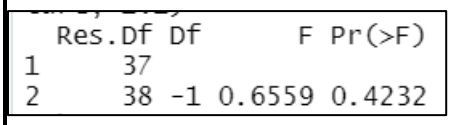
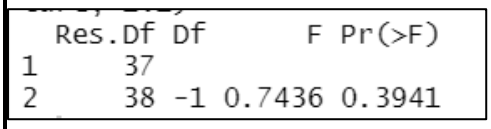
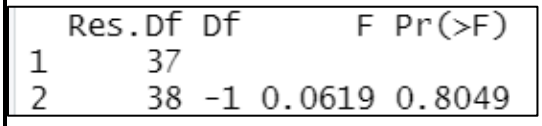
```
  Res.Df Df      F  Pr(>F)
1     37
2     38 -1 4.0923 0.05035 .
```

```
  Res.Df Df      F    Pr(>F)
1     37
2     38 -1 13.605 0.0007208 ***
```

4.	Infant Mortality Rate	Does Not	0.06222	
5.	Gross Domestic Product (GDP)	**Does**	**0.05035**	

(Source: calculated by author)

Whether Other variables Granger Cause Healthcare expenditure or not

Sr. No.	**Variables**	**Granger Cause or Not?**	**P value**	**R-Outputs**
1.	Literacy Rate	Does Not	0.7475	
2.	Gross National Income (GNI)	Does Not	0.8049	
3.	Life Expectancy	Does Not	0.4232	
4.	Infant Mortality Rate	Does Not	0.3941	
5.	Gross Domestic Product (GDP)	Does Not	0.8049	

(Source: calculated by author)

Causal relationships seen:

1. Literacy Rate: It has no causal relationship here.
2. Gross National Income: It has a unidirectional relationship with healthcare expenditure. Healthcare Expenditure Granger causes GNI.
3. Life Expectancy: It has a unidirectional relationship with healthcare expenditure. Healthcare expenditure granger-causes life expectancy.
4. Infant Mortality Rate: Has no causal relationship here.
5. Gross Domestic Product: It has a unidirectional relationship as Healthcar Expenditure granger-causes GDP.

(C) INDIA

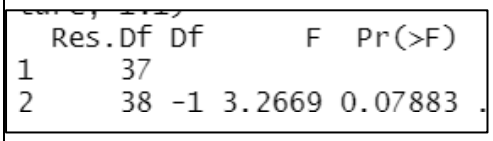
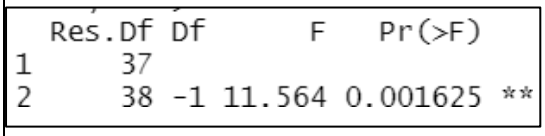
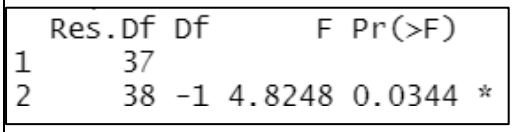
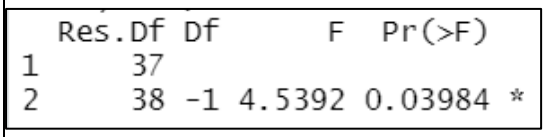
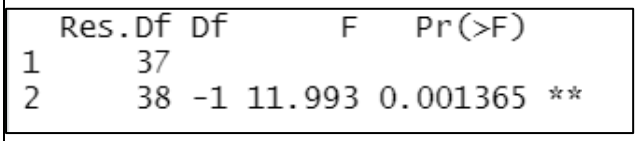
The following table shows whether Healthcare Expenditure Granger-Causes other variables or not. The output is as follows:

Sr. No.	Variables	Granger Cause or Not?	P value	R-Outputs
1.	Literacy Rate	Does Not	0.3469	Res.Df Df F Pr(>F) 1 37 2 38 -1 0.9079 0.3469
2.	Gross National Income (GNI)	Does Not	0.2661	Res.Df Df F Pr(>F) 1 37 2 38 -1 1.2752 0.2661
3.	Life Expectancy	Does Not	0.1238	Res.Df Df F Pr(>F) 1 37 2 38 -1 2.4804 0.1238
4.	Infant Mortality Rate	**Does**	**0.02552**	Res.Df Df F Pr(>F) 1 37 2 38 -1 5.4169 0.02552 *
5.	Gross Domestic Product (GDP)	Does Not	0.1761	Res.Df Df F Pr(>F) 1 37 2 38 -1 1.9025 0.1761

(Source: calculated by author)

The following table shows whether Healthcare Expenditure Granger-Causes other variables or not. The

output is as follows:

Sr. No.	Variables	Granger Cause or Not?	P value	R-Outputs
1.	Literacy Rate	Does Not	0.07883	
2.	Gross National Income (GNI)	**Does**	**0.001625**	
3.	Life Expectancy	**Does**	**0.0344**	
4.	Infant Mortality Rate	**Does**	**0.03984**	
5.	Gross Domestic Product (GDP)	**Does**	**0.001365**	

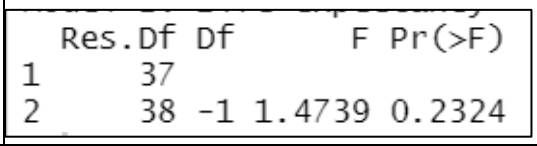
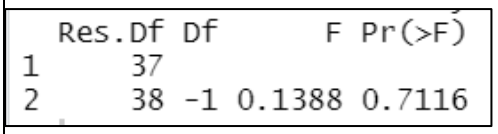
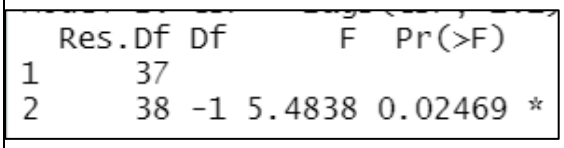
Causal relationships seen:

1. Literacy Rate: It has no causal relationship here.
2. Gross National Income: It has a unidirectional relationship with healthcare expenditure. GNI Granger causes healthcare expenditure.
3. Life Expectancy: It has a unidirectional relationship with healthcare expenditure. Life expectancy Granger causes healthcare expenditure.
4. Infant Mortality Rate: It has a bidirectional relationship with healthcare expenditure. Infant Mortality rate Granger causes healthcare expenditure and healthcare expenditure granger-causes Infant Mortality Rate.
5. Gross Domestic Product: It has a unidirectional relationship with healthcare expenditure. GDP Granger causes healthcare expenditure.

(D) CHINA

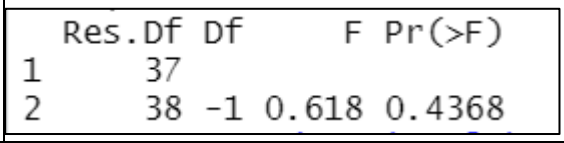
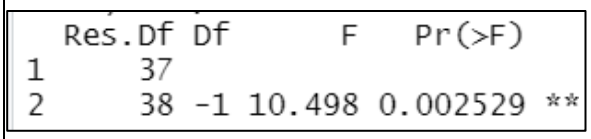
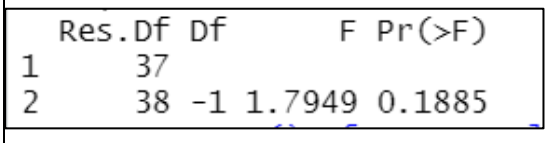
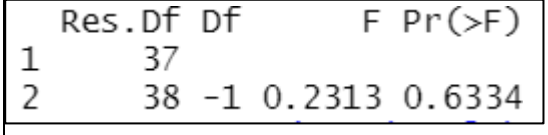
The following table shows whether Healthcare Expenditure Granger-Causes other variables or not. The output is as follows:

Sr. No.	Variables	Granger Cause or Not?	P value	R-Outputs
1.	Literacy Rate	Does Not	0.1682	Res.Df Df F Pr(>F) 1 37 2 38 -1 1.9759 0.1682
2.	Gross National Income (GNI)	**Does**	**0.0086**	Res.Df Df F Pr(>F) 1 37 2 38 -1 7.6986 0.008612 **

3.	Life Expectancy	Does Not	0.2324	
4.	Infant Mortality Rate	Does Not	0.7116	
5.	Gross Domestic Product (GDP)	**Does**	**0.0246**	

(Source: calculated by author)

Whether Healthcare Expenditure Granger-Causes other variables or not. The output is as follows:

Sr. No.	**Variables**	**Granger Cause or Not?**	**P value**	**R-Outputs**
1.	Literacy Rate	Does Not	0.4368	
2.	Gross National Income (GNI)	**Does**	**0.002529**	
3.	Life Expectancy	Does Not	0.1885	
4.	Infant Mortality Rate	Does Not	0.6334	

5.	Gross Domestic Product (GDP)	**Does**	**0.0002472**	Res.Df Df F Pr(>F) 1 37 2 38 -1 16.451 0.0002472 ***

(Source: calculated by author)

Causal relationships seen:

1. Literacy Rate: It has no causal relationship here.
2. Gross National Income: It has a bidirectional relationship with healthcare expenditure. GNI Granger causes healthcare expenditure and healthcare expenditure granger- causes GNI.
3. Life Expectancy: It has no causal relationship here.
4. Infant Mortality Rate: It has no causal relationship here.
5. Gross Domestic Product: It has a bidirectional relationship with healthcare expenditure. GDP Granger causes healthcare expenditure and healthcare expenditure granger-causes GDP.

DISCUSSIONS

The Augmented Dickey Fuller Test was conducted on several economic indicators for Brazil, Russia, India, and China. The results showed that most of the indicators were non-stationary without differencing but became stationary after being differenced to the second level. The infant mortality rate required differencing to the first or second level depending on the country. Stationarity of the data implies that the statistical properties of the data are consistent over time, making it suitable for further analysis without producing unreliable or invalid results. Secondly. I conducted the Granger Causality test and a correlation analysis to see the correlation and causation relationships between Healthcare Expenditure and the socio- economic variables.

Healthcare Expenditure and Literacy Rate:

1. It has a unidirectional relationship in Brazil and no causal relationship in Russia, India and China. The unidirectional relationship where literacy rate granger-causes healthcare expenditure may be an indirect relationship. Firstly, an increased healthcare expenditure may not be directed or targeted towards education or literacy. Healthcare expenditure is mainly used for addressing specific more health related concerns.
2. An increased Healthcare Expenditure may increase the level of literacy rate in the following ways – Firstly, improved health conditions can affect a child's cognitive development positively and is essential in the early development phases to affect heir ability to learn and perform well. Illnesses and malnutrition prevalent in rural India might lead to problems such as absenteeism, lower concentration, poor academic performance, and reduced learning. Better healthcare because of increased healthcare spending can address this issue. Secondly, it reduces the overall level of disease including chronic illnesses, contagious illnesses, etc. by providing better and easier access to healthcare facilities.
3. However, we do not see a causal relationship between the two variables in most cases since healthcare expenditure may improve other things for example, nutrition levels which in turns improve the literacy rate.
4. Furthermore, Literacy is a more complex variable and includes several cultural, social and economic factors. Looking at Brazil, it is a diverse nation and is highly stratified with significant income and

wealth disparities. Russia on the other is diverse in terms of ethnic, linguistic, and religious factors. There are also political issues persistent. Considering India, it is the nation with the second largest population currently, with diverse cultures and socio-economic backgrounds. There is also a big middle-income population. Lastly, China has the largest population and a lot of ethnic fragmentation and linguistic differences. These factors should be considered while looking at the complexity of Literacy rate. However, the strong correlation suggests the presence of an indirect relationship between the variables.

5. Lastly, the impact of healthcare expenditure on Literacy rate may take time to materialise since there is an indirect relationship. There might be a reverse causality between the variables which has been examined in Part II of this paper.

Healthcare Expenditure and Gross National Income

1. There is a bidirectional causal relationship in the case of China which may be due to might lead to better health outcomes which can increase productivity and a higher Gross National Income level. With increased healthcare spending the sector expands and creates more job opportunities which might lead to higher employment and a higher level of economic growth. This applies perfectly in the case of Russia and China as there is a causal relationship.
2. There is a unidirectional relationship in Russia where healthcare expenditure granger- causes GNI. It will be due to the same reason as described above.
3. On the other hand in Brazil and India there is a unidirectional relationship where GNI granger causes Healthcare Expenditure which may be due a higher level of disposable income which leads to a higher demand for healthcare and drives up the healthcare expenditure.

Healthcare Expenditure and Life Expectancy

1. Brazil shows a bidirectional causal relationship between the variables. It is because a higher health expenditure leads to better healthcare services and facilities which leads to a longer life. On the other hand with increased life expectancy, due to a bigger older population the demand for healthcare would be higher.
2. Russia shows a unidirectional relationship where healthcare expenditure granger causes life expectancy. The reason is same as above.
3. India shows a unidirectional relationship as well where life expectancy granger causes the healthcare expenditure. The reason is same as above.
4. China shows no causal relationship since life expectancy better life expectancy is dependent on other direct factors such as lifestyle choices, environmental factors, genetics and socio-economic status as well.

Healthcare Expenditure and Infant Mortality rates

1. It shows a unidirectional relationship where infant mortality granger-causes healthcare expenditure. This is because due to increase infant mortality, there is a need for better healthcare and follow up care which drives up healthcare expenditure.
2. There is no causal relationship seen in the case of Russia and China since infant mortality rate is affected by caused by other factors such as nutrition, sanitation and access to education. An increased healthcare expenditure may not lead to a reduced infant mortality rate due to reasons such as inefficient utilisation.
3. There is a bidirectional causal relationship in the case of India. Increased healthcare expenditure leads to lower infant mortality significant expansion of healthcare infrastructure. Increased number

of private hospitals, clinics and diagnostic centres have ensured better pre-natal and postpartum care which has directly reduce the infant mortality rate, justifying the causal relationship. The reverse relationship is due to the same reason as explained in point 1.

Healthcare Expenditure and Gross Domestic Product

1. In the case of Brazil, India and China there is a unidirectional causal relationship where GDP granger-causes the healthcare expenditure. Due to rising healthcare demand, technological developments, rising labour costs, administrative expenses, and governmental spending, healthcare spending tends to rise with GDP. Better healthcare is a desire of wealthier populations, and technical breakthroughs are costly. High-salaried medical experts are in high demand, and healthcare systems need a lot of administrative support. In order to fulfil the rising demand for services as the GDP rises, governments may decide to raise healthcare spending.
2. Russia also sees a unidirectional relationship where healthcare expenditure granger- causes the GDP. Increased healthcare expenditure can have positive economic effects, including better health outcomes, job creation, innovation, increased public spending, and tourism which leads to increases in GDP.

PART III: REGRESSION ANALYSIS

In this part we have taken Healthcare Expenditure as a percentage of Total Expenditure to be the dependent (Y) variable and the Literacy rate, Gross National Income, Life Expectancy, Infant Mortality rate and Gross Domestic Product as the independent (X) variables and create a Multiple Regression Model.

(I) MULTIPLE LINEAR REGRESSION ANALYSIS

The first test we performed in this section is the Regression analysis. We have created a Regression function to investigate the relationship between a dependant variable and one or more independent variables. Future values can be predicted, the link between variables may be understood, the influence of a variable can be estimated, and confounding variables can be controlled.

Here, the dependent variable is Healthcare Expenditure as a percentage of Total Expenditure and the independent variables are Literacy rate, Gross National Income (GNI), Life Expectancy, Infant Mortality Rate and Gross Domestic Product (GDP).

The null hypothesis (H0) states that the independent variable has no effect on the dependent variable and is not statistically significant. The alternate hypothesis (H1) states that the independent variable has an effect on the dependent variable and is statistically significant.

(A) BRAZIL

TheR-output for regression analysis is as follows:

```
Call:
lm(formula = `Healthcare Expenditure as a % of Total Expenditure` ~
    `Literacy rate, adult total(15 and above)` + GNI + `Life expectancy` +
        `Infant mortality rate per 1000 live` + GDP)

Residuals:
       Min         1Q     Median         3Q        Max
-0.0073764 -0.0022367 -0.0008722  0.0016831  0.0104981

Coefficients:
                                          Estimate Std. Error t value Pr(>|t|)
(Intercept)                             -7.437e-01  2.374e-01  -3.133 0.003493 **
`Literacy rate, adult total(15 and above)`  3.612e-03  2.567e-03   1.407 0.168256
GNI                                     -8.027e-05  2.037e-05  -3.941 0.000370 ***
`Life expectancy`                        5.362e-03  1.476e-03   3.632 0.000891 ***
`Infant mortality rate per 1000 live`    3.055e-03  1.498e-03   2.039 0.049013 *
GDP                                      2.215e-14  3.889e-15   5.695 1.95e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.003813 on 35 degrees of freedom
Multiple R-squared:  0.9416,    Adjusted R-squared:  0.9332
F-statistic: 112.8 on 5 and 35 DF,  p-value: < 2.2e-16
```

(Source: calculated by author)

Interpretation of the output

Regression equation:

HE = -0.7437 + 0.0036LR - 0.00008027GNI + 0.0054LE+ 0.0031IM+ 2.215e-14GDP+ error

1. Literacy Rate: The coefficient is positive and is 0.0036. However, the relationship is not statistically significant. So, we cannot reject the null hypothesis, meaning that literacy rate has no effect on Healthcare Expenditure.
2. Gross National Income (GNI): The coefficient estimate is negative (-8.027e-05), indicating that higher GNI (Gross National Income) is associated with lower healthcare expenditure. This relationship is statistically significant (p-value < 0.001), meaning we can reject the null hypothesis that the true coefficient is zero.
3. Life Expectancy: The coefficient estimate is positive (0.005362), indicating that higher life expectancy is associated with higher healthcare expenditure. This relationship is statistically significant (p-value = 0.000891).
4. Infant mortality: The coefficient estimate is positive (0.003055), indicating that higher infant mortality rates are associated with higher healthcare expenditure. This relationship is marginally statistically significant (p-value = 0.049013), meaning we can reject the null hypothesis at the 0.05 significance level, but not at more stringent levels.
5. GDP: The coefficient estimate is positive (2.215e-14), indicating that higher GDP (Gross Domestic Product) is associated with higher healthcare expenditure. This relationship is statistically significant (p-value < 0.001).

   In this model all values besides Literacy Rate are statistically significant and influence the Healthcare Expenditure. Furthermore, the Multiple R-squared is high with a value of 0.9416 meaning the data has fit the regression model well. Lastly. The p-value for F- statistic is extremely low at < 2.2e-16 meaning the model as a whole is statistically significant.

(B) RUSSIA

The R-output for regression analysis is as follows:

```
Call:
lm(formula = `Healthcare Expenditure as a % of Total Expenditure` ~
    `Literacy rate, adult total(15 and above)` + GNI + `Life expectancy` +
        `Infant mortality rate per 1000 live` + GDP)

Residuals:
     Min       1Q   Median       3Q      Max
-0.72152 -0.24198  0.04168  0.22620  0.69683

Coefficients: (1 not defined because of singularities)
                                        Estimate Std. Error t value Pr(>|t|)
(Intercept)                            6.304e+01  2.351e+01   2.681  0.01101 *
`Literacy rate, adult total(15 and above)` -4.702e-01  2.106e-01  -2.233  0.03189 *
GNI                                     1.509e-12  2.185e-13   6.905 4.38e-08 ***
`Life expectancy`                      -1.461e-01  4.696e-02  -3.112  0.00363 **
`Infant mortality rate per 1000 live`  -1.574e-01  5.252e-02  -2.997  0.00491 **
GDP                                            NA         NA      NA       NA
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3321 on 36 degrees of freedom
Multiple R-squared:  0.9032,    Adjusted R-squared:  0.8924
F-statistic: 83.97 on 4 and 36 DF,  p-value: < 2.2e-16
```

(Source: calculated by author)

Interpretation of the output

Regression equation:

HE= 63.04 - 0.4702LR + 1.509e-12GNI - 0.1461LE - 0.1574IM + NA GDP

1. Literacy Rate: The coefficient is negative and is -0.4702 indicating that a higher Literacy rate is associated with a lower Healthcare Expenditure. This relationship is statistically significant (p-value < 0.01), meaning we can reject the null hypothesis that the true coefficient is zero.
2. Gross National Income (GNI): The coefficient estimate is positive (1.509e-12), indicating that higher GNI (Gross National Income) is associated with higher healthcare expenditure. This relationship is statistically significant (p-value < 0.01), meaning we can reject the null hypothesis that the true coefficient is zero.
3. Life Expectancy: The coefficient estimate is negative (-0.1461), indicating that higher life expectancy is associated with lower healthcare expenditure. This relationship is statistically significant (p-value = 0.00363).
4. Infant mortality: The coefficient estimate is negative (-0.1574), indicating that higher infant mortality rates are associated with lower healthcare expenditure. This relationship is statistically significant (p-value = 0.00491), meaning we can reject the null hypothesis.
5. GDP: The coefficient estimate is not applicable. This is because one variable has been excluded due to singularities.

   In this model all values are statistically significant and influence the Healthcare Expenditure. Furthermore, the Multiple R-squared is high with a value of 0.9032 meaning the data has fit the regression model well. Lastly. The p-value for F-statistic is extremely low at < 2.2e-16 meaning the model as a whole is statistically significant

(C) INDIA

The R-output for regression analysis is as follows:

```
Call:
lm(formula = `Healthcare Expenditure as a % of Total Expenditure` ~
    `Literacy rate, adult total(15 and above)` + GNI + `Life expectancy` +
        `Infant mortality rate per 1000 live` + GDP)

Residuals:
      Min        1Q    Median        3Q       Max
-0.164674 -0.059165  0.004197  0.063135  0.163591

Coefficients:
                                        Estimate Std. Error t value Pr(>|t|)
(Intercept)                           -2.529e+01  1.273e+01  -1.986   0.0549 .
`Literacy rate, adult total(15 and above)`  1.312e-02  2.592e-02   0.506   0.6157
GNI                                   -2.498e-12  1.729e-12  -1.445   0.1574
`Life expectancy`                      3.273e-01  1.218e-01   2.686   0.0110 *
`Infant mortality rate per 1000 live`  8.718e-02  4.470e-02   1.950   0.0592 .
GDP                                    3.985e-13  1.733e-13   2.299   0.0276 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.08178 on 35 degrees of freedom
Multiple R-squared:  0.7316,    Adjusted R-squared:  0.6933
F-statistic: 19.08 on 5 and 35 DF,  p-value: 3.962e-09
```

(Source: calculated by author)

Interpretation of the output

Regression equation:

HE= -25.29 + 0.0131LR - 2.498e-12GNI + 0.3273LE+ 0.08718IM + 3.985e-13GDP+error

1. Literacy Rate: The coefficient is positive and is 0.0131 indicating that a higher Literacy rate is associated with a higher Healthcare Expenditure. This relationship is statistically significant (p-value < 0.1), meaning we can reject the null hypothesis that the true coefficient is zero.
2. Gross National Income (GNI): The coefficient estimate is negative (- 2.498e-12), indicating that higher GNI (Gross National Income) is associated with lower healthcare expenditure. This relationship is not statistically significant, meaning we cannot reject the null hypothesis.
3. Life Expectancy: The coefficient estimate is positive (0.3273), indicating that higher life expectancy is associated with higher healthcare expenditure. This relationship is statistically significant (p-value = 0.0110).
4. Infant mortality: The coefficient estimate is positive (0.0871), indicating that higher infant mortality rates are associated with higher healthcare expenditure. This relationship is marginally statistically significant (p-value = 0.0592), meaning we can reject the null hypothesis at the 0.1 significance level, but not at more stringent levels.
5. GDP: The coefficient estimate is positive (3.985e-13), indicating that higher GDP (Gross Domestic Product) is associated with higher healthcare expenditure. This relationship is statistically significant (p-value < 0.001).

   In this model all values besides GNI are statistically significant and influence the Healthcare Expenditure. Furthermore, the Multiple R-squared is high with a value of 0.7316 meaning the data has fit the regression model well. Lastly. The p-value for F- statistic is extremely low at < 3.962e-09 meaning the model as a whole is statistically significant.

(D) CHINA

The R-output for regression analysis is as follows:

```
Call:
lm(formula = `Healthcare Expenditure as a % of Total Expenditure` ~
    `Literacy rate, adult total(15 and above)` + GNI + `Life expectancy` +
        `Infant mortality rate per 1000 live` + GDP)

Residuals:
     Min       1Q   Median       3Q      Max
-0.21603 -0.05474  0.01147  0.04708  0.23069

Coefficients:
                                        Estimate Std. Error t value Pr(>|t|)
(Intercept)                            4.085e+00  4.561e+00   0.896  0.37651
`Literacy rate, adult total(15 and above)` -1.629e-01  1.193e-02 -13.658 1.37e-15 ***
GNI                                    1.511e-13  1.725e-13   0.876  0.38691
`Life expectancy`                      1.797e-01  6.886e-02   2.609  0.01326 *
`Infant mortality rate per 1000 live`  -7.113e-02  6.518e-03 -10.913 8.21e-13 ***
GDP                                    1.336e-13  4.609e-14   2.899  0.00643 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.08358 on 35 degrees of freedom
Multiple R-squared:  0.9902,    Adjusted R-squared:  0.9889
F-statistic: 710.6 on 5 and 35 DF,  p-value: < 2.2e-16
```

(Source: calculated by author)

Interpretation of the output

Regression equation:

HE = 4.085 - 0.163LR + 1.511e-13GNI + 0.1797LE - 0.07113IM + 1.336e-13*GDP + error

1. Literacy Rate: The coefficient is positive and is -0.1623 indicating that a higher Literacy rate is associated with a higher Healthcare Expenditure. This relationship is not statistically significant, meaning we cannot reject the null hypothesis that the true coefficient is zero.
2. Gross National Income (GNI): The coefficient estimate is negative (1.511e-13), indicating that higher GNI (Gross National Income) is associated with lower healthcare expenditure. This relationship is not statistically significant, meaning we cannot reject the null hypothesis.
3. Life Expectancy: The coefficient estimate is positive (0.1797), indicating that higher life expectancy is associated with higher healthcare expenditure. This relationship is statistically significant (p-value = 0.01326).
4. Infant mortality: The coefficient estimate is positive (-0.07113), indicating that higher infant mortality rates are associated with lower healthcare expenditure. This relationship is marginally statistically significant (p-value = 0.0592), meaning we can reject the null hypothesis at the 0.1 significance level, but not at more stringent levels.
5. GDP: The coefficient estimate is positive (1.336e-13), indicating that higher GDP (Gross Domestic Product) is associated with higher healthcare expenditure. This relationship is statistically significant (p-value < 0.001).

   In this model all values besides GNI are statistically significant and influence the Healthcare Expenditure. Furthermore, the Multiple R-squared is high with a value of 0.9902 meaning the data has fit the regression model well. Lastly. The p-value for F- statistic is extremely low at <2.2e-16 meaning the model as a whole is statistically significant.

DISCUSSIONS

In this part of the paper, we have examined the impact of socio-economic variables on healthcare expenditure. Firstly, We have run a Multiple Regression model for all nations. All the models have a high multiple R-squared meaning that they are fit for the data.

Furthermore, the p-values are also extremely small indicating that they are significant. Literacy Rate and Healthcare Expenditure

In Brazil, India, and China, an increase in literacy rate is expected to lead to higher healthcare expenditure due to increased awareness and demand for medical services. However, this relationship is not statistically significant in Brazil and India. In contrast, in Russia, a rise in literacy rate may lead to better lifestyles and reduced chronic diseases, potentially reducing the need for healthcare expenditure.

Gross National Income and Healthcare Expenditure

As per the regression analysis, an increased GNI causes an increase in healthcare expenditure in the case of Russia whereas a fall in the case of Brazil, India and China but the relationship is not statistically significant in the case of China. The former case can be explained by the fact that higher income levels would lead to higher investment in general as also on healthcare. The latter case can be explained by the fact that although the GNI increases the focus of the Government might be on other factors such defence or infrastructure. This may lead to a fall in healthcare expenditure as a proportion of total expenditure.

Life Expectancy and Healthcare Expenditure

The increase in life expectancy does lead to an increase in healthcare expenditure in the cases of Brazil, India and China which can be explained by the fact that the longer people live the higher is their demand for healthcare services. Furthermore, when life expectancy increases there is an increased emphasis on better quality of life and demand for healthcare rises. Also, having a bigger older age population would require more specialised and intensive healthcare services. An increase in life expectancy reduces the healthcare expenditure in Russia. This could possibly be explained by the fact that there were improvements in public health generally over the examined time that reduced the prevalence of certain diseases.

Infant Mortality Rate and Healthcare Expenditure Looking at the regression analysis, in the case of Brazil and India increase infant mortality leads to an increased healthcare expenditure. Higher infant mortality can be associated with a need for better preventative care and the need for government to allocate more resources towards maternal care and child health outcomes.

Gross Domestic Product (GDP) and Healthcare Expenditure

As per the regression analysis, an increase in GDP causes and increase in healthcare expenditure in the case of Brazil, India and China and is not applicable in the case of Russia due to omitting of data because of singularities.

RESEARCH GAP

While this study has aimed to look at the causal effects of healthcare expenditure, there are no direct ones. It has indirect effects. One aspect of the gap in research is examining the possible factors that affect these complex socio-economic variables. The second aspect involves examining these indirect relationships between the nations. Lastly, developing nations usually spend lower amounts and underutilise the healthcare resources. The reasons behind this should also be examined.

CONCLUSION

Examining our results, we can conclude that healthcare expenditure has indirect effects on socio-economic variables and has defined trends with which it moves. It does not have a direct impact on these variables as it directly impacts health outcomes only, which in turn cause changes in socio-economic variables. For instance, a higher healthcare expenditure improves nutrition and health outcomes which directly impact the examined variables like Literacy Rate, GNI and GDP. There is no direct causal effect of healthcare expenditure on maximum variables and is because there are indirect relationships since the examined socio- economic variables are complex and multifaceted in nature and several other social, political and cultural factors impact them.

Secondly, while examining the effect of socio-economic variables on healthcare expenditure, we see that a lot of these variables have a direct causal relationship with healthcare expenditure. This indicates that improving/ working on these variables is essential in improving the healthcare expenditure.

A limitation to our analysis was that we could not use panel data analysis due to methodological constraints and less data.

Furthermore, our analysis proves that there is underutilisation of healthcare expenditure as it does not lead to improved economic outcomes in India. These nations should prioritise upgrading their healthcare infrastructure, enhancing the effectiveness of healthcare delivery, and expanding access to healthcare in rural regions. In order to enhance healthcare results, public-private partnerships should be expanded, and technology should be invested in. The current holes in its healthcare system should be filled and should provide better healthcare services by putting these policy recommendations into practise.

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