

**MAJOR RESEARCH PROJECT – EXPLORING THE RELATIONSHIP BETWEEN HEALTH AND
ECONOMIC GROWTH IN DEVELOPING AND WEALTHY NATIONS**

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MAJOR RESEARCH PROJECT – EXPLORING THE RELATIONSHIP BETWEEN HEALTH AND ECONOMIC GROWTH IN DEVELOPING AND WEALTHY NATIONS

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This study examines the striking paradox that exists between healthcare and economic growth of developing and wealthy nations. On one side there is the thought that nations with greater wealth or higher Gross domestic product (GDP) will lead to improved health within its nation, while countries with less GDP will have poorer health conditions. On the other side of the paradigm is the thought that more healthy nations will elicit greater economic growth or higher GDP's in its country, while less healthy nations will elicit poorer economic growth.

To explore this relationship further a theoretical and literature review was conducted to develop a foundation of the current body of knowledge related to this paradox. Of particular note were the findings of Preston and the development of the Preston curve, which illustrated that countries with higher GDP per capita tended to have a corresponding increase in life expectancy. These finding spurred on the current study which used simple linear regression models to examine the role of various health expenditure variables on health indicators (life expectancy at birth and infant mortality rate) for both developing and wealthy nations.

The results of this study indicated that when all nations are considered together the percentage of government spending on health care was the strongest predictor for the health of a nation. There were other expenditure variables that elicited strong correlations with the health indicator metrics such as: the per-capita government spending on health and the number of doctors per 10 000 population.

Although these results only touch the surface of the role of health expenditure on the health of a population they do highlight the importance of the increased funding to health services by governments in developing countries. As healthier populations experience increased productivity of labor resources thus improving the economic growth of the nation. These extrapolations are very rudimentary as they do not take into account the population size of the country and the current focus of health funding by the governments. More research will need to be done to examine more thoroughly the role that government funding in health care plays in the economic growth of a country.

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1. INTRODUCTION

Current research projects a global rising trend in public spending on health care over the next 50 years (OECD, June 2013). This increased spending on health will continue to put pressure on public budgets over the next decade. The Organization for Economic Co-operation and Development (OECD) has projected that the combined public health and long-term care expenditure for OECD countries will potentially grow from six percent of GDP from 2006-2010 to nine and a half percent in 2060. These projections are made under the assumption that policies will be put into place that act more strongly to rein in costs than they have in the past, otherwise spending could reach upwards of fourteen percent of GDP (OECD, June 2013).

Health care expenditure is driven by a number of factors including both demographic and non-demographic drivers (de la Maisonneuve and Oliveira Martins, 2013). The demographic drivers are most closely linked with the age structure of the population and the prevalent evolution of its health status; while one major non-demographic driver includes income. The responsiveness of health expenditures to income still remains an unsettled issue (de la Maisonneuve and Oliveira Martins, 2013). The combination of demographic and income effects fails to explain a large part of the total growth in public health-care expenditure in the past.

Future health care spending will be driven by a combination of new technology and rising relative prices whereas (de la Maisonneuve and Oliveira Martins, 2013).

Within the next decade the world will see megatrends in Global Healthcare including: innovations and demand in emerging economies, personalized medicine and technological advances, aging populations overwhelming the system, raising costs, global pandemics, environmental challenges, and medical tourism (people travelling abroad to receive health care) (Dillon & Prokesch, 2014). With all of these emerging global health care trends a focus on each country's ability to financially handle the changing climate needs to be called into focus.

The purpose of this study is to assess the health care expenditure of developing and wealthy nations and to identify any trends or relationships between the various methods of health spending and the perceived affects this spending has on the health of corresponding population. The first section of this paper will address a literary review on an emerging paradox in the field that asks if greater GDP of a nation leads to better healthcare or on the flipside does a healthier population ultimately affecting an increase in the nations GDP.

From this point data from the World Health Organization (WHO) will be analyzed to see if any correlations or trends exist in the various methods of healthcare expenditure and the health of a population, measured in both: life expectancy and infant mortality rate. A comparison of countries varying in their economic prosperity will be made and resulting trends will be both highlighted and discussed. The aim of this paper is to highlight the current view on healthcare expenditure while exploring some of the global trends and that exist between developing and wealthy nations.

2. ECONOMIC GROWTH THEORY

To help develop a basic foundation in economic growth theory as it relates to productivity, capital and labor, a review of theoretical concepts from Abel, Bernanke & Smith (2003) was done. The theories presented below will help to justify the importance of labor and productivity in terms of economic growth. This concept will be further explored later in the literature review when the impact of health and an individual's ability to work is called to question.

2.1. PRODUCTIVITY FUNCTION, CAPITAL AND LABOR

A nation's economic performance depends on many factors, two of which include; natural/human resources and capital stock (buildings and machines). The growth of an economy depends on input. Input is usually characterized as capital and labor. Output of goods and services depend on the quantities of available inputs.

Output (Y)

Input- Capital (K)

Labor (N)

Productivity (A) – the effectiveness with which inputs are uses

This relationship is characterized by the *production function*, which relates total output to the economy's use of capital, labor and productivity;

$$Y = A F(K, N) \text{ (EQUATION 1)}$$

When you isolate the function and examine output in regards to either capital input or labor input you can determine the product function of both scenarios. In figure 1 it is assumed that the labor input is in an equilibrium and output is only a function of capital stock.

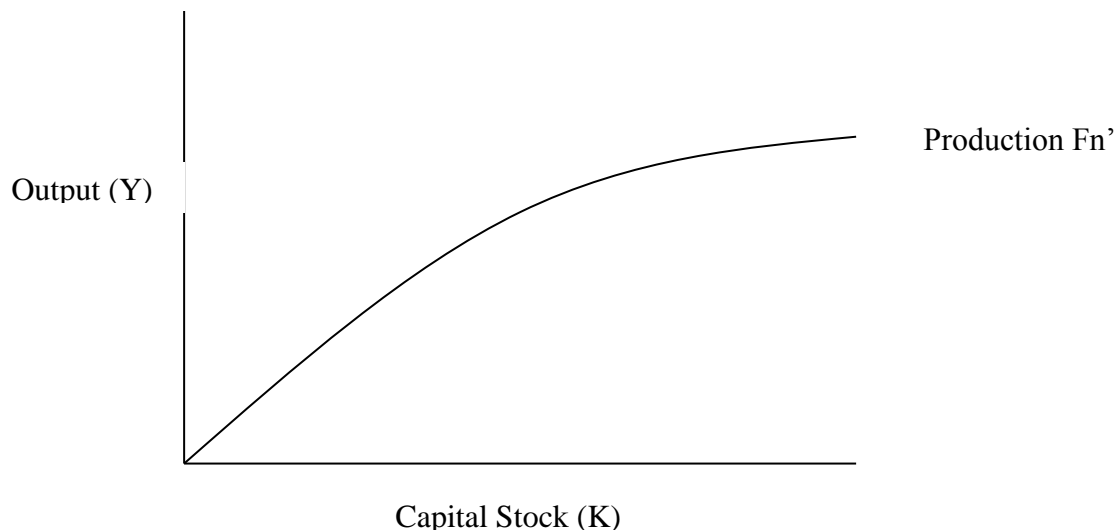


FIGURE 1. THE PRODUCTION FUNCTION AS IT RELATES OUTPUT (Y) TO CAPITAL STOCK (K).

The above function indicates two main concepts;

- 1) As capital stock increases, more output can be produced.
- 2) Although more capital leads to more output, it does so at a decreasing rate.

The *marginal product of capital* (MPK) is the increase in output produced from a 1-unit increase in capital stock. The MPK can be determined by the slope of the tangent line on the production function curve and is also represented in equation 2.

$$\text{MPK} = \Delta Y / \Delta K \text{ (EQUATION 2)}$$

The MPK is positive when there is an increase in both output and capital stock and the MPK decreases as capital stock increases. This decrease in MPK is referred to as *diminishing marginal productivity*. As a practical example, consider the situation where there are minimal pieces of equipment for workers to use in a company, in this situation the addition of extra machines would increase the output produced by the company, as more workers would have more equipment.

Eventually it will get to the point where there is enough equipment for the hired workers and adding more equipment will not increase the total output, because there would be no one to use the added equipment. A similar function can be described for situations where the capital stock is held in equilibrium and output is only a function of the labor (figure 2).

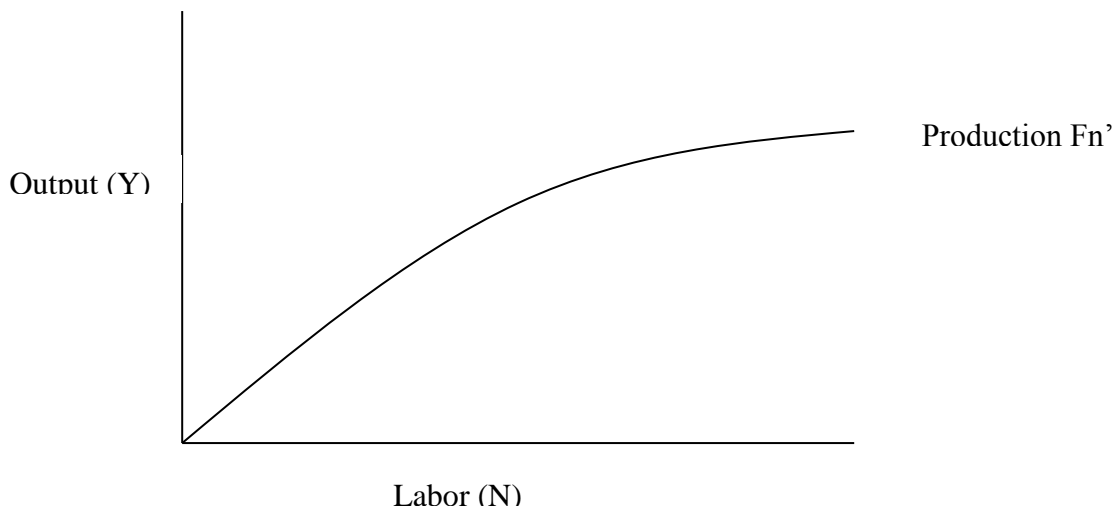


FIGURE 2. THE PRODUCTION FUNCTION AS IT RELATES OUTPUT (Y) TO LABOR (N).

The marginal product of labor (MPN) holds similar theory as the MPK; in this case each additional unit of labor produces additional output.

Changes in the economy's production function are referred to as *supply shocks*. Supply shocks can be either positive or negative; a positive shock raises the total amount of output produced for given quantities of capital or labor. While a negative shock will decrease the total output produced for given quantities of capital or labor.

2.2. ECONOMIC GROWTH

A. GROWTH ACCOUNTING MODEL

Thus it stands that the growth of outputs of an economy are dependent on the growth of the inputs and/or the growth of productivity. If input and productivity remain constant then there is no economic growth. The relationship between the rate of output growth and the rate of input/ productivity growths is described through the growth accounting equation;

$$\Delta Y/Y = \Delta A/A + \alpha_K \Delta K/K + \alpha_N \Delta N/N \text{ (EQUATION 3)}$$

$\Delta Y/Y$ – rate of output growth

$\Delta A/A$ – rate of productivity growth

α_K – elasticity of output with respect to capital

$\Delta K/K$ – rate of capital growth

α_N – elasticity of output with respect to labor

$\Delta N/N$ - rate of labor growth

The elasticity function in the equation examines the percentage increase of output with respect to a 1% increase in either capital or labor. This information is estimated from historical data and falls between 0-1.

THE GROWTH ACCOUNTING EQUATION INDICATES THAT OUTPUT GROWTH ($\Delta Y/Y$) CAN BE DIVIDED INTO THREE MAIN PARTS:

- Productivity growth- $\Delta A/A$
- Increased capital inputs- $\Delta K/K$
- Increased labor inputs- $\Delta N/N$

Changing the quality and the quantity of the input will have effects on the degree of output. For example one hour from a skilled worker will result in a greater output than one hour from an unskilled worker.

The one component of the equation that is not characterized by inputs and outputs is the improvements to total factor productivity and can be determined by rearranging the growth accounting equation;

$$\Delta A/A = \Delta Y/Y - \alpha_K \Delta K/K - \alpha_N \Delta N/N \text{ (EQUATION 4)}$$

B. GROWTH DYNAMICS

The growth accounting model works under the assumption that the rates of input are given, it does not explain why capital stock and labor grow at the rates they do. The *neoclassical model* addresses how the growth process of an economy evolves over time.

This model addresses the relationship between the standard of living and fundamental factors such as; saving rate, population growth and rate of technical progress. Behind the basis of the model is the assumption that the work force grows at a fixed rate (n) and at the beginning of each year (t) the nation's output can be determined by the capital (K_t) and the labor (N_t). That output (Y_t) is distributed either as an investment in new capital (or replacing worn-out capital) (I_t) or it is consumed by the populations (C_t);

$$C_t = Y_t - I_t \text{ (EQUATION 5)}$$

Since the labor of a nation is growing continuously it is convenient to consider consumption, output and capital stock on a per worker basis. This is easily accomplished by divided each component by your labor.

$y_t = Y_t/N_t$ – output per worker in year t

$c_t = C_t/N_t$ - consumption per worker in year t

$k_t = K_t/N_t$ – capital stock per worker in year t

This last equation is referred to as the capital- labor ratio. The neoclassical model works to identify each of these functions change over time.

C. PER-WORKER PRODUCTION FUNCTION

The production function discussed earlier can also be defined on a per worker term as;

$$y_t = f(k_t) \text{ (EQUATION 6)}$$

In the neoclassical model when the production function is removed the economy has the opportunity to reach a steady state where the output/worker, consumption/worker and capital stock/worker become consistent. To better understand how the growth models works it is important to first clarify how the system works in its steady state.

Investments in a steady state are devoted to either replacing worn-out capital or expanding the size of the capital stock. In this case depreciation of capital in year t can be denoted as dK_t . The amount that capital stock increases by is denoted as nK_t , because in the steady state, capital per worker is constant meaning that total capital stock increases at the same rate as the labor force, which is n .

In the steady state the investment into an economy are determined by;

$$I_t = (n + d)K_t \text{ (EQUATION 7)}$$

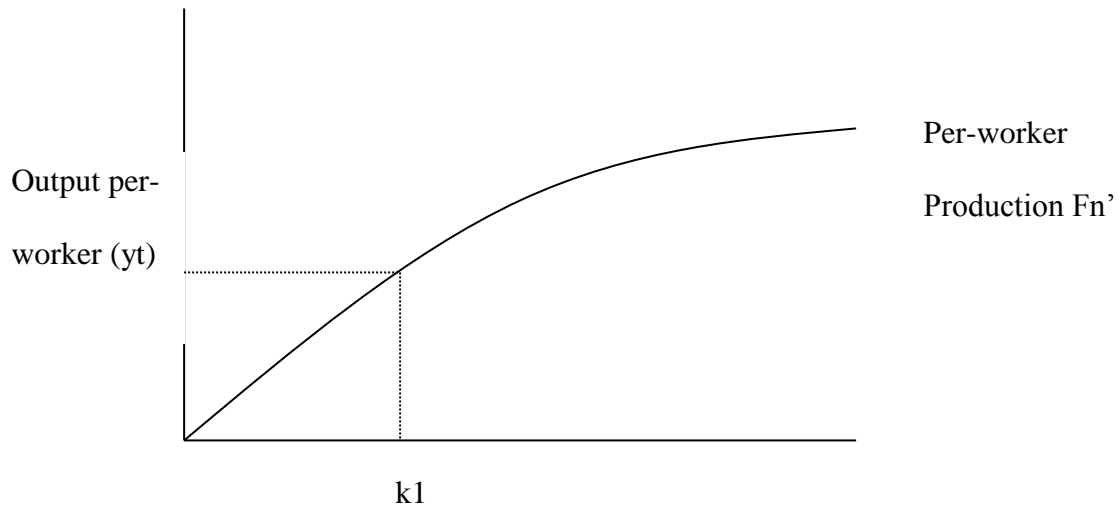


FIGURE 3. THE PER-WORKER PRODUCTION FUNCTION AS IT RELATES OUTPUT PER-WORKER TO THE CAPITAL-LABOUR RATIO.
(Abel, 2003)

3. LITERATURE REVIEW

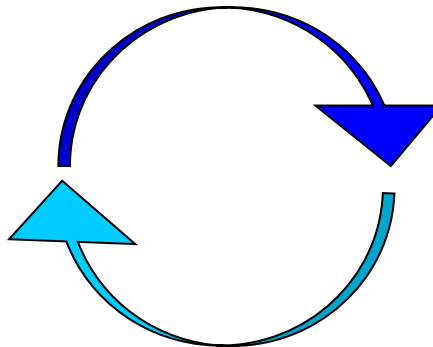
3.1. DESCRIBING THE PARADOX

A striking paradox exists in developing countries with regards to healthcare and the economy. Poverty tends to exacerbate poor health, while poor health makes it harder for individuals to get out of poverty. The World Health Organization (WHO) was quoted in 2010 as saying that over 100 million people were being pushed into poverty each year due to the costs of healthcare (Griffith, 2010). The problem is most prevalent in countries where people have to pay directly for any health services they receive. In developing countries within Africa a fit, strong person is an asset and allows poor people to work and poor children to learn. Where a weak/ ill person is a liability both to the individual and to those that need to provide them with support. This becomes particularly detrimental to families when the ill person is the primary source of income. In some cases these costs can be devastating and sends the family into a cycle of poverty from where they can never recover (Dodd & Munck, 2000).

The first section of this paper will explore the paradox in more detail and determine the relationship between healthcare and economic growth in developing and wealthy nations and to determine how one may influence the other. The proposed paradigm can be seen in figure 4, and illustrates the two theories that will be examine more thoroughly within this body of work relating healthcare to the economy and vice versa.

On the one side there is the thought that nations with greater wealth will lead to improved health within that nation; the converse being that nations with less gross domestic product (GDP) will have poorer health conditions. The other half of the circle would be that human capital and health lead to greater GDP. Literature reviews for each of these theories will be assessed and summaries of main findings will be presented in the current paper.

Does improvement in GDP lead to actual improvement of health?



Does human capital and health lead to growth in GDP?

3.2. DOES IMPROVEMENT IN GDP LEAD TO ACTUAL IMPROVEMENT OF HEALTH?

It is generally taken for granted in a lot of literature in epidemiology and public health that increases in income results in improvements in health. Continued research in the field however, is beginning to denote that the relationship may not be as simple as “increased income causes improvement to health.”

A lot of economic literature has been skeptical about any causal link from income to health; mainly there is a trend toward the other half of the paradox (health leads to economic growth) (Deaton, 2003). One of the main papers supporting a link between income and health has been the research conducted by Preston (1975).

Preston’s (1975) research showed that among the poorest countries, increases in average income were strongly associated with increases in life expectancy. This research goes on to show that as the income per person rises, the relationship flattens out and is weaker among the richest countries. This graphical relationship was given the name of the Preston Curve and a recreation of this curve can be seen in Figure 5 (data retrieved from the World Bank).

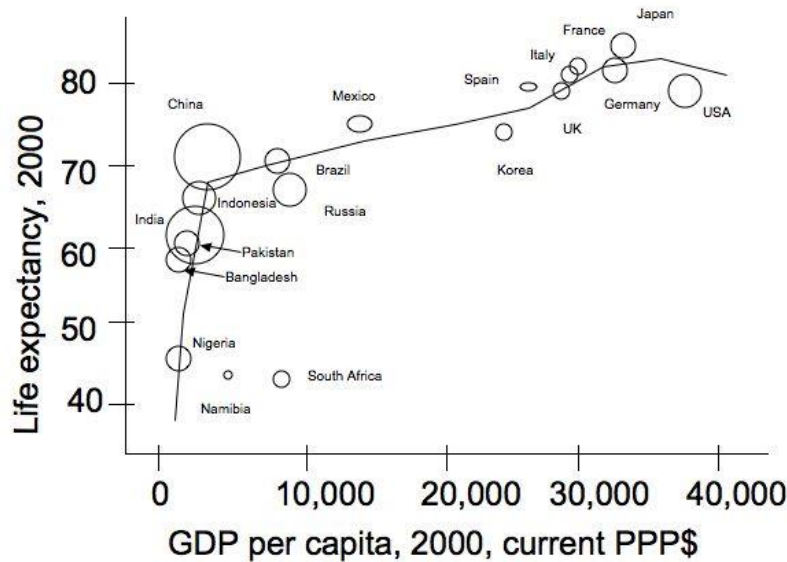


FIGURE 5. THE PRESTON CURVE: LIFE EXPECTANCY VERSUS GDP PER CAPITA

Along this same line of reasoning, Preston originally noted that this relationship also characterizes the relationship between mortality and income and that there would be a negative relationship across countries between income inequality and life expectancy.

The redistribution of funds from wealthy to poor countries will increase the health of the poor more than it would hurt the health of the rich, thus improving the average national or world health (Preston, 1975).

A. EXPLORATION OF THE PRESTON CURVE

Further exploration of the Preston curve invokes the discussion of the priority of healthcare in countries and the payoff, in terms of added years of life, such financial commitment results in. To explore further the financial commitment of countries to their healthcare programs, Figure 6 highlights the healthcare expenditure from a variety of countries from low economic development to well developed countries, as a percentage of their GDP.

FIGURE 6. THE HEALTH EXPENDITURE, LIFE EXPECTANCY AND GDP PER CAPITA IN 2012 OF A VARIETY OF COUNTRIES FROM VARYING ECONOMIC LEVELS.

Country	Health expenditure (% Of GDP)	Life Expectancy (Age in years)	Population (millions)	GDP per capita 2012- (Current US\$ billion)	Healthcare funds/person (\$)
Nigeria	5.3	52.46	170.0	262.6	81.87
Namibia	5.3	52.03	2.4	13.1	288.63
South Africa	8.5	49.48	51.0	384.3	640.50
Bangladesh	3.7	70.06	153.0	115.6	27.96
Pakistan	2.5	66.71	180.0	231.2	32.11
Indonesia	2.7	71.9	241.0	878.2	98.39
India	3.9	67.48	1260.0	1842.0	57.01
Russia	6.2	69.85	143.0	2015.0	873.64
Brazil	8.9	73.02	194.0	2253.0	1033.59
China	5.2	74.99	1350.0	8358.0	321.94
Mexico	6.2	76.86	116.0	1178.0	629.62
Argentina	8.1	77.32	40.8	470.5	934.08
Korea	7.2	79.55	48.9	1130.0	1663.80
Spain	9.4	81.37	46.2	1349.0	2744.72
Italy	9.5	81.95	60.9	2013.0	3140.15
France	11.6	81.56	63.6	2613.0	4765.85
UK	9.3	80.29	63.2	2435.0	3583.15
Germany	11.1	80.32	81.8	3400.0	4613.69
Japan	9.3	84.19	128	5960.0	4330.31
Canada	11.2	81.57	34.9	1821.0	5843.90
USA	17.9	78.62	314.0	1568.0	893.86

The above figure brings to light a couple of interesting trends in the terms of global health expenditure and the relationship to life expectancy. First and foremost there appears to be a trends between countries that contribute the lowest percentage of their GDP towards healthcare and on average lower life expectancy of their citizens. The average life expectancy's range between approximately 49 years old, in developing country South Africa, to as high as 84 years old, in wealth nations such as Japan. The average percentage of GDP spent on healthcare ranges between 2.5, in Pakistan to as high as 17.9 in the United States. This data allows for a lot of very interesting discussions based on the efficiency of countries healthcare plans and their implementation. It also suggests further exploration into the cost benefit of healthcare expenditure. For example, how much more money does a country need to commit to their healthcare to gain, on average, an extra year of life.

Other questions also arise as to why some countries can commit lower percentages of their GDP and still have on average higher life expectancies. For example, as of 2012 Canada committed approximately 11% of their GDP to healthcare where the US committed approximately 18%, this translates into approximately \$204 and \$282 billion. Of course the instant consideration has to be given to the size of the population, in terms of Canada and the US there is a large difference. In Canada that \$204 billion is essentially divided among a population of approximately 35 million, making it approximately \$6000/person.

The US, on the other hand, is committing \$282 billion to a population of over 300 million resulting in approximately \$900/person.

Interestingly enough, of the more wealthy nations the United States actually have the lowest per person funds available. This comparison demonstrates that the size of the population plays an important role in the interpretation and comparison of healthcare expenditure.

The emerging trends in this data table allow for a more focused consideration of external factors that may be influencing the healthcare of these nations and how efficiently or effectively funding is being used to address healthcare strategies. South Africa for example, has the lowest average life expectancy but also has relatively high healthcare funding per person in comparison to the other developing countries. This could potentially be linked to the large variation of wealth within the country, an issue referred to as the relative income hypothesis.

There are two working hypothesis that consider the effects of income on health; they are the absolute income hypothesis and the relative income hypothesis. The absolute income hypothesis, is the same as that supported by Preston, suggests that (while holding other things constant) the higher an individual's income the better their health is (Preston, 1975; Pritchett & Summers, 1996; Gravelle, 1998). The relative income hypothesis, alternately suggests that an individual's health is also affected by the distribution of income within

society. This means that an individual with a given income would have worse health if they lived in a society with greater inequality of income than in a society where income was more equally distributed (Wilkinson, 1994).

Often this level of inequality is measured by the GINI coefficient, which is a measure of statistical dispersion intended to represent the income distribution of a nation's citizens (Wikipedia, 2013). The scaling of this coefficient would have a value of zero represent an absolute equality of income between residents, while a value of 1 would be an absolute inequality. The GINI coefficient of South Africa is among one of the highest in the world ranging at about .63 (de Klerk, 2004). To help comprehend the range of wealth within South Africa it is significant to mention that 10% of the population at the top of the economic ladder control the highest share of national income compared to the rest of the world (Global Finance, 2013). There is a growing link between South Africa's emerging multiracial middle class and unionized labor elite and on the other hand there is a growing black underclass. In South Africa almost half of the population, primarily black, live below the poverty line (de Klerk, 2004).

These hypothesis and the literature surrounding the affects income has on health are subject to statistical artefact. Gravelle (1998) suggests that the correlations between population level measures of mortality and inequality provide biased estimates of the importance of any relative income effect. Both the absolute and relative income hypotheses predict that a reduction in the inequality of income can improve the health of

a population (Gravelle, 1998); however, sufficient evidence does not currently exist to support a linear relation between the two.

B. EFFECTIVE UTILIZATION OF GDP TOWARDS HEALTHCARE STRATEGIES

In line with the theory that countries with higher GDP result in residents with better health (measured in life expectancy) the consideration of where health care expenditure is being utilized needs to be considered. Healthcare strategies and implementation can face many challenges that ultimately affect the efficient utilization of funds. In the past 50 years two major programs to help primary healthcare capabilities within developing countries have been implemented (or an effort has been made to implement them). In 1978, approximately 130 nations got together in Alma Ata Kazakhstan at the annual *International Conference on Primary Health Care* to discuss the urgent and effective national and international call to action to develop and implement primary health care (PHC) throughout the world (Declaration of Alma-Ata, 1978). Twenty years later and the implementation of these strategic plans were being recalled and reformed in a new strategy called the Millennium Development goals (MDG), which an additional twenty years later these MDG's are still struggling to be integrated worldwide (Vellemen, 2013).

Some of the challenges that arose in the PHC initiative stemmed from lack of resources and in some cases the presence of other competing health projects. The countries that

were successful in implementing the PHC initiative saw a profound decrease in infant mortality.

Primary healthcare provided the opportunity for women and families to receive basic health education, which saw to improved clean water and sanitation efforts as well as decreased vaccine preventable and communicable diseases (Magawa, 2012). The PHC initiative essentially improved the health and wellness of developing nations.

Both Zambia and South Africa provide two examples of how the GDP and health expenditure of a country affected the ability to implement this PHC initiative. During 1981 Zambia began to implement the PHC, initially the country was very successful in implementing the program because of the global demand for copper (Zambia's main export). The steady progress of implementing PHC included training the community health workers, building health centers in rural areas, improved distribution of medicines, a strengthened transport system as well as improved health planning and management. These changes were short-lived when the global demand for copper diminished, with it went the increase in the country's GDP. This left a lot of the programs being implemented into the country without funds. Moving forward the government chose not to reallocate funds to the project and a lot of the progresses observed by the country were lost. There was a resultant increase in both vaccine preventable and communicable

diseases and Zambia went on to have one of the highest rates of under-five mortality in Africa (WHO, 1994).

Although there are many facets to be considered in this example, such as the significant power of influence the government has in determining where funds are allocated, none-the-less it demonstrates that when the GDP of a nation is great the funds available for healthcare programs potentially can be increased resulting in better health for the country's residents.

The second example brings South Africa back to the forefront of discussion and highlights a potential explanation for the high funds available per person in a country with very low life expectancy. The PHC program would have been able to provide basic but affordable healthcare advantages for all residents, despite their economic status.

This program was unsuccessfully implemented, partly because of slow up-take by the government but also because of the presence of competing health programs within the country that already consumed a large portion of available resources (Magawa, 2012). South Africa has the highest rate of HIV & AIDS in the world at 17% of the population infected, this increase in disease burden makes the implementation of PHC for all a challenge as there are shortages of health workers and health infrastructure, all of which

have contributed to South Africa's current poor health indices (Kautzky & Tollman, 2009). It is possible that extensive funds have been committed to other health programs such as HIV and AIDS, programs which are important to the wellbeing of the country but fail to address multiple other chronic health concerns that face the residents of the country, resulting still in a lowered life expectancy.

As it stands, not a lot of the literature supports a strong correlation between the GDP of a nation and the health of its residents. Preston (1975) provides the strongest research supporting a relationship between the two through the use of the Preston curve, but as we have discussed there are multiple considerations that need to be taken into account with this curve. The real-life examples of the implementation of the PHC initiative have shown that a country's GDP can affect the health of its residents but that is dependent on the use of funds and having the support of the government to champion such endeavors.

It is also true that funding more programs than just healthcare is important to the health of a population and this may contribute to the dispute of the direct relationship between GDP and health of a nation. Funding towards education, employment opportunities and other wellness programs can help individuals make healthier informed life decisions, thus resulting in increased health and life expectancy. It is important to consider the varying needs of the populations, what is required by Canadian citizens for better health will not necessarily be the same as that required by residents of Nigeria. Wealthier nations have chronic stress and obesity epidemics where developing countries focus more on clean

water, food accessibility and basic vaccinations; advantages wealthier nations may take for granted.

3.3. DOES HUMAN CAPITAL & HEALTH LEAD TO GROWTH IN GDP

A. HEALTH SPENDING TO INCREASE THE GDP OF A NATION

A very recent article presented by Kumar (2013) explored the role that health care spending of organizations of economic co-operation and development countries (OECD) had on the gross domestic product of that country. The study assessed these companies from 1960-2007 using the generalized method of moments (GMM).

The GMM is a semi-parametrically efficient estimation method (Kumar, 2013). The study used this method to examine the association between health spending and GDP for 10 OECD countries. Their findings indicated that with a 1% increase in real GDP per capita there is an associative increase of approximately .67% in real per capita health spending in these countries. This is new evidence that supports the above half of the paradox. Further the study went on to find that a bi-directional causality was found to exist between the per capita spending and GDP. Essentially implying that OECD countries that spend more on healthcare, raises the GDP growth of that country (Kumar, 2013). This could be interpreted by the fact that more money spent on healthcare would increase the health of the citizens making them more vital and viable for manual labor or work in general.

MAJOR RESEARCH PROJECT – EXPLORING THE RELATIONSHIP BETWEEN HEALTH AND ECONOMIC GROWTH IN DEVELOPING AND WEALTHY NATIONS

B. THE INPUTS AND OUTPUTS OF HEALTH

The examination of the relationship between health and economic outcomes can be made either individually or at the national level by examining two types of health measures; inputs into health and health outputs. Weir (2007) clearly identifies these measures in his study, where inputs are the physical factors that influence an individual's health. Some obvious examples of measure of input may be the population with access to clean drinking water, the number of physicians per capita and the nutrient composition of diet. There are stark differences between poor and rich countries in all of these facets. The health outcomes are characteristics that are determined both by the health inputs and by genetic endowment.

Some examples as we have already seen in this paper are life expectancy, height, the ability to work hard, and cognitive functioning (Weir, 2007). Human capital, as discussed by Weir (2007) is a combination of an individual's ability to work hard, cognitive function, and other aspects of health. It is difficult to identify direct measures of human capital, it is thus inferred by wages. It becomes challenging identifying a relationship between health and economic growth when so many factors and inputs to health exist, it becomes even more challenging when the outcome of health in relation to productivity and ability to work is even more subjective/ambiguous. Recent literature has gone on to isolate the inputs into health and examined the effects on economic growth of countries.

3.4. THE EFFECT OF HEALTH ON ECONOMIC GROWTH

A growing body of literature has found that improving the health of a population has a positive influence on the living standards and GDP of that nation. A study by Weil (2007) found that health explains approximately 23% of the variance of log GDP per worker. Weil (2007) states that improving world health may have an indirect effect of individuals such that it may lead to individuals acquiring schooling, ultimately saving more money and increasing their productivity per worker. At its essence this theory is rooted in the concept that the direct economic payoff of health improvements are a result of people living longer, healthier lives. The report of the WHO's Commission on Macroeconomics and Health states;

The linkages of health to poverty reduction and to long-term economic growth are powerful, much stronger than is generally understood. The burden of disease in some low-income regions, especially sub-Saharan Africa, stands as a stark barrier to economic growth and therefore must be addressed frontally and centrally in any comprehensive development strategy. (World Health Organization 2001).

To further support the theory that health improvements are positively correlated with economic growth a study conducted by Spraley (2008) found that for an increase in life expectancy by one percentage point resulted in an increased total GDP by 3.87 percentage points. The results also showed a strong and positive correlation between increases in life expectancy and total GDP per working age population (Sparley, 2008).

Weir (2007) identifies a couple of channels through which health affects the level of output in a country. The most direct association is that healthy people, in general, make for better workers. Healthy people work harder and longer and are capable of thinking more and clearly. Conclusions that can be drawn from a lot of the literature is that productivity is the most significant source of income differences between countries, accounting for more than half of the variance of income. Weir (2007) has gone on to identify that a significant fraction of this residual productivity variations is accounted for by variations in health among countries (Weir, 2007).

The differences between poor and rich countries and the available accesses to better health care and basic living essentials also supports the relationship between health and GDP. Wealthier nations are able to provide better education and nutrition to its population, thus resulting in healthier individuals capable of contributing to the workforce and economy of a nation.

Poorer countries are not privy to basic essentials such as water, education and nutrition and may not be able to support a health population, thus reducing the number of able-bodied workers.

The effects of health on the GDP of a nation are rooted in the concept of human capital, as we have previously discussed in the mathematical theory of this paper. Human capital, a stock of competencies embodied in the ability of individuals to perform labor and to produce economic value (Wikipedia, 2013). The healthier an individual is the more capable they are to contribute to an economy. Also the healthier an individual is the longer they live and the longer they can be an active part of the economy. It is therefore intuitive that better health leads to an increase in GDP.

3.5. SUMMARY OF LITERATURE REVIEW

The literature for this study found that there is support for both sides of the paradox, that countries with higher GDP do have better health and those countries with better health and human capital result in higher GDP. The most interesting findings from this study come from the trends observed in the Preston curve in figure 2 and the data collected in table 1. Since the concept of higher GDP eliciting healthier populations is less founded in literature, data sets that deviate from a positive correlation between the two really ignite interest. For example, the United States has the highest GDP per capita but they do not

have the highest life expectancy, this inconsistency in trend spurs on the question of why this might be?

Is life expectancy the best indicator for health? How are funds truly being used in the nation? Is there a better health program for the country? How does health expenditure relate to life expectancy in other countries? The questions this one discrepancy raises are extensive. Moving forward it will be the aim of our study to explore these trends in more detail, identifying correlations between health expenditure and life-expectancy and perhaps to highlight a few key comparisons or discrepancies along the way.

4. METHODOLOGY

The Preston Curve discussed in the above literature review sparked further inquiries to what factors contribute to the better health outcomes in countries of varying wealth. As previously discussed relationships have been discussed between the GDP of a nation and the corresponding health of that nation. It will be this studies objective to further explore this relationship by more closely examining the relationship between wealth/health expenditure and the overall health of the population.

To explore these potential relationships two elements needed to be highlighted:

- 1) The output or dependent factor that will be used to represent the health of a country.
- 2) The input or the independent factors that may account for changes to the health of a country.

For the purpose of this study the two dependent factors that will be used to represent the relative health of a country will be the life expectancy of its population and the infant mortality rate. Different international organizations such as the World Health Organization (WHO), United Nations, Department of Economic and Social Affairs and United Nations Children’s Fund have identified these as appropriate indicators for the health of a population (Robine, Romieu & Cambois, 1999).

To assess the role that GDP and healthcare expenditure has on the health of varying nations a data set, also derived from the WHO, has been selected for analysis.

The data set seen in Appendix A was obtained from the Global Health Expenditure Database and highlights the most current analysis of varying combinations of healthcare expenditures from 2012. The following table indicates the predictor variables and how they are referred to throughout the remained of the analysis.

DESCRIPTION OF THE PREDICTOR VARIABLE	PREDICTOR VARIABLE SHORTHAND
Health spending as a percentage of GDP	Health spending
Government spending on health as a percentage of all health spending	Government spending
Private spending on health as a percentage of all health spending	Private spending
Per capita total spending on health (PPP int. \$)	Per capita total spending on health
Per capita government spending on health (PPP int. \$)	Per capita government spending on health
Doctors per 10,000 population	Doctors per 10000 pop

To assess whether relationships did exist between health expenditure and the general health of a country a series of linear regression analysis were conducted using SPSS. The first group of analysis considered whether relationships existed between health expenditure predictors and life expectancy with all countries regardless of wealth and status. The second wave isolated the developing countries from wealthier nations and reassessed the role of the health expenditure variables on the health of nations. From this point, graphs and analysis with the most significant/intriguing results were further explored and discussed.

5. RESULTS

The following section highlights some of the key findings from the extensive volume of simple linear regression analysis conducted. Section 5.1 assesses all health expenditure predictor variables individually as they explain the effect on the life expectancy for both wealthy and developing nations. Section 5.2 assesses all health expenditure predictor variables individually as they explain the effect on the infant mortality rate for both wealthy and developing nations. Section 5.3 separates the wealthy from developing nations in the assessment of the health expenditure variables on both health indicators. Due to the extensive volume of simple linear regression analysis conducted, only a select variety of outcomes are discussed below. Only regression analysis that produce a t statistic of $p \leq 0.05$ will be considered statistically significant.

5.1. DESCRIPTIVE STATISTICS

A sample of 21 countries from varying financial wealth and development were chose for analysis, based off of the countries represented in the Preston Curve in figure 2. Taken in total, the health expenditure variables elicited average (means) and standard deviation indicated in the table below.

PREDICTOR VARIABLE	AVERAGE (MEANS)	STANDARD DEVIATIONS
Health spending as a percentage of GDP (%)	7.8	3.81
Government spending on health as a percentage of all health spending (%)	57.62	17.08
Private spending on health as a percentage of all health spending	42.39	17.08
Per capita total spending on health (PPP int. \$)	2017.75	2168.99
Per capita government spending on health (PPP int. \$)	1372.4	1452.42
Doctors per 10,000 population	19.98	13.44

The average (mean) and standard deviation of the health predictors: Life expectancy and Infant mortality rate are observed in the following table. On average the life expectancy at birth of all countries is 73.4 years old with a variance of approximately nine years. The average infant mortality rate of all countries is approximately 22 infants out of 1000 with a standard deviation of approximately 23.

HEALTH PREDICTORS	AVERAGE (MEANS)	STANDARD DEVIATIONS
Life Expectancy at birth (2011)	73.4	8.65
Infant mortality rate (probability of dying between birth and age 1 per 1000 live births)	21.65	23.37

5.2. LIFE EXPECTANCY AS A HEALTH INDICATOR

Drawing from the data from Figure 6 and in Appendix A, a variety of linear regressions were conducted to determine what independent variables may be used to explain the effects on life expectancy of populations throughout the world, both developing and wealthy. Figure 7 highlights some of the key statistical findings from the regression analyses conducted to assess the role of these predictors on describing the life expectancy at birth (referred to in figures as lifeexpect).

FIGURE 7. REGRESSION ANALYSIS OF VARIOUS PREDICTORS FOR HEALTHCARE EXPENDITURE ON LIFE EXPECTANCY IN BOTH DEVELOPING AND WEALTHY NATIONS.

Predictor	Constant	B	SE β	β	t-stat	Sig.	R	R ²
Government spending	51.072	.388	.077	.765	5.037	.000	.765	.585
Private spending	89.826	-.388	.077	-.765	-5.037	.000	.765	.585
Health spending	63.021	1.317	.436	.580	3.019	.007	.580	.336
Per capita total spending on health	68.042	.003	.001	.666	3.783	.001	.666	.443
Per capita government spending on health	67.303	.004	.001	.746	4.748	.000	.746	.556
Doctors per 10000 pop	64.583	.441	.111	.685	3.992	.001	.685	.470

The results of the linear regression suggest that a significant portion of the total variation in life expectancy rates can be predicted by all of the preceding health expenditure variables: Government spending as a percentage of total healthcare spending and private spending t-stat (5.037, -5.037), $p < 0.001$, Health spending as a percentage of GDP t-stat (3.019), $p < 0.05$, per capita total spending on health t-stat (3.783), $p \leq .001$, per capita government spending on health t-stat (4.748), $p < .001$, doctors per 10 000 population t-stat (3.992), $p \leq 0.001$. Additionally, it is found that government and private spending as a percentage of total healthcare spending and the per capita government spending on healthcare have the strongest correlation with life expectancy ($R = .765$ & $.746$ respectively) and both account for over half of the variance in data ($R^2 = .585$ & $.556$ respectively).

The following figures help to better visualize the direct relationships that exist between government and private spending as a percentage of total healthcare spending and its correlation with life expectancy; as well as the per capita government spending on healthcare as it relates to life expectancy. For a more thorough examination of other health expenditure variables and life expectancy see Appendix B. These figures are all inclusive and contain both developing nations as well as wealthy nations.

FIGURE 8. THE GOVERNMENT SPENDING ON HEALTH FOR BOTH WEALTHY AND DEVELOPING NATIONS AS A PERCENTAGE OF ALL HEALTH SPENDING AS A PREDICTOR FOR LIFE EXPECTANCY.

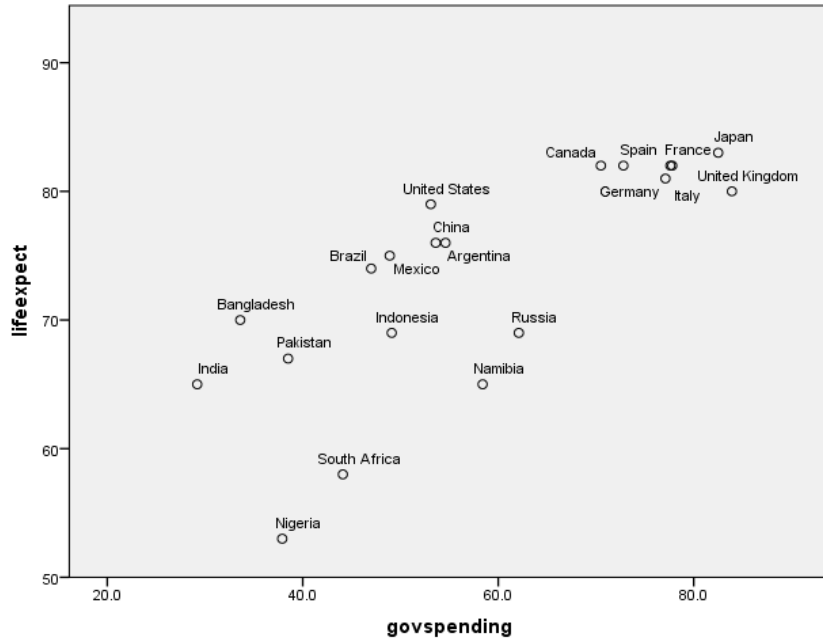


FIGURE 9. USING PRIVATE SPENDING ON HEALTH AS A PERCENTAGE OF ALL HEALTH SPENDING TO PREDICTOR FOR LIFE EXPECTANCY.

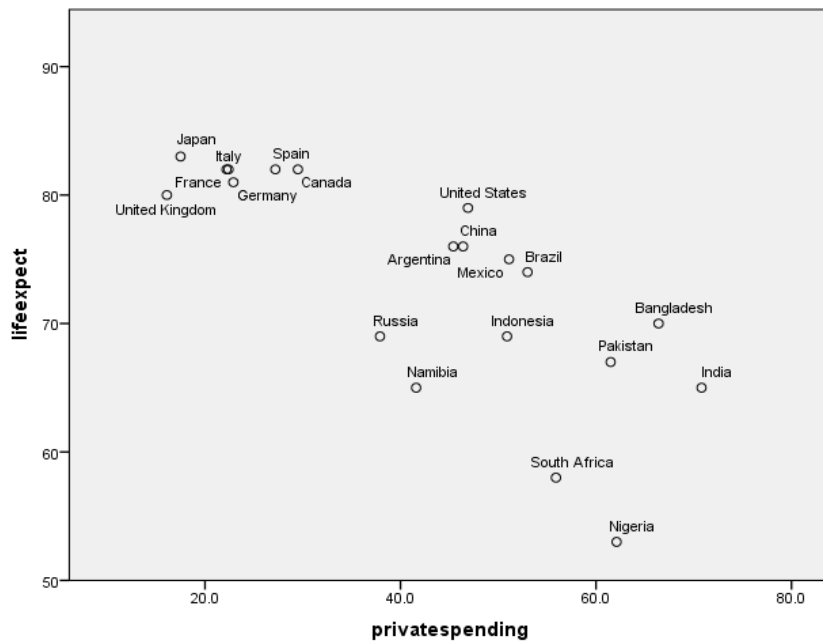
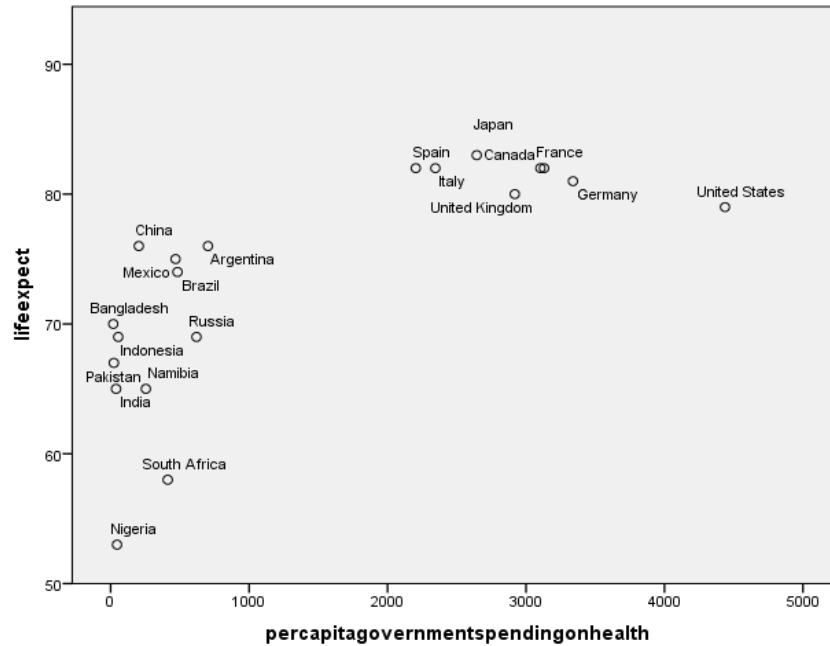


FIGURE 10. THE PER CAPITA GOVERNMENT SPENDING ON HEALTH (PPP INT. \$) AS A PREDICTOR FOR LIFE EXPECTANCY.



5.3. INFANT MORTALITY RATE AS A HEALTH INDICATOR

A series of similar regression analysis were run with the dependent variable being the infant mortality rate (referred to in figures as infant). Figure 14 highlights the most statistically relevant or interesting results from the regression analysis.

FIGURE 11. REGRESSION ANALYSIS OF VARIOUS PREDICTORS FOR HEALTHCARE EXPENDITURE ON INFANT MORTALITY IN BOTH DEVELOPING AND WEALTHY NATIONS.

Predictor	Constant	B	SE β	β	t-stat	Sig.	R	R ²
GDP per capita	31.692	-.005	6.712	-0.45	-2.138	0.047	.450	.202
Government spending	82.125	-1.050	.207	-.767	-5.074	.000	.767	.589
Private spending	-22.839	1.050	.207	.767	5.074	.000	.767	.589
Health spending	52.244	-3.883	1.119	-.633	-3.469	.003	.633	.401
Per capita total spending on health	35.030	-.007	.002	-.616	-3.313	.004	.616	.379
Per capita government spending on health	36.342	-.011	.003	-.665	-3.782	.001	.665	.443
Doctors per 10000 pop	46.785	-1.258	.283	-.723	-4.446	.000	.723	.523

Similar to the results found with life expectancy as the health predictor, the infant mortality rate was found to have significant relationships with all the independent variables. The main difference between the two health predictors is that there is a negative relationship between dependent and independent variables, which was to be expected, as health expenditure increases the rate of infant mortality decreases. Another difference between the two analyses is that the GDP per capita of a nation was found to have a significant relationship with infant mortality (albeit weaker than the other independent variables).

GDP per capita t-stat (-2.831), $p < .05$, Government and private spending as a percentage of health spending t-stat (-5.074), $p < .001$, Health spending as a percentage of GDP t-stat (-3.469), $p < .01$, per capita total spending on health t-stat (-3.782), $p < .01$, per capita government spending on health t-stat (-3.782), $p \leq .001$, doctors per 10 000 population t-stat (-4.446), $p < .001$. Additionally, it is found that government and private spending as a percentage of total healthcare spending, the per capita government spending on healthcare and the number of doctors available per 10 000 in populations have the strongest correlation with life expectancy ($R = .767$, $.665$ & $.723$ respectively) and both government/private spending as a percentage of health care spending and the number of doctors available account for over half of the variance in data ($R^2 = .589$ & $.523$ respectively).

The following figures help to better visualize the direct relationships that exist between government and private spending as a percentage of total healthcare spending and its correlation with life expectancy; as well as the number of doctors available per 10 000 in population e as it relates to life expectancy. For a more thorough examination of other health expenditure variables and infant mortality rates see Appendix B. These figures are all inclusive and contain both developing nations as well as wealthy nations.

FIGURE 12. THE GOVERNMENT SPENDING ON HEALTH OF BOTH WEALTHY AND DEVELOPING NATIONS AS A PERCENTAGE OF ALL HEALTH SPENDING AS A PREDICTOR FOR INFANT MORTALITY.

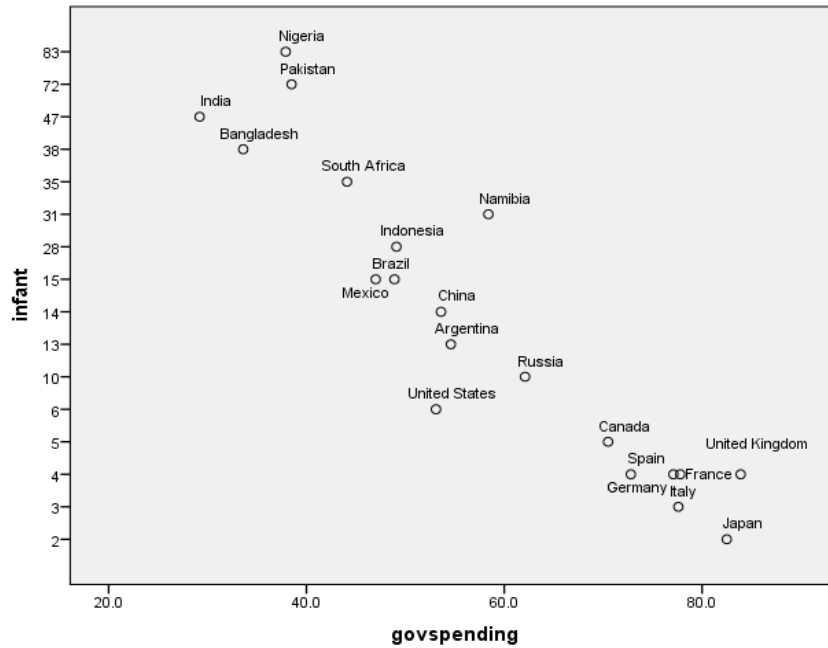
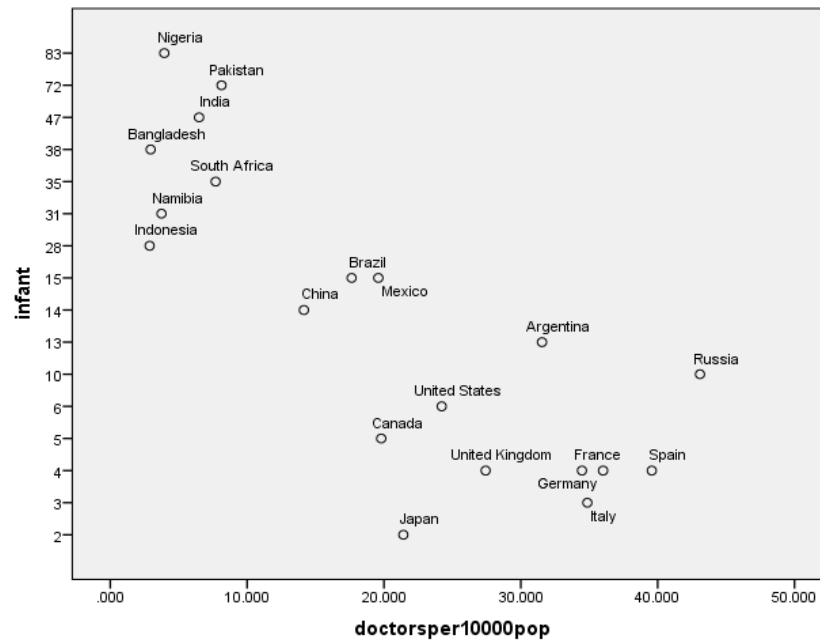


FIGURE 13. THE NUMBER OF DOCTORS AVAILABLE FOR EVERY 10,000 PEOPLE FOR BOTH WEALTHY AND DEVELOPING NATIONS AS A PREDICTOR FOR INFANT MORTALITY.



5.4. DEVELOPING VERSUS WEALTHY NATIONS

To better understand the strength of the relationship between the predictors for healthcare expenditure and their effect on the health of various countries, the data was separated into two groups. The countries were divided into the wealthy nations, which based off of the Preston Curve consisted of data from Mexico and above on the curve; and developing nations which was China and below on the curve. The following linear regression analyses were done with this isolated data set and a statistical summary of the findings can be observed below.

A. DEVELOPING NATIONS LIFE EXPECTANCY & INFANT MORTALITY

The purpose of this analysis was to compare the effect of the independent health expenditure variables on health indicators between developing countries and wealthy countries.

FIGURE 14. REGRESSION ANALYSIS OF VARIOUS PREDICTORS FOR HEALTHCARE EXPENDITURE ON LIFE EXPECTANCY IN DEVELOPING NATIONS.

Predictor	Constan		SE β	β	t-stat	Sig	R	R ²
	t	B						
GDP per capita	63.923	.002	.001	.594	2.090	.070	.594	.353
Government spending	57.286	.205	.216	.319	.952	.369	.319	.102
Private spending	77.824	-.205	.216	-.319	-.952	.369	.319	.102
Per capita total spending on health	65.619	.002	.006	.136	.388	.708	.136	.018
Per capita government spending on health	65.348	.006	.011	.185	.533	.609	.185	.034

Doctors per 10000 pop	64.552	.185	.188	.328	.983	.354	.32	.10
							8	8

Based off of the predetermined level of statistical significance ($p < .001$) the results for the developing nations multiple linear regressions suggest that no significant proportion of the total variation in life expectancy can be determined by any of the health expenditure variables.

Linear regressions were also conducted for the infant mortality rate within developing nations. The results from these linear regressions were similar to those for life expectancy, none of the health expenditure independent variables could be used as a predictor for infant mortality, and there were no statistically significant relationships between health expenditure variables and infant mortality rates within the developing nations.

FIGURE 15. REGRESSION ANALYSIS OF VARIOUS PREDICTORS FOR HEALTHCARE EXPENDITURE ON INFANT MORTALITY IN DEVELOPING NATIONS.

Predictor	Constant	B	SE β	β	t-stat	Sig	R	R ²
Health spending	57.469	-3.849	3.356	-.376	-1.147	.285	.376	.141
Government spending	104.699	-1.486	.602	-.658	-2.469	.039	.658	.433
Private spending	-43.921	1.486	.602	.658	2.469	.039	.658	.433
Doctors per 10000	49.054	-1.062	.590	-.537	-1.800	.110	.537	.288

B. WEALTHY NATIONS LIFE EXPECTANCY & INFANT MORTALITY

The purpose of this analysis was to compare the effect of the predictors associated with GDP and health expenditure on health indicators between developing countries and wealthy countries. The focus of the linear regression analysis for this section is on wealth nation outcomes.

FIGURE 16. REGRESSION ANALYSIS OF VARIOUS PREDICTORS FOR HEALTHCARE EXPENDITURE ON LIFE EXPECTANCY IN WEALTHY NATIONS.

Predictor	Constant	B	SE β	β	t-stat	Sig.	R	R ²
Government spending	67.750	.178	.041	.838	4.338	.002	.838	.702
Private spending	85.566	-.178	.041	-.838	-4.338	.002	.838	.702
Per capita total spending on health	78.514	.000	.000	.346	1.044	.327	.346	.120
Per capita government spending on health	76.626	.001	.001	.616	2.215	.058	.616	.380
Doctors per 10000 pop	77.147	.106	.126	.284	.837	.427	.284	.081

The results of the multiple linear regressions suggest that once again that no significant relationships exist between the health expenditure variables and life expectancy at the $P < .001$ level of significance. However at a level of significant of $P < .01$ both government and private spending as a percentage of healthcare spending could be used as predictors of life expectancy, unlike the developing nations where the closes statistical significance was at $p \leq 0.1$. Government and private spending t-stat (4.338 & -4.338), $p < 0.01$. The correlation between government/ private spending and life expectancy is quite strong ($R = .838$) and the degree of life expectancy variation that can be explained by government/private spending is approximately 70% ($R^2 = .702$).

The following two figures (17 and 18), graphically represent the relationship between government and private spending as it relates to life expectancy within wealthy nations.

FIGURE 17. THE GOVERNMENT SPENDING ON HEALTH AS A PERCENTAGE OF ALL HEALTH SPENDING AS A PREDICTOR FOR LIFE EXPECTANCY IN WEALTHY NATIONS.

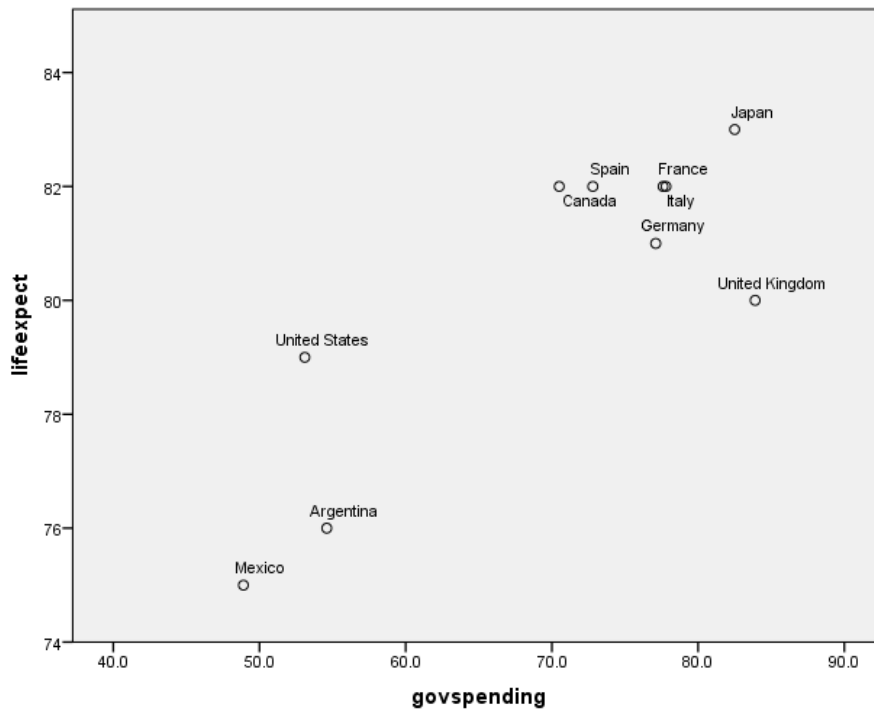
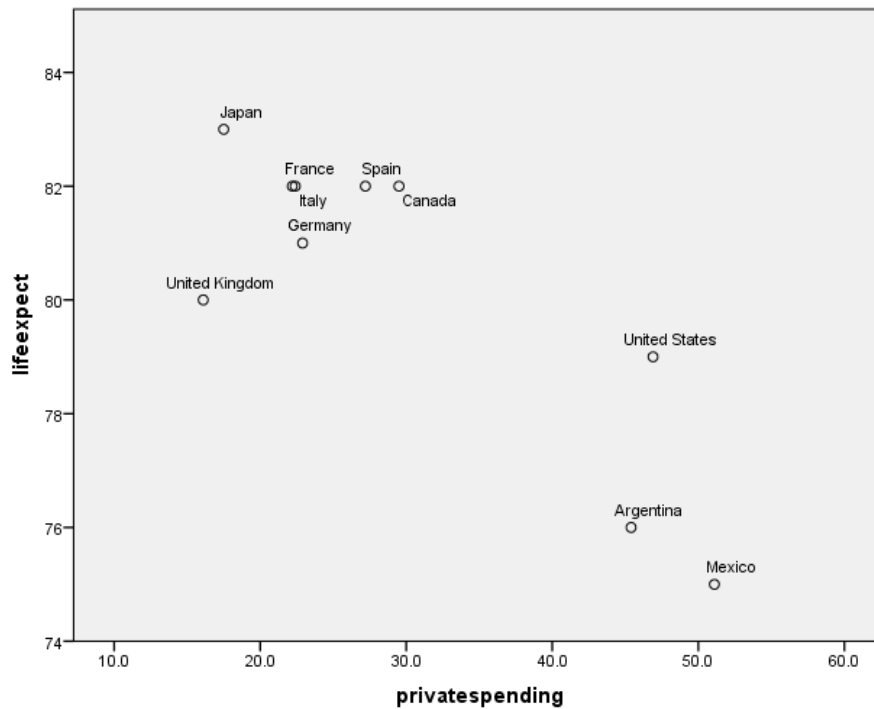


FIGURE 18. THE PRIVATE SPENDING ON HEALTH AS A PERCENTAGE OF ALL HEALTH SPENDING AS A PREDICTOR FOR LIFE EXPECTANCY IN WEALTHY NATIONS.



The final set of linear regression analysis conducted are the health expenditure variables as predictors for infant mortality rate only within wealthy nations. Figure 19 gives a breakdown of the results from the regression analysis.

FIGURE 19. REGRESSION ANALYSIS OF VARIOUS PREDICTORS FOR HEALTHCARE EXPENDITURE ON INFANT MORTALITY IN WEALTHY NATIONS.

Predictor	Constant	B	SE β	β	t-stat	Sig.	R	R ²
Health spending	12.083	-.578	.457	-.408	-1.265	.241	.408	.167
Government spending	26.304	-.291	.062	-.856	-4.692	.002	.856	.733
Private spending	-2.751	.291	.062	.856	4.692	.002	.856	.733
Per capita total spending on health	9.724	-.001	.001	-.480	-1.546	.161	.480	.230
Per capita government spending on health	12.830	-.003	.001	-.739	-3.100	.015	.739	.546
Doctors per 10000 pop	11.207	-.180	.200	-.303	-.901	.394	.303	.092

The results of the infant mortality rate as the health indicator mirror the results of life expectancy within wealthy nations. The closest two health expenditure variables that may be used to predict infant mortality are government and private spending, but once again only in the level of significance is held at $p < .01$. Government and private spending t-stat (4.692, -4.692), $p < .002$. The correlation between government and private spending and infant mortality rate is quite strong ($R = .856$) and the degree of infant mortality rate variance that can be explained by government/ private spending is approximately 73% ($R^2 = .733$). Graphical representation of these relationships between infant mortality rate and government and private spending can be seen in figure 20 and 21.

FIGURE 20. THE GOVERNMENT SPENDING ON HEALTH AS A PERCENTAGE OF ALL HEALTH SPENDING AS A PREDICTOR FOR INFANT MORTALITY IN WEALTHY NATIONS.

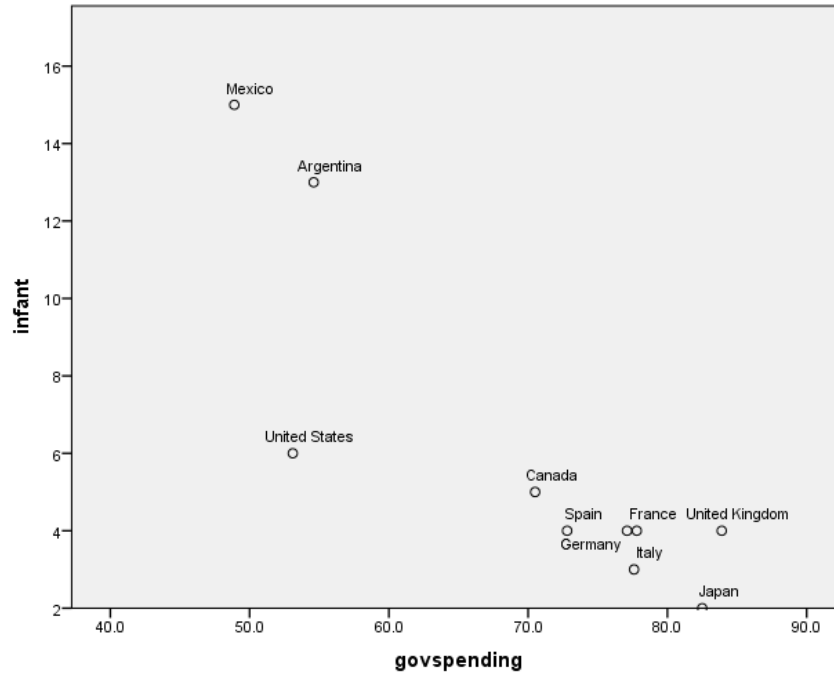
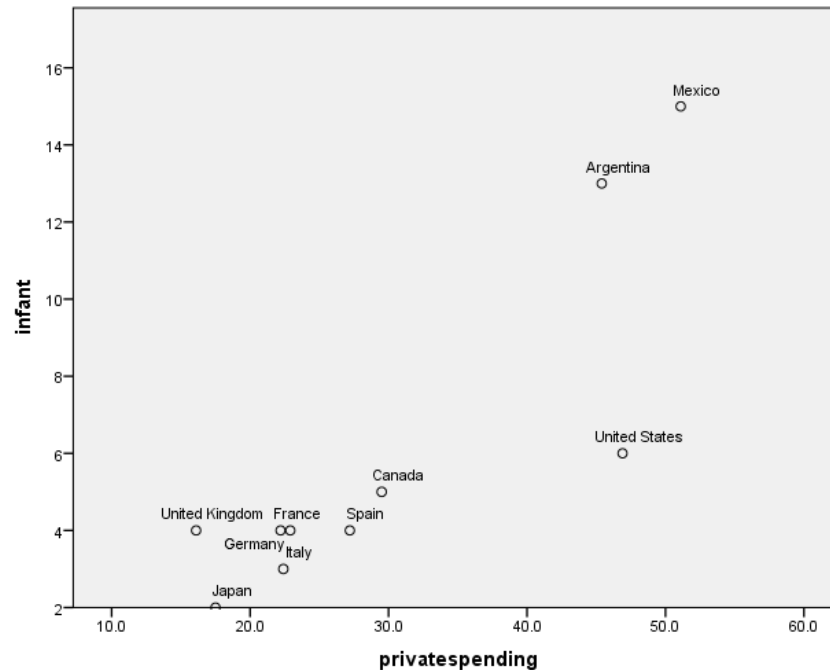


FIGURE 25. THE PRIVATE SPENDING ON HEALTH AS A PERCENTAGE OF ALL HEALTH SPENDING AS A PREDICTOR FOR INFANT MORTALITY IN WEALTHY NATIONS.



6. DISCUSSION

6.1. EXAMINATION OF THE RESULTS

Results from the linear regression analysis have highlighted a variety of noteworthy trends in the relationship between health expenditure and health predictors. The following section will discuss the role of government spending on health as the strongest predictor health expenditure variable and how this may be observed and applied to varying nations. It will also consider the rationality of government funding per/capita and doctors per 10 000 population as being some of the stronger predictors of health in both countries. Results elicited particularly interesting trends when the sample was divided into wealthy and developing nations. This section will aim to address why these trends might have been observed and what it may mean for all nations.

The degree with which government/private spending as a percentage of total health spending can be used to predict for health indicators was most significant in both health indicators for both developing and wealthy nations. When considering all countries together, as the percentage of government funding to health services increased by one percent the life expectancy increased by approximately .39 years and infant mortality rate decreased by approximately 1.1.

Additionally, regardless of wealth or development, the per-capita government spending also had a strong correlation with health indicators. For each dollar increase in per-capita government funding the life expectancy of the population increased by only .001 years and the infant mortality rate decreased by .011. These results align with our previous findings on the strength of government spending as a percentage of total health spending for predicting health indicators.

If the percentage of government funding towards health care increases then it would make sense that the per-capita government spending on health care would also increase. As is seen in the results the higher the percentage of funding allocated to health care and the greater the dollar amount of funding provided by the government towards healthcare, the more promising the effects on health (longer life expectancy and a smaller number of infant mortality rates).

Governments of countries that have higher GDP per-capita contribute both a higher percentage of their GDP to healthcare or provide greater funds per capita towards it. This trend may be explained by the fact that countries with higher GDP have more funds available to commit to other programs and endeavors in their countries while still have enough to cover health services. Nations like Nigeria, India and China all have lower GDP per capita, which could be attributed to the fact that they all have among the highest populations of all countries examined.

Developing countries were anywhere from four to ten times more heavily populated than the wealthy nations. This increase in population might speak to the government's inability to provide sufficient funding towards health services to effect a strong enough response on health of the population. Government in developing nations are responsible for providing all services in all government ministries to the entirety of its very large populations, spreading the GDP even thinner across the varying services. Wealthy nations have less heavily populated countries which may result in government funding providing a greater impact for each individual versus the reach of funding in developing nations.

Another interesting trend noted in the results was the strength of the number of doctors per 10 000 in population as a predictor of health indicators. The strength of this relationship was particularly stronger when both countries were considered together. When comparing between the two health indicators the number of doctors per 10 000 in population was a stronger predictor for infant mortality rate than for life expectancy at birth. The developing countries had a lower quantity of doctors per 10 000 than the wealthy countries and potentially as a result had higher infant mortality rates. The negative correlation indicated that as the number of doctors increased the rate of infant mortality decreased by approximately 1.25, where the relationship between doctors and life expectancy showed that for every additional doctor available per 10 000 in population the life expectancy of the citizens only increased by approximately .4 years.

One possible reason for why the effect of the number of doctors on infant mortality rate is greater than for life expectancy may be due to the nature of the health indicators. Having direct contact and medical guidance from doctors at birth can immediately affect the outcome of infant mortality. Simply said, having more doctors available will increase the amount of infants that survive within their first year, the effect is direct and immediate. Life expectancy has the added component of a variety of medical issues taking place over a lifetime, meaning the effect of the number of doctors available per 10 000 population may be diluted due to the less immediate measurable and the inability to account for all extraneous variables.

When separating the wealthy from developing nations in the exploration of the correlations between health expenditure and health indicators, it was interesting to discover that none of the health expenditure variables could be used as predictors for health in developing nations. The closest any of the health expenditure variables came to being a strong predictor for health was government funding within wealthy nations and only at the $p < 0.01$ levels representing an increase in .18 years in life expectancy and decrease of .29 in infant mortality.

It stands to reason that when the sample was essentially cut in half the power of the analysis decreased and if a larger sample size was observed there may have been changes in the results.

When all nations were considered together it provided a range of outputs covering life expectancy from approximately 49 years of age in South Africa to 84 years of age in Japan. As was observed in the Preston curve most countries that had a higher GDP per capita experienced a corresponding increase in life expectancy. It is potential that when the sample size was cut in half and developing nations were analyzed separate from wealthy nations the variation of results in both life expectancy and infant mortality rate was too large to indicate any correlation. To help offset this variability in the data a larger sample size developing countries will need to be assessed. The same is true for the wealthy nations, as they produced a potentially stronger relationship between health expenditures and health indicators, however not to the same strength as all nations considered together.

6.2. HOW THESE RESULTS RELATE TO THE PARADOX

The results from this analysis have highlighted the importance of government funding in health services in order to positively affect a nations health (increased life expectancy and decreased infant mortality rates). As previously discussed the total GDP of a nation is related to the government's ability to provide additional funding into health service. These results feed into the paradox discussed in the literature review. Does it stand to reason that the health of a nation brings about a raise in GDP or is it the greater GDP facilitating a healthier nation? This study illustrates that some health expenditure variables are better predictors of health indicators than others within a global context.

The role of the government in providing funding and health services to a nation is one of the strongest predictors of health when all variables are considered.

Although further and more in-depth analysis is required to assess in what exact capacities this funding effects health, this study provides a starting point for future analysis and exploration. In terms of the originally discussed paradox it stands to reason that especially in developing nations where the labor resource is highly dependent on the health of the individuals, investing greater funds into health care will result in a healthier and more productive work force. This study indicates at a very basic level that countries with smaller GDP per capita should assess how it best distributes its funding and should consider increased funding to health care as an investment into the potential economic growth of the nation.

It is true that wealthy nations with higher GDP per capita are at an advantage, being able to commit great portions of its GDP to health while still maintaining a high quality of services in other ministries such as education, technology, business and development, all factors that can also increase the economic growth of a nation. Another advantage that wealthy nations tend to have over developing nations is the population size. As previously discussed the wealthier nations on average had a population size of approximately 88 million people while the developing nations had on average a population size of approximately 350 million people.

This increase in population size dilutes any additional funding per capita the government may contribute to health services, making the impact less effective than what may be seen in wealthy nations.

7. FUTURE RESEARCH AND CONCLUSION

7.1. FUTURE RESEARCH

This study brought to light some interesting trends between GDP and health expenditure of both developing and wealthy nations and the effect these variables had on the health of a nation. Much more research can be conducted in this field to explore in more depth and direction of government spending on health such as: which programs are governments investing in, are their more impactful programs that could elicit better national health conditions and does the selection of the program depend on the development and wealth of the nations. For example, would funding be better spend on primary health care and female and maternity care/education in developing nations than in wealthy nations? This is one potential area that may be well suited for further research.

Future studies may also consider multiple regression analysis, assessing the interaction affect between multiple health expenditure variables on health indicators. The wealth of data available from the WHO is quite extensive and allows for a plethora of addition areas of study. It would also be interesting to re-examine the separation of developing from wealthy nations with greater sample sizes, also possible through data from WHO. Having a greater sample size for both groups will provide a more accurate and

representative portrayal of the strength of health expenditure variables on the health of a nation.

The prediction equation created through this study may also be used to project the life expectancy and infant mortality rate of varying nations depending on the health expenditure variable assessed.

7.2. CONCLUSION

Although these results only touch the surface of the role of health expenditure on the health of a population they do highlight the importance of the increased funding to health services by governments in developing countries. Healthier populations increase the productivity of labor resource thus improving the economic growth of the nation.

Although these extrapolations are very rudimentary and not take into account the population size of the country and the current focus of health funding by the governments; they do provide interesting considerations for governments of developing nations in how to invest in future economic growth of its country.

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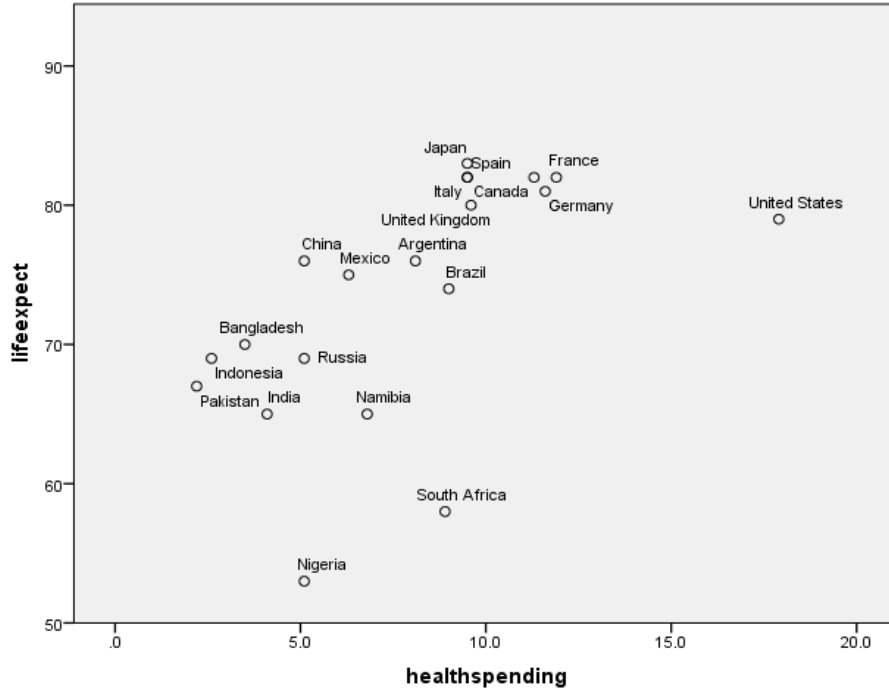
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APPENDIX A: WHO HEALTH EXPENDITURE MEASUREMENTS AND HEALTH PREDICTORS ACCUMULATED DATASET FOR 2011 AND 2012 FOR A SELECTION OF WEALTH AND DEVELOPING NATIONS.

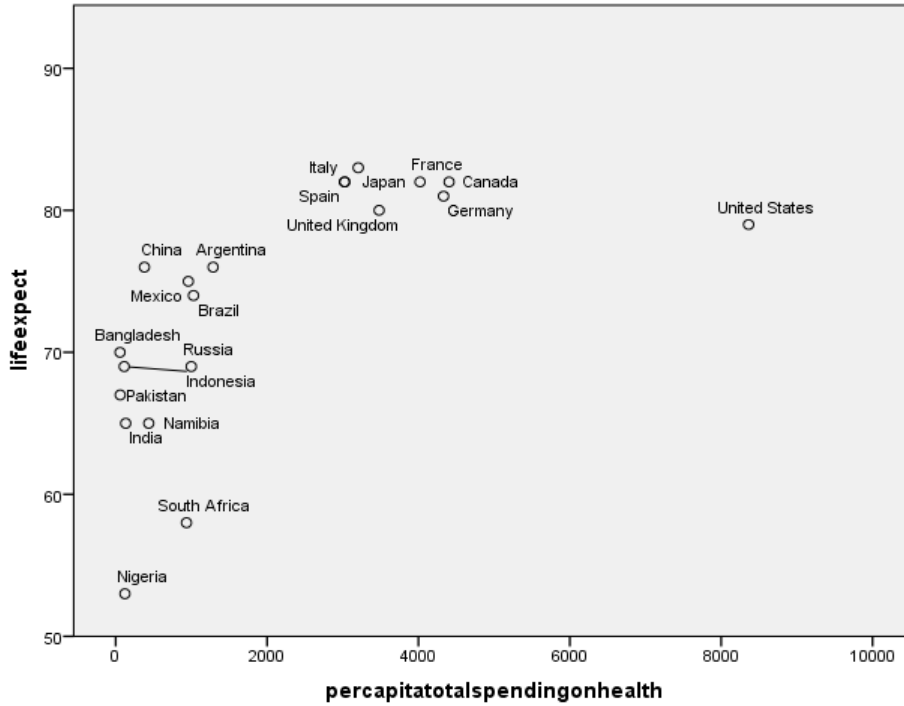
Location	ISO country code	Infant mortality rate (probability of dying between birth and age 1 per 1000 live births) 2010	life expectancy at birth (2011)	Health spending, % of GDP	Government spending on health as % of all health spending	Private spending on health as % of all health spending	Private prepaid plans as % of private spending on health	Per capita total spending on health (PPP int. \$)	Per capita government spending on health (PPP int. \$)	Doctors, per 10,000 population
Nigeria	NG	83	53	5.1	37.9	62.1	3.1	121	46	3.95
Namibia	NA	31	65	6.8	58.4	41.6	61.2	436	254	3.74
South Africa	ZA	35	58	8.9	44.1	55.9	66.1	935	412	7.7
Bangladesh	BD	38	70	3.5	33.6	66.4	0.3	57	19	2.95
Pakistan	PK	72	67	2.2	38.5	61.5	0.4	59	23	8.13
Indonesia	ID	28	69	2.6	49.1	50.9	3	112	55	2.88
India	IN	47	65	4.1	29.2	70.8	4.6	132	39	6.49
Russia	RU	10	69	5.1	62.1	37.9	9.9	998	620	43.089
Brazil	BR	15	74	9	47	53	40.4	1028	483	17.64
China	CN	14	76	5.1	53.6	46.4	6.9	379	203	14.15
Mexico	MX	15	75	6.3	48.9	51.1	7.8	959	469	19.59
Argentina	AR	13	76	8.1	54.6	45.4	25.3	1287	703	31.55
Spain	ES	4	82	9.5	72.8	27.2	20.3	3027	2204	39.57
Italy	IT	3	82	9.5	77.6	22.4	4.6	3022	2345	34.86
France	FR	4	82	11.9	77.8	22.2	60.1	4021	3130	34.47
United Kingdom	GB	4	80	9.6	83.9	16.1	6.5	3480	2919	27.43
Germany	DE	4	81	11.6	77.1	22.9	40.3	4332	3339	36.01
Japan	JP	2	83	9.5	82.5	17.5	12.7	3204	2644	21.42
Canada	CA	5	82	11.3	70.5	29.5	43.3	4404	3104	19.8
United States	US	6	79	17.9	53.1	46.9	67.8	8362	4437	24.22
Mean		21.65	73.4	7.88	57.615	42.385	24.23	2017.75	1372.4	19.98195
Standard Deviation		23.36	8.65	3.80	17.07	17.07	24.31	2168.99	1452.41	13.4389992

APPENDIX B: ADDITIONAL REGRESSION ANALYSIS GRAPHICAL REPRESENTATION OF RELATIONSHIPS BETWEEN HEALTH EXPENDITURE VARIABLES AND PREDICTORS FOR HEALTH.

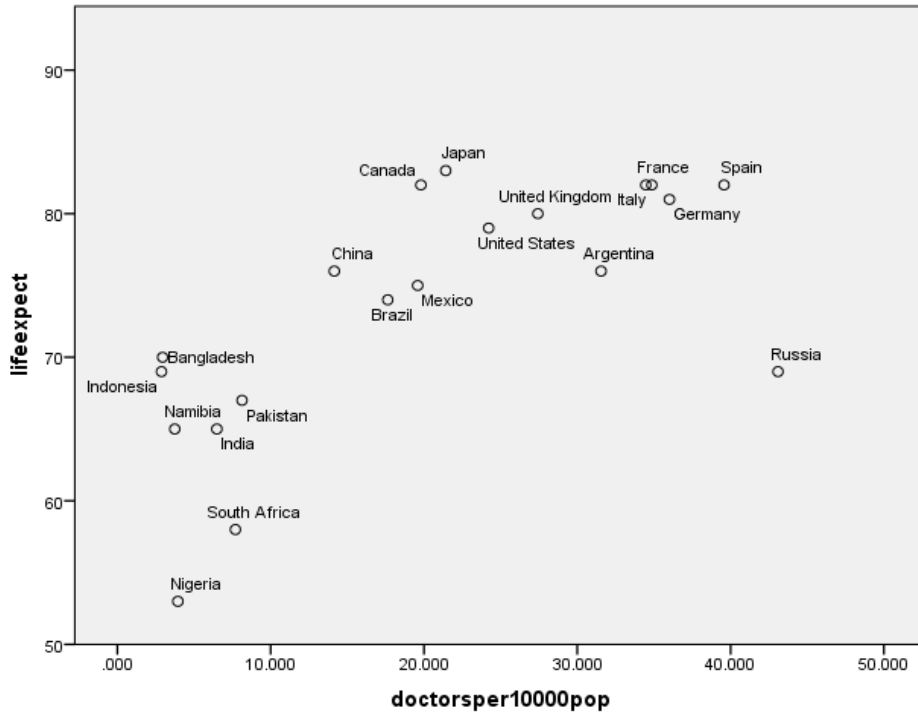
THE HEALTH SPENDING FOR BOTH WEALTHY AND DEVELOPING NATIONS AS A PERCENTAGE OF GDP AS A PREDICTOR FOR LIFE EXPECTANCY.



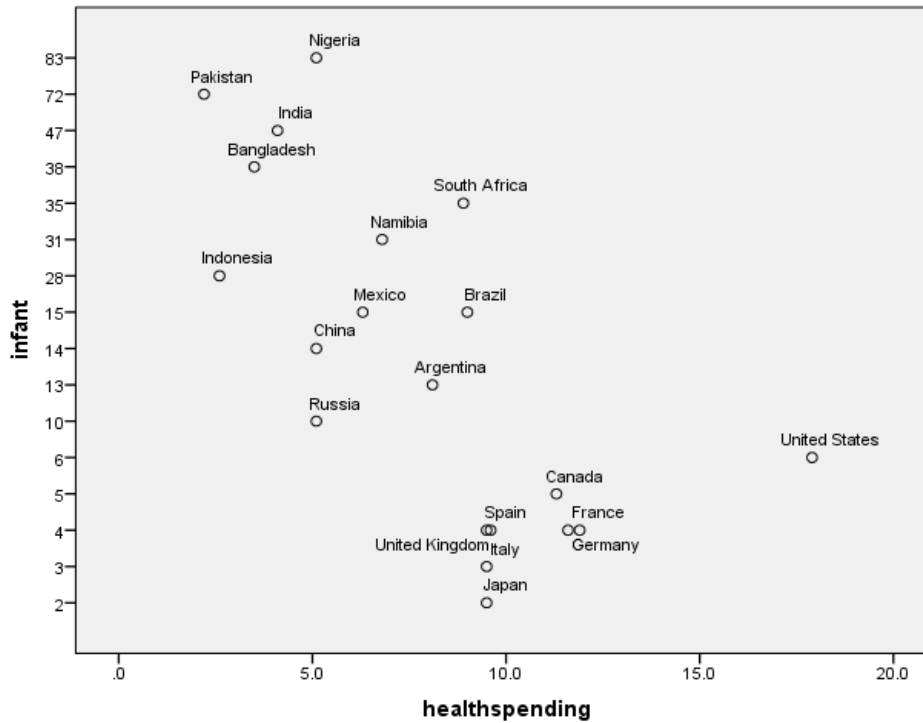
THE PER CAPITA TOTAL SPENDING ON HEALTH (PPP INT. \$) AS A PREDICTOR FOR LIFE EXPECTANCY.



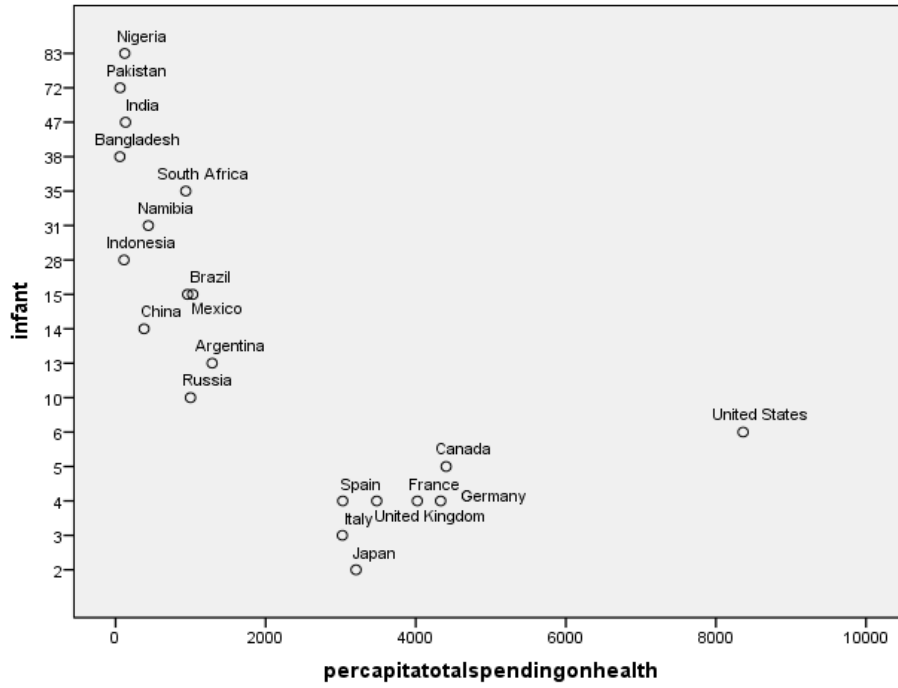
THE NUMBER OF DOCTORS AVAILABLE FOR EVERY 10,000 PEOPLE AS A PREDICTOR FOR LIFE EXPECTANCY.



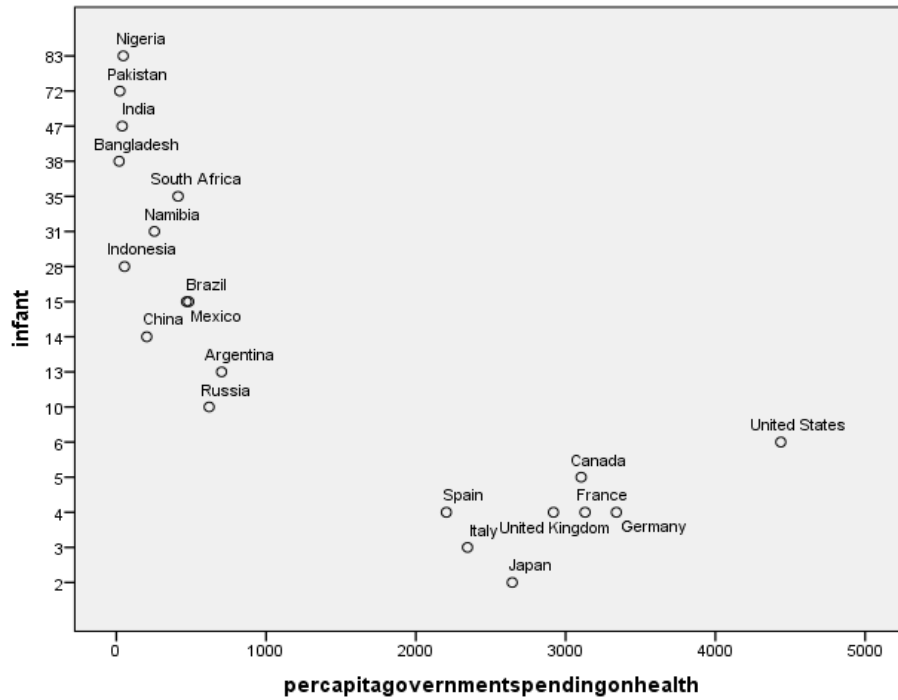
THE HEALTH SPENDING OF BOTH WEALTHY AND DEVELOPING NATIONS AS A PERCENTAGE OF GDP AS A PREDICTOR FOR INFANT MORTALITY.



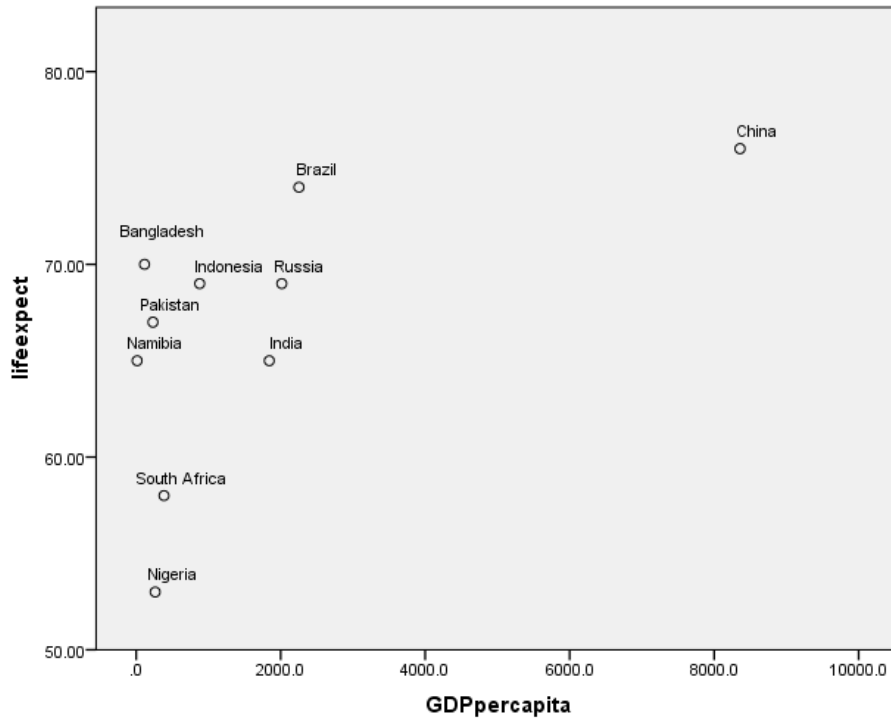
THE PER CAPITA TOTAL SPENDING ON HEALTH (PPP INT. \$) FOR BOTH WEALTHY AND DEVELOPING NATIONS AS A PREDICTOR FOR INFANT MORTALITY.



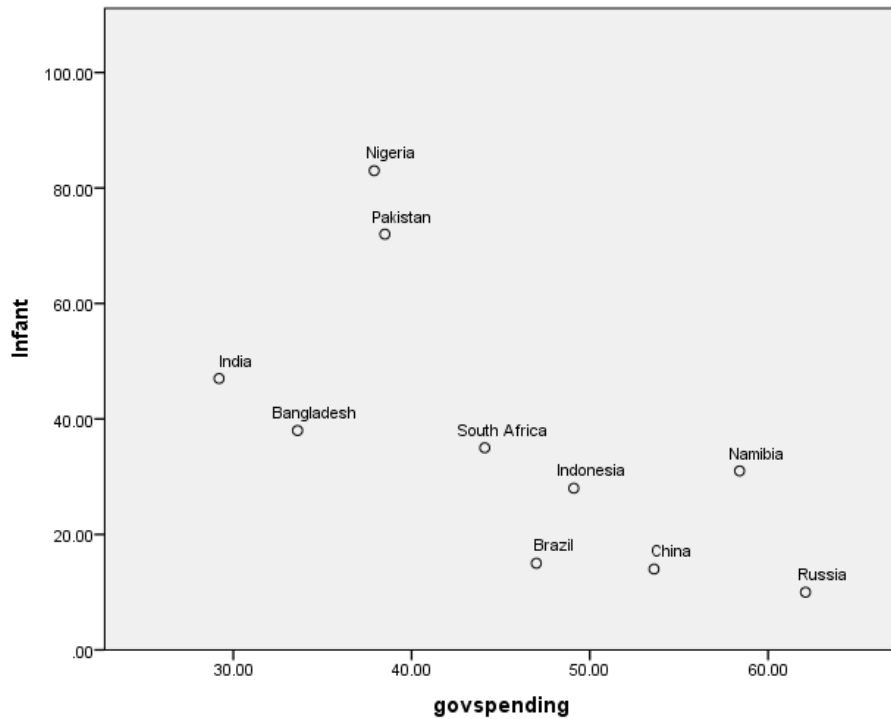
THE PER CAPITA GOVERNMENT SPENDING ON HEALTH (PPP INT. \$) FOR BOTH WEALTHY AND DEVELOPING NATIONS AS A PREDICTOR FOR INFANT MORTALITY.



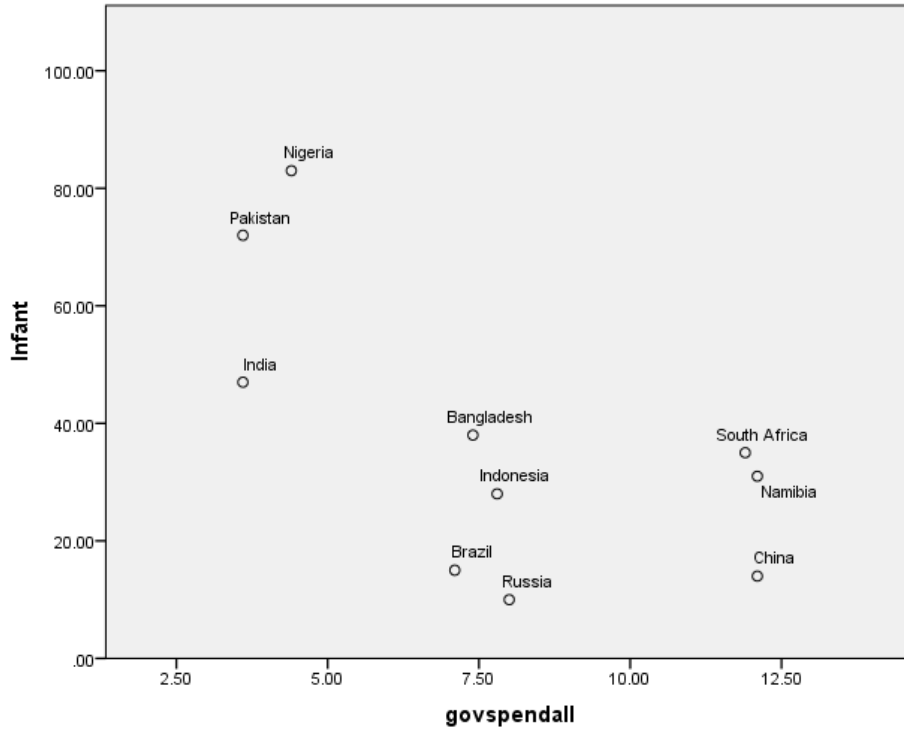
THE GDP PER CAPITA AS A PREDICTOR FOR LIFE EXPECTANCY WITHIN DEVELOPING NATIONS.



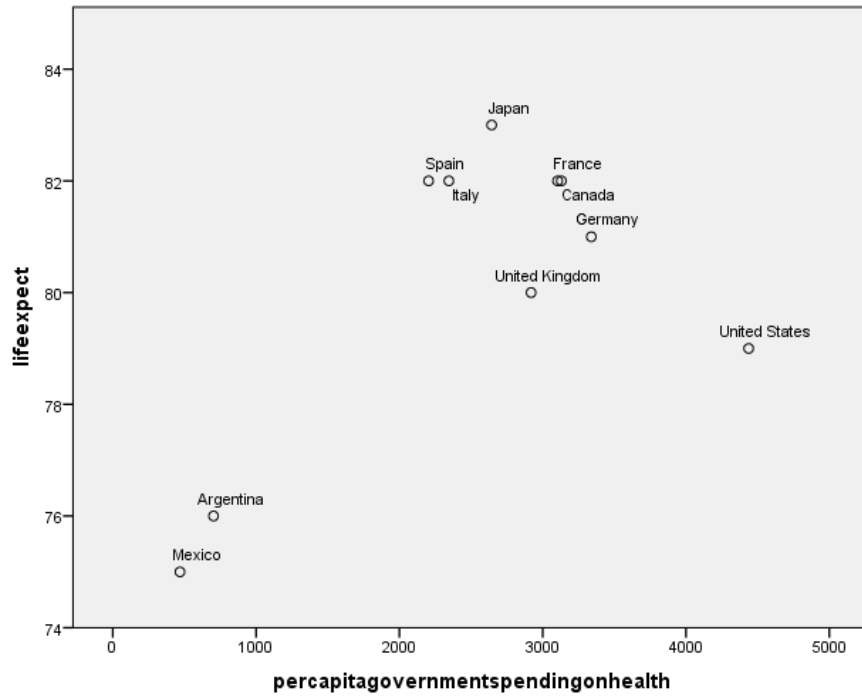
THE GOVERNMENT SPENDING ON HEALTH AS A PERCENTAGE OF ALL HEALTH SPENDING AS A PREDICTOR FOR INFANT MORTALITY IN DEVELOPING NATIONS.



THE GOVERNMENT SPENDING ON HEALTH AS A PERCENTAGE OF ALL SPENDING AS A PREDICTOR FOR INFANT MORTALITY IN DEVELOPING NATIONS.



THE PER CAPITA GOVERNMENT SPENDING ON HEALTH (PPP INT. \$) AS A PREDICTOR FOR LIFE EXPECTANCY IN WEALTHY NATIONS.



**MAJOR RESEARCH PROJECT – EXPLORING THE RELATIONSHIP BETWEEN HEALTH AND
ECONOMIC GROWTH IN DEVELOPING AND WEALTHY NATIONS**

THE PER CAPITA GOVERNMENT SPENDING ON HEALTH (PPP INT. \$) AS A PREDICTOR FOR INFANT MORTALITY IN WEALTHY NATIONS.

