The Impact of Health Expenditure on Life Expectancy and Mortality Rates

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Abstract

This study examines the impact of health expenditure on health outcomes such as: life expectancy, infant mortality and under-5 mortality rates. Establishing a relationship between health expenditure and health outcomes is very complex because several outside factors other than health expenditure contribute to health outcomes. This study observes data from 2010 to 2017 globally for 217 countries. Numerous variables are used in the analysis of this study.

The empirical results indicate that an increase in total health expenditure has a significant positive impact on health outcomes. Public health expenditure positively significantly impacts infant and under-5 mortality rates, any change in life expectancy is insignificant. Private health expenditure positively significantly impacts life expectancy, any change in infant and under-5 mortality rates is insignificant. Environmental variables show to have more impact on males compared to females, total health expenditure and the number of physicians impact males more than females.

I. Introduction

If an individual has poor health it can impact their quality of life, but it also can have an impact on the overall economy of the country. When in poor health an individual cannot participate in the workforce and other facets of the economy. If an individual cannot afford investments in their health or these services are simply not provided by the government, we see negative impacts on health outcomes for adults and children likewise. According to the World Health Organization, nearly nine million children under the age of five die every year. Around 70% of these deaths are from diseases that could have been treated with access to basic healthcare (WHO).

"We can end poverty" is the mission statement for the UN's MDGs (the Millennium Development goals). This is a global effort in reducing poverty by implementing eight goals. The goals range from eradicating extreme poverty and hunger to reducing child mortality rates and so on. To achieve these goals, the Group of Eight in 2005, paid the World Bank, the IMF and the African Development Bank to cancel the debt owed by developing countries. This was done to ease the financial burden of these developing countries such that they could redirect their resources to healthcare and education expenditure. Many countries that received this forgiveness increased healthcare expenditure; some accomplished the set MDGs and others accomplished nothing. This sparks the argument of how effective healthcare expenditure is on health outcomes such as life expectancy and child mortality rates.

What is the impact of health expenditure on life expectancy and mortality rates? I believe this question is worthy of study because if the data shows that health expenditure has an effect on lifespan and mortality rates. This can assist public officials in decisions regarding investment in

public health. There is disagreement in the literature whether health expenditure has any impact at all on health outcomes. Some studies, such as Gupta (2003) concluded that the effect of health expenditure on health outcomes is weak. Others have found that health expenditure does not have any impact on health outcomes (Musgrove 1996). Instead Nixon and Ulmann (2006) indicate a significant positive effect between the variables. My research will be centered on estimating the effect of health expenditure on two health outcomes, life expectancy at birth and mortality rates.

II. Literature Review

The starting point for all research regarding the demand for health is Michael Grossman's "The Demand for Health: A Theoretical and Empirical investigation" (1972) It is different from previous research because the approach forms a distinction between commodities and market goods. The commodity of good health is treated as a durable item. Grossman states that individuals take part in health producing activities on their own time and then complement it by purchasing medical inputs to improve health status. Individuals inherit an initial stock of health that depreciates over time and this can be increased by adding investment into health. Direct inputs into the production of gross investments in the stock of health include own time, medical care, diet, exercise, housing, and other market goods as well (Grossman 1972). Along with direct input there are environmental factors which includes variables such as education. However, in 2000 Grossman developed the Health Production Function approach which follows the traditional model of the production function and views the health system as a production unit with the goal of producing health care. In this case health is a commodity that is produced by the health system.

In 2006, Nixon and Ulmann employed the Health Production Function approach to view health as an output of the health care system. Nixon and Ulmann went further and viewed the impact of health expenditure on males and on females. They reported a relatively weak impact of health care on life expectancy. However, they found a significant contribution of health care expenditure in improving infant mortality rates. Similarly, Bokhari, Gai, and Gottret (2006) also employed the use of the Health Production Function approach to observe the impact of government health expenditures on health outcomes. They chose to study under-five mortality rates and maternal mortality rates because government health expenditures often consist of budgets for sub-sectors, within the health care sectors such as primary care, secondary care (Bokhari, Gai and Gottret 2006). The under-five mortality rate is viewed as a primary care while maternal mortality rates is viewed as an outcome from secondary care. Both of these studies found mixed results. Nixon and Ulmann found that increases in healthcare expenditure only affected health outcomes marginally, while Bokhari, Gai and Gottret found other variables to be significant such as paved road networks, education, and income.

The next paper being reviewed is "Health Expenditure, Health Outcome and the role of good governance by Marwa Farag, AK Nandakumar, Stanley Wallack and Dominic Hodgkin. The goal of this paper is to indicate that a country's level of development in general and economic development in particular is what matters for population health (Farag 2013). Up until this time a limited number of studies recorded evidence for the effect of a country's health spending on population health outcomes. However, the ones that existed were critiqued for small sample sizes. This study included 133 low- and middle-income countries and views the impact of healthcare expenditure on infant and child mortality rates. With this expanded dataset the

evidence of the effect of a country's health spending should be clearer. The goal is to help guide these low-income countries to achieve the set MDGs.

The paper by Eric Arthur and Hassan Oaikhenan argues there is a difference in the impact of public expenditure and private expenditure on health outcomes. They employ the Grossman model on data from Sub-Saharan Africa. Health is inherited and needs investment to prevent depreciation. The results are interesting because they are significant but inelastic for overall health expenditure's effect on health outcomes. When healthcare expenditure is separated between public and private, public expenditure significantly improved mortality rates in infants and under-five children, while having no significant effect on life expectancy. Private expenditure, is positively significantly affects life expectancy, while having no significant effect on infant and under-five mortality rates.

A recent study by Boachie, Ramu and Polajeva (2018), continues to examine public health expenditures and health outcomes: using data from Ghana. Health expenditure is an input in the production of given health outcomes. This study focuses on Ghana because health outcomes remain low due to high malnutrition, morbidity, and mortality compared to the global average. Earlier studies have produced conflicting results. In this study public health expenditure was found to be statistically significant in infant mortality rate reductions and life expectancy increases.

Based on the literature, measuring the effects of health expenditure on health outcomes yields mixed results. What is the impact of health expenditure on life expectancy and mortality rates? The purpose of this study is to determine whether health expenditure has any significant influence on health outcomes, while observing the different effects of private and public health expenditure and the impact on males and on females. All previous research either observed

public vs private expenditure or male vs female impact, I am combining both ideas. Similar environmental variables from previous studies will be used such as: access to safely managed drinking water, access to proper sanitation services and immunization rates for diseases such as DPT and measles. The dataset being used is the most recently updated World Bank data. All countries will be included. As well a fixed effect model is used to assist in controlling for omitted variable bias.

III. Theoretical Model

The theoretical background of this topic can be traced back to 1972 when Michael Grossman developed the Grossman Model of Health Demand.

$$H = F(X) \quad (1)$$

In the equation above H is a measure of individual health output and X is a vector of individual inputs to the health production function F. The elements of the vector include: nutrient intake, income, consumption of public goods, education, time devoted to health-related procedures, initial individual endowments like genetic makeup, and community endowments such as the environment (Grossman). The Grossman Model was then further specified by Fayissa and Gutema (2005).

$$H = F(Y, S, V, D) \quad (2)$$

The major difference between the two above equations is that the original theoretical model analyzes health production on the micro level, while the revised model analyzes the production at the macro level. H is still a vector of health outcomes. While Y is a vector of per capita

economic variables (income and health expenditure), S is a vector of social variables (education and population age), V is a vector of environmental factors (sanitation, prevalence of diseases and availability of water) and D is a vector of health service variables (rate of immunization).

$$H = F (y_1 , y_2 , \ldots, y_n; s_1 , s_2 , \ldots, s_n; v_1 , v_2 , \ldots, v_n; d_1 , d_2 , \ldots , d_n;) \quad (3)$$

In its scalar form equation (2) is represented by equation (3). Where $Y = (y_1, y_2, \ldots y_n)$; $S = (s_1, s_2, \ldots s_n)$; $V = (v_1, v_2, \ldots v_n)$; and $D = (d_1, d_2, \ldots d_n)$. n represents the number of variables in each sub-group.

IV. Empirical Model

$$\ln H = \ln \Omega + \sum \alpha_i (\ln y_i) + \sum \beta_i (\ln s_i) + \sum \lambda_i (\ln v_i) + \sum \gamma_i (\ln d_i) \quad (4)$$

Equation 4 combines the elasticities and the sums of all the sub-categories. α_1, β_1, λ_1, and γ_1 are the elasticities. From the Grossman Model, Ω is an estimate of the initial health stock. Likewise, Ω is assumed to be inherited from parents. $\sum$ is a summation operator which sums all the factors within each sub-category. ln H is the log of health outcomes, ln y_i is the log of economic variables, ln s_i is the log of social variables, ln v_i is the log of environmental variables and ln d_i is the log of health service variables.

$$\ln H_{it} = \alpha_0 + \alpha_1 \ln THE_{it} + \alpha_2 \ln S_{it} + \alpha_3 \ln V_{it} + \alpha_4 \ln D_{it} + u_{it} \quad (5)$$

$$\ln H_{it} = \beta_0 + \beta_1 \ln PRI_{it} + \beta_2 \ln PUB_{it} + \beta_3 \ln S_{it} + \beta_4 \ln V_{it} + \beta_5 \ln D_{it} + u_{it} \quad (6)$$

In equations 5 and 6, health outcomes (H_{it}) is proxied with life expectancy (LE), infant mortality rates (IMR), and under-5 mortality rates (U5MR). In equation 5, total health expenditure is used to measure health investment (THE). In equation 6, (PRI) and (PUB) represent private and public health expenditure respectively. $\boldsymbol{\alpha}_0$ and β_0 are the intercepts. As for $\boldsymbol{\alpha}$ and β represent the coefficients of the explanatory variables such as income, education and immunization rates. The explanatory variables include: GDP per capita, total healthcare expenditure, private healthcare expenditure, public healthcare expenditure, access to safely managed drinking water, access to basic sanitation services, immunization rate of DPT, immunization rate of measles, prevalence of HIV and number of physicians. For life expectancy, GDP per capita total healthcare expenditure, private healthcare expenditure, public healthcare expenditure, access to safely managed drinking water, access to basic sanitation services, immunization rate of DPT, immunization rate of measles, and number of physicians all are expected to have a positive sign (an increase in life expectancy). The prevalence of HIV is expected to have a negative sign. For infant and under-5 mortality rates, GDP per capita total healthcare expenditure, private healthcare expenditure, public healthcare expenditure, access to safely managed drinking water, access to basic sanitation services, immunization rate of DPT, immunization rate of measles, and number of physicians are expected to have a negative sign (decrease in the number of deaths). The prevalence of HIV is expected to hold a positive sign. U_{it} is the error term. The data ranges from 2010 to 2017 for 217 countries globally. However, some countries will not be included in the data because some did not have complete data for the viewed time period.

Table 1 contains the means and variances of dependent and explanatory variables used in this study. The immunization rates for DPT and measles have been recorded to be relatively high at 88.49 and 87.89 percent with standard deviation of 13.58 and 12.93 percent. Access to drinking water and proper sanitation services are average at 78.13 and 75.51 percent Lastly the prevalence of HIV is low at 1.95 percent.

For the empirical analysis, a fixed effect model is used to estimate the effects of health expenditure and other variables on health outcomes. A fixed effect model is used in order to assist in controlling for omitted variable bias due to unobserved heterogeneity when heterogeneity is constant over time. Omitted variables could include death from war or death from an accident, in which the healthcare system cannot prevent. All countries globally were used in order to obtain a large enough dataset. Tables 2 through 5 represent the results from the fixed effect model.

V. Results

The results indicate that the regressions in tables 2 through 5 explain between 77 and 85 percent of the variation in the data. The coefficients represent the change in health outcomes resulting from a one percent change in any of the explanatory variables. The data suggests that total health expenditure has a significant effect on health outcomes. A positive and significant coefficient is recorded for life expectancy (positive coefficient means an increase in life expectancy), while a negative and significant coefficient is recorded for under-5 and infant mortality rates (negative coefficient means a decrease in mortality rates). Tables 3 and 4 express the results of public and private health expenditure. In table 3 public expenditure significantly impacted under-5 and infant mortality rates with the expected sign, which is negative. However, life expectancy had the expected sign (positive) but the results were weakly significant. In table

4, which expresses private expenditure, life expectancy was recorded to be significant while under-5 and infant mortality rates were insignificant, all had their expected signs respectively. Specifically, a 1% increase in total healthcare expenditure will positively affect all health outcomes. A 1% increase will increase life expectancy by 2.625 percent and decrease under-5 and infant mortality rates by 1.512 and 1.785 percent respectively. As for public health expenditure a 1 percent increase in expenditure results in a 5.348 and 4.272 percent decrease in under-5 and infant mortality rates respectively. Table 5 views the impact on health outcomes of males and females. A 1% increase in total health expenditure results in a 2.735 and 2.356 percent increase for males and females respectively. A 1% increase in the prevalence of HIV has a much more detrimental impact on males. A 2.019 and 1.501 decrease in life expectancy for males and females respectively. All data regarding confidence intervals can be found in table 6.

VI. Discussion of Results

The goal of this study was to determine if health expenditure has any significant effect on health outcomes. The findings suggest health expenditure has a significant impact on life expectancy, under-5 and infant mortality rates. The addition this study brings to the existing literature is viewing the impact of total healthcare expenditure on males vs females globally. The results are mixed for the impact on males and females. Males experience a larger increase in life expectancy after a 1% increase in total health expenditure compared to females. Access to safely managed drinking water has very similar results for males and females, .023 and .029 increase in life expectancy. Access to safely managed sanitation services was also similar at a .046 percent increase for males and a .065 percent increase for females. The prevalence of HIV had a detrimental effect on males compared to females, a 1% increase in HIV leads to a 2.019 percent decrease in males and a 1.501 decrease in females. Likewise, number of physicians greatly

impacted males with a 1.391 percent increase in life expectancy. GDP per capita for males, immunization rate of DPT for males and immunization rate of measles all had expected signs but were not significant. GDP per capita and immunization rate for DPT for females did not hold the expected sign and were not significant. In the Grossman Model four variables are present that effect health outcomes, those variables include: economic, social, environmental and health services.

Given that all of the health outcomes significantly improve with the increase in health expenditure, it is recommended that governments invest in programs that help promote these health outcomes. In the Grossman Model four variables are present that effect health outcomes, those variables include: economic, social, environmental and health services. A mix of health expenditure can help achieve maximum positive health outcomes. All data regarding confidence intervals can be found in table 6. The addition this study brings to the existing literature is viewing the impact of total healthcare expenditure on males vs females globally. Several of the variables experience produce similar results such as total healthcare expenditure, access to safely managed water, and the immunization rate of measles. However, several variables are significantly different the prevalence of HIV has a much more detrimental effect of males compared to females, the prevalence of HIV reduces life expectancy in males by 2.019 percent and 1.501 percent in females.

VII. Policy Implications and Limitations

Given that all of the health outcomes significantly improve with the increase in health expenditure, it is recommended that governments invest in programs that help promote these health outcomes. The data suggests an increase in health expenditure should continue to improve health outcomes. Governments across the globe should deliver a mix of public and private

expenditure programs. An increase in public health expenditure would help promote the acquisition of up-to-date equipment and properly trained health care personnel. Public health expenditure significantly impacts under-5 and infant mortality rates. Private expenditure would allow individuals to invest in their health (the Grossman model) more programs such as an insurance programs would promote an affordable way to invest in health. Private expenditure significantly impacts life expectancy. One of the main takeaways from this study is that governments should invest much time and resources into the accessibility of safely managed drinking water and the accessibility of basic sanitation services. Both variables were shown to significantly impact both life expectancy and mortality rates with the expected sign. Specifically, one of the MDGs includes providing a sustainable management of water and sanitation.

There were some limitations to the study. The World Bank provides good data however, there was an amount of missing data for developing countries on certain variables. As well, healthcare expenditure does not always promise growth of health outcomes, these funds must be allocated to the proper services that promote good health.

VIII. Conclusion

The purpose of this study was to observe the impact of healthcare expenditure has on health outcomes such as life expectancy and mortality rates in infants and children under 5. Another goal achieved in this study was to observe the impact of total health expenditure on males compared to females. The Grossman Model was employed and a fixed effect model was used to estimate the model. The results show total healthcare expenditure has a significant and positive impact on health outcomes. Variables that were significant include access to safely managed water, access to properly managed sanitation services immunization rates of measles, and the

number of physicians per 1000 people. Public health expenditure significantly lowers mortality rates in infants and under-5 children. Variables that were significant include: include access to safely managed water, access to properly managed sanitation services and the number of physicians per 1000 people. While private health expenditure significantly increases life expectancy. Variables that were significant include: GDP per capita, access to safely managed water, access to properly managed sanitation services and the number of physicians per 1000 people. Total health expenditure has a greater impact on males compared to females from a 1% increase in total health expenditure. Variables that were significant include: access to safely managed water, access to properly managed sanitation services and the prevalence of HIV. Males also experience a much more detrimental effect when a 1% increase of the prevalence of HIV occurs compared to females. Overall, GDP per capita, access to safely managed drinking water, and the immunization rates for measles all improved health outcomes. The prevalence of HIV decreased health outcomes.

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X. Appendix

Variable	Label	N	Mean	Std. Dev	Minimum	Maximum
LEB	Life Expectancy at birth (years)	1604	71.57	8.21	45.1	85.42
LEF	Life Expectancy at birth, female (years)	1604	74.06	8.59	48.07	87.6
LEM	Life Expectancy at birth, male (years)	1604	69.16	7.99	42.42	84.1
IMR	Infant-mortality rate	1544	24.49	22.17	1.5	108.3
U5MR	Under-5 mortality rate	1544	33.1	33.78	1.8	208.6
LogGDP	LOG of GDP per capita	1642	8.77	1.48	5.46	12.15
LogTHE	LOG of total healthcare expenditure	1484	5.8	1.6	2.54	9.23
LogPRI	LOG of private healthcare expenditure	1484	4.73	1.56	0.57	8.84
LogPUB	LOG of public healthcare expenditure	1492	4.99	2.03	0.25	8.97
WAT	Access to safely managed drinking water (% of population)	872	78.13	26.53	6.19	100
SAN	Access to basic sanitation services (% of population)	1686	75.51	28.63	5.71	100
DPT	Immunization rate DPT (% of children)	1535	88.49	13.58	6	99
IRM	Immunization rate measles (% of children)	1535	87.89	12.93	25	99
HIV	Prevalence of HIV (% of population)	1120	1.95	4.48	0.1	28.2
PHY	Physicians (per 1000 people)	807	2.04	1.53	0.001	8.19

Table 1

The GLM Procedure: Total Health Expenditure and Health

Outcomes			
Explanatory Variables	LEB	U5MR	IMR
LogTHE	2.625***	-1.512***	-1.785***
	(7.40)	(-0.97)	(-1.67)
LogGDP	-0.225	(1.17)	(1.05)
	(-0.58)	(-0.97)	(-0.90)
WAT	0.025*	-0.106***	-0.093***
	(2.33)	(-2.23)	(-2.86)
SAN	-0.055***	-0.374***	-0.219***
	(4.16)	(-6.38)	(-5.47)
DPT	0.011	0.240	0.211*
	(0.29)	(1.45)	(1.87)
IRM	0.059	-0.896***	-0.639***
	(1.41)	(-4.87)	(-5.09)
HIV	-1.76***	1.229	-0.093
	(-7.43)	(1.18)	(-0.13)
PHY	-0.681***	-2.47***	-1.903***
	(-3.90)	(-3.20)	(-3.62)
Number of Observations	360	360	360
R-squared	0.846	0.774	0.795
Note: t-statistics in parentheses			
*** p <0.01, ** p < 0.05, p < 0.1			

Table 2

The GLM Procedure: Public Health Expenditure and Health Outcomes

Explanatory Variables	LEB	U5MR	IMR
LogPUB	1.862*	-5.348***	-4.272***
	(6.15)	(-4.19)	(-4.94)
LogGDP	0.171	3.627**	2.211**
	(0.43)	(2.18)	(1.96)
WAT	0.026**	-0.101***	-0.089***
	(2.40)	(-2.16)	(-2.84)
SAN	-0.051***	-0.323***	-0.182***
	(3.72)	(-5.55)	(-4.62)
DPT	0.039	0.241	0.204*
	(1.02)	(1.50)	(1.87)
IRM	0.01	-0.862***	-0.601***
	(0.23)	(-4.84)	(-4.99)
HIV	-1.614***	1.578	0.112
	(-6.74)	(1.56)	(0.16)
PHY	-0.568***	-2.021***	-1.619***
	(-3.22)	(-2.72)	(-3.22)
Number of Observations	360	360	360
R-squared	0.839	0.784	0.807

Note: t-statistics in parentheses

*** p <0.01, ** p < 0.05, p < 0.1

Table 3

The GLM Procedure: Private Health Expenditure and Health Outcomes

Explanatory Variables	LEB	U5MR	IMR
LogPRI	1.418***	-0.55	-0.655
	(5.81)	(-0.52)	(-0.92)
LogGDP	1.326***	-2.258**	-2.332***
	(5.35)	(-2.12)	(-3.21)
WAT	0.026**	-0.107**	-0.094***
	(2.31)	(-2.25)	(-2.89)
SAN	0.061***	-0.379***	-0.225***
	(4.49)	(-6.49)	(-5.65)
DPT	0.028	0.226	0.195*
	(0.73)	(1.37)	(1.73)
IRM	0.051	-0.884***	-0.625***
	(1.18)	(-4.80)	(-4.97)
HIV	-1.558***	1.088	-0.259
	(-6.49)	-1.05	(-0.37)
PHY	-0.531***	-2.591***	-2.046***
	(-3.01)	(-3.42)	(-3.95)
Number of Observations	360	360	360

R-squared	0.837	0.774	0.794
Note: t-statistics in parentheses			
*** p <0.01, ** p < 0.05, p < 0.1			

Table 4

The GLM Procedure: Total Health Expenditure and Health Outcomes

Explanatory Variables	LEM	LEF
LogTHE	2.735***	2.356***
	(7.04)	(6.55)
LogGDP	0.157	-0.449
	(0.37)	(-1.14)
WAT	0.023*	0.029***
	(1.91)	(2.67)
SAN	0.046***	0.065***
	(3.17)	(4.86)
DPT	0.047	-0.022
	(1.14)	(-0.57)
IRM	0.011	0.103**
	(0.23)	(2.43)
HIV	-2.019***	-1.501***
	(-7.78)	(-6.25)
PHY	-1.391***	0.045

	(-7.27)	(0.26)
Number of Observations	360	360
R-squared	0.817	0.851
Note: t-statistics in parentheses		
*** p <0.01, ** p < 0.05, p < 0.1		

Table 5

Ttest procedure at 95% CI			
Variables	Mean	Lower CL	Upper CL
LEB	71.56	71.16	71.97
LEM	69.16	68.77	36.55
LEF	74.06	73.64	74.48
IMR	24.5	23.39	25.6
U5MR	33.1	31.41	34.79
LogGDP	8.77	8.69	8.84
LogTHE	5.8	5.72	5.88
LogPRI	4.73	4.65	4.81
LogPUB	4.99	4.89	5.09
WAT	78.13	76.37	79.9
SAN	75.51	74.15	76.88
DPT	88.49	87.81	89.17
IRM	87.89	87.24	88.53
HIV	1.95	1.68	2.21

PHY	2.04	1.93	2.15

Table 6