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THE IMPACT OF PUBLIC HEALTH EXPENDITURE ON HEALTH OUTCOMES IN ZAMBIA.

A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, UNIVERSITY OF LUSAKA IN PARTIAL FULFILMENT OF THE AWARD OF THE MASTER OF SCIENCE IN ECONOMICS AND FINANCE.

BY

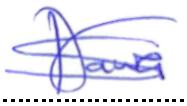
NAWA SAELA

MSCECF22216230

DECLARATION

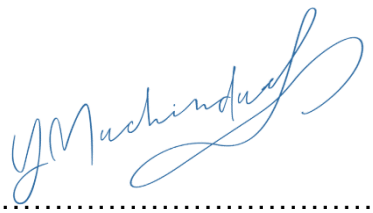
I, Nawa Saela hereby declare that this dissertation represents my own research work, except where otherwise indicated and acknowledged. It has not been previously submitted for the award of a degree at this or any other university either in whole or in part.

Name of Student: Nawa Saela

Signed: 

Date: 20/03/2025

Name of Supervisor: Prof Yasmin Sultana-Muchindu (For Dr. Joseph Phiri)

Signed: 

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DEDICATION

I dedicate this dissertation to my dear parents and wife for their unwavering love and support throughout my academic journey.

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LIST OF ABBREVIATIONS AND ACRONYMS

AU	African Union
GDP	Gross Domestic Product
GEH	Government Expenditure on Health
MENA	Middle East and North Africa
MoFNP	Ministry of Finance and National Planning
MOH	Ministry of Health
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary Least Squares
QoG	Quality of Governance
SDG	Sustainable Development Goals
SSA	Sub Saharan Africa
U5MR	Under-five Mortality Rate
WHO	World Health Organisation
ZDHS	Zambia Demographic Health Survey
GMM	General Methods of Moments
VECM	Vector Error Correction Model
VAR	Vector Autogressive Analysis

ABSTRACT

Government health expenditure is critical in enhancing the health and welfare of human capital as well as promoting economic growth. Thus, the objective of this study was to examine whether public expenditure allocations to the health sector improves health outcomes in Zambia.

Zambia's public health spending has been increasing in both nominal and real terms. It increased from K2.7 billion in 2015 to K23.2 billion in 2024 (MoFNP, 2024). The country also made steady progress in reducing under five mortality rates from 75 deaths per 1,000 live births in 2014 to 42 deaths per 1,000 live birth in 2024 (MoFNP, 2022; ZDHS, 2024). Therefore, it was imperative to investigate whether the improved health outcomes as measured by the decline in under-five mortality could be attributed to increased public health spending.

To achieve its objectives, the study used the co-integration technique and the Vector Error Correction Model (VECM) considering that most economic variables are characterized as non-stationary thereby yielding spurious regression results. After achieving stationarity, the model was then estimated using the Ordinary Least Squares (OLS) method on annual time series data for under-five mortality rates (dependent variable), per capita public health spending, per capita income, immunisation (against measles), and total fertility rates for Zambia for the period 2000 to 2021 obtained from the World Bank Database (World Development Indicators).

While the limitations of this study are acknowledged and results may be interpreted with caution, this study did not find evidence that per capita public health expenditure improves health outcomes in Zambia. Instead, the results provide evidence that per capita income and total fertility rates are key determinants of health outcomes in Zambia. Specifically, the elasticity for per capita income was found to be -0.29, implying that a 10 percent increase in per capita income results in a 2.9 percent reduction in under-five mortality.

This study points to the fact that the Government of Zambia should implement policies aimed at promoting sustainable economic growth considering the impact of real per capita income on health outcomes. Additionally, Government should endeavor to increase its budgetary allocations to the health sector to a minimum of 15% of the national budget in line with the Abuja Declaration in order to improve health outcomes.

CHAPTER 1: INTRODUCTION

1.1 Background

Improving public health care investment is essential to any country's development agenda. This is consistent with the United Nation's Sustainable Development Goal number three which states "ensure healthy lives and promote well-being for all at all ages" (Oladosu, Chanimbe and Anaduaka, 2022). However, there has been competing debates regarding the role of public health expenditures in improving health outcomes. One perspective stress that increased public health expenditure increases overall positive health outcomes through universal access to healthcare while the other perspective asserts that public health expenditures are less efficient than private, and therefore public health quality declines in such a system.

Government health expenditure is also critical in enhancing the health and welfare of human capital as well as promoting economic growth. Thus, countries normally allocate significant amount of resources to the health sector in order to guarantee the health and wellbeing of its citizenry and thus ensure their meaningful contribution to the economic growth of their countries (Yaqub, Ojapinwa and Yussuf, 2012; Rajkumar and Swaroop, 2008). It is actually assumed that increasing health services (i.e. more physicians and/or hospital beds) provides a corresponding increase in the health status of a population because of increased accessibility (Kim and Moody, 1992).

According to the World Health Organisation (WHO), increasing life expectancy at birth by 10% increases economic growth rate by 0.35% a year (Anyanwu and Erhijakpor, 2007). Meanwhile, Sachs (2001) found that about 50% of the growth differential between rich and poor countries is due to ill-health. Moreover, developing countries are characterized by poor health outcomes and high disease burdens which inhibits economic growth (Acemoglu and Johnson, 2007). Thus, governments invest substantial financial resources to the health sector with the hope of improving the health outcomes in their countries.

Although, the developing countries recognise the importance improved health outcomes in terms of its impact on economic growth, most of them face serious challenges in improving public health due to limited fiscal space among other factors. Notably, the prevalence of large-scale health problems such as high infant mortality rate and low life expectancy, are as a result of the scarce health resources and infrastructure. In fact, available statistics reveal that apart from health care budgets that are far below the developed countries, the few health

infrastructures available are unbalanced between urban-rural areas (Novignon, Olakojo, Nonvignon, 2012; Edeme, 2017). Most often the rural areas have inadequate health infrastructures which are poorly stocked with drugs and other medical supplies. Usually, people in the rural areas have to travel long distances to access quality health care.

While factors such as improved immunization, improved water and sanitation, residential environment, and education also play a role, public health expenditure is considered to be an important factor in influencing health outcomes in developing countries, particularly in terms of reducing the incidence of infant and child mortality (Gani, 2008). Thus, countries have prioritized policies on health-care expenditure considering that countries with high levels of health spending are those that have succeeded in lowering their mortality rates (Gani, 2008; Dhrifi, 2019).

It is also assumed that healthier individuals can affect the economy in four ways: (i) they might be more productive at work and so earn higher incomes; (ii) they may spend more time in the labor force, as less healthy people take sickness absence or retire early; (iii) they may invest more in their own education, which will increase their productivity; and (iv) they may save more in expectation of a longer life thus increasing the funds available for investment in the economy (Bloom and Canning, 2003; Anyanwu and Erhijakpor, 2007).

In most countries, the public sector plays a dominant role in providing the health and educational services necessary to build human capital (Anyanwu and Erhijakpor, 2007). However, the private sector also has its place in improving health outcomes.

While Zambia's health sector comprises of the public, private-for-profit, and private-not-for-profit providers, the public sector however, has a dominant role in providing health services in both rural and urban sectors (MOH, 2017). Consequently, this study focused on the public health sub sector.

Zambia's public health spending has been increasing in both nominal and real terms. Specifically, it increased its budgetary allocation to the health sector from K2.7 billion (7.4% of the national budget) in 2015 to K23.2 billion (10.7 % of the national budget) in 2024 (MoFNP, 2024). However, this allocation is still below the Abuja Declaration which requires AU member state to commit not less than 15 percent of their national budget to the health sector.

Zambia has made steady progress in reducing under five mortality rates from 75 deaths per 1,000 live births in 2014 to 42 deaths per 1,000 live birth in 2024 (MoFNP, 2022 and ZDHS, 2024). Despite these improvements, the under-five mortality rate for Zambia is still relatively high compared to the SDG target of at least as low as 25 deaths per 1,000 live births. Therefore, a key policy challenge for policy makers is to continue improving the health outcomes such as under-five mortality. This is particularly important since the public sector is the main source of health financing in Zambia and public spending on health care is one of the largest government expenditure items.

In light of the foregoing, this study examined whether public expenditure allocations to the health sector improves health outcomes in Zambia. It used under five mortality rates rather than life expectancy as a health outcome measure for a number of reasons. Firstly, compared to life expectancy, mortality is more strongly associated to changes in economic conditions in the developing world. Secondly, in developing countries, declines in mortality rates explain a large portion of improvements in life expectancy (Cutler, Deaton and Lleras-Muney, 2006). Thirdly, existing literature shows that in developing countries, mortality depends on access to medicines and health facilities, water and sanitation, fertility patterns, maternal health, maternal and infant nutrition, maternal and infant disease exposure, and female literacy in addition to per capita GDP and economic inequality (Akinci et al, 2014).

Therefore, this study used time series data for public health spending (independent variable) and under-five mortality rates (dependent variable) as well as other selected control variables that determine health outcomes namely; per capita income, immunisation and total fertility rate for which consistent and comprehensive data was available.

1.2 Statement of the Research Problem

The causal relationship between health expenditures and health outcomes continues to attract the attention of many. However, despite decades of intensive study, there is no general consensus regarding the effectiveness of monetary health inputs for health outcomes. In particular, the available literature on the effects of health expenditures on health outcomes are inconclusive with findings ranging from impacts, to limited impacts and impacts on selected interventions (Anyanwu and Erhijakpor, 2007; Gani, 2009; Akinlo and Sulola, 2019; Karaman et, al., 2020).

Further, Zambia's public health spending has been increasing in both nominal and real terms. Particularly, it increased its budgetary allocation to the health sector from K2.7 billion (7.4% of the national budget) in 2015 to K23.2 billion (10.7 % of the national budget) in 2024 (MoFNP, 2024). However, this allocation is still below the Abuja Declaration which requires AU member state to commit not less than 15 percent of their national budget to the health sector.

In view of the increased funding to the health sector, the country has made steady progress in reducing under five mortality rates. Under-five mortality rates reduced from 75 deaths per 1,000 live birth in 2014 to 42 deaths per 1,000 live births in 2024 (MoFNP, 2022; ZDHS, 2024). Despite these improvements, the under-five mortality rate for Zambia is still relatively high when compared to the SDG target which requires every country to reduce under-five mortality to at least as low as 25 per 1,000 live births (https://www.who.int/news-room/fact-sheets). In addition, while relevant interventions such as immunization and oral rehydration therapy are found to cost low (Cutler, Deaton and Lleras-Muney, 2006) and aids in minimizing deaths among children, the incidence of under-five mortality in Zambia raises the question of whether national budgetary allocation to these forms of health care services are adequate and effective in terms of its impact on under-five mortality (Gani, 2008).

Considering the importance of public spending on health in enhancing the health and welfare of human capital as well as promoting economic growth, it becomes necessary to assess the contribution of the government spending towards improvements in health status (Edeme, 2017). Therefore, with the ever-increasing health expenditures comes the need to evaluate their effectiveness in order to ascertain whether past expenditure on health affected the health outcomes in Zambia. In addition, it is important for researchers and policy makers to understand whether increases in expenditure is needed to improve health outcomes in Zambia (Anyanwu & Erhijakpor, 2007; Martin et, al. 2009). These are questions that can only be answered by studying the relationship between public health expenditures and health outcomes in Zambia in order to inform policy making.

1.3 Research Objectives

1.3.1 General Objective

The general objective of this study was to examine whether increasing public expenditure allocations to the health sector improves health outcomes in Zambia.

1.3.2 Specific Objectives

The specific objectives of the study were as follows:

a) To determine the impact of per capita public health expenditure on under-five mortality rate in Zambia.
b) To determine the impact of per capita income on under-five mortality rate in Zambia.
c) To determine the impact of immunization on under-five mortality rates in Zambia.

1.4 Research Hypotheses

a) H_0: There is a significant negative relationship between per capita public health expenditure and under-five mortality rate in Zambia.

   H_1: There is no significant negative relationship between per capita public health expenditure and under-five mortality rate in Zambia.

b) H_0: There is a significant negative relationship between per capita income and under-five mortality rate in Zambia.

   H_1: There is no significant negative relationship between per capita income and under-five mortality rate in Zambia.

c) H_0: There is a significant negative relationship between immunization and under-five mortality rate in Zambia.

   H_1: There is no significant negative relationship between immunization and under-five mortality rate in Zambia.

1.5 Scope of the Study

This study focused on the impact of government expenditure on health outcomes in Zambia. Consequently, the data used in this study was drawn from Zambia. Specifically, under-five mortality rate was used as a dependent variable while Government health expenditure, the independent variable was measured by the level of government spending on health services (per capita public health spending) including other control variables namely; per capita income, immunisation and total fertility rate. Therefore, annual time series data for Zambia for the period 2000 to 2021 was put together for econometric testing. On the basis of the evidence from the analysis, this study has provided insights that can inform policy making in order to ensure better health outcomes (Anyanwu and Erhijakpor, 2007).

1.6 Significance of the Study

While a lot of research has been conducted providing evidence of public health expenditure improving health outcomes such as under-five mortality rates (Bokhari, Gai, Gottret, 2006), there is very limited research on the subject matter in Zambia. In addition, it is imperative to study the impact of public health care spending considering the relationship between health and economic growth as well as its impact on the quality and quantity of the health system and the long-run effect on health outcomes (Ssozi and Amlani, 2015; Ayipe and Tanko, 2023). Further, there is need for more empirical studies on the effect of health expenditure on child mortality considering the high levels of under-five mortality in Zambia (Akinlo and Sulola, 2018). Therefore, this study provides empirical evidence for policy making.

1.7 Definition of key Terms and Concepts

The following are the definitions of the key terms and concepts used throughout this study:

a) **Sustainable Development Goals**: The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity (https://www.undp.org).
b) **National Budget**: A National Budget is a policy instrument which shows how the Government intends to spend forecasted revenues within the fiscal year in order to deliver public goods and services in the most efficient and effective way (MoFNP, 2022).

c) **Health Outcomes:** A change in the health status of an individual, group, or population which is attributable to a planned intervention or series of interventions, regardless of whether such an intervention was intended to change health status (WHO,1998).

1.8 Organisation of the Report

Following this introduction, the rest of the paper is structured as follows: literature review is presented in chapter 2 followed by a discussion of the methodological approach adopted in this study which is presented in chapter 3. Data presentation and analysis is presented in chapter 4 followed by a discussion of results and findings in chapter 5. Conclusion is discussed in chapter 6 while recommendations are highlighted in chapter 7 followed by a list of references.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents both theoretical and empirical literature reviews on public health expenditure and health outcomes. This is in order to have insights of the theories that attempt to explain the relationship between public health expenditure and health outcomes. This section also highlights the previous work that has been done on the current subject matter.

2.2 Empirical Review

There has been an increased interest in recent years to examine the relationship between public health expenditure and health outcomes especially on child mortality. Thus, several studies have explored the relationship between health spending and health status both in developing and developed countries.

Previous research used different estimation techniques and different types of data including panel, cross sectional and time series data. In addition, some studies focused on the effect of total health spending while others concentrated on revealing the relative roles of private and public health spending on improving health status (Boachie and Ramu, 2016).

The available literature provides conflicting findings on the relationship between public health expenditure and health outcomes ranging from no impacts, to limited impacts and impacts on selected interventions (Anyanwu and Erhijakpor, 2007, Gani, 2008 and Karaman et, al. 2020).

While majority of the studies the researcher reviewed on the impact of public health spending on health outcomes provide evidence that public health spending is associated with improved health outcomes, a few studies found contrary results.

Bhalotra (2007) studied the effectiveness of state health expenditure on infant mortality using a national sample survey and merged by birth cohort with a 29-year panel of data on state health expenditure, income and other variables in India. The study found that state health spending saves no life. However, upon allowing lagged effects, controlling in a flexible way for trended unobservable and restricting the sample to rural households, a significant effect of health expenditure on infant mortality emerges, the long run elasticity being about -0.24.

Similarly, Akinlo and Sulola (2019) examined the impact of public health expenditure on under five and infant mortality rates using data from 10 selected Sub Saharan Africa for the period 2000-2008. The study showed that public health expenditure does not help to reduce under

five and infant mortality in the selected Sub Saharan African Countries. However, the study showed that total health expenditure does explain improvements in under five and infant mortality. Other variables in the model namely; HIV prevalence, immunisation, health aid, urbanisation and GDP per capita were found to be significantly associated with reduced under five and infant mortality.

In the same vein, Filmer and Pritchett (1999) examined the impact of both public spending on health and non-health factors (economic, educational, cultural) in determining under five mortality. The study found that higher public expenditure on health is associated with lower under five mortality. However, the association was both empirically small with an elasticity of -0.135 and imprecisely estimated. The effect is statistically significant only at the 10 percent level with a t-statistic of 1.78. In addition, the elasticity of child mortality with respect to income was found to be 0.6 which is consistent with previous findings using cross sectional or time series national level data. Further, the study found that an additional year of schooling results in a 10% reduction in mortality.

Dhrifi (2019) also studied the effects of health care expenditure on child mortality rates through an analysis of the tripartite relationship among developed and developing economies by comparing low, lower-middle, upper-middle and higher-income countries. The study found that health expenditure has a positive effect on reducing child mortality only for upper-middle-income and high-income countries, whereas for low-income and lower-middle-income countries, health spending does not have significant impact on child health status. The study also found that at lower development levels, public spending has a greater effect on mortality rates than private expenditure while at high development levels, private health expenditure has a positive impact on child mortality. Similarly, Issa and Ouattara (2005) assessed the effect of health expenditure, private and public, on infant mortality rates at different development stage. The authors employed OLS and panel data techniques on 160 countries and they found that the effect on child mortality is channeled through public expenditure at low development levels and through private expenditure at high development stages. They also found negative relationship between infant mortality rates and per capita income and female education while the effect of the environment variable was statistically weak.

Deluna and Peralta (2014) studied the relationship among public health expenditures, income and health outcomes in the Philipines from 1981 to 2010. The authors used Vector Autogressive Analysis and Granger Causality test to determine the direction of relationship

of the variables. The study revealed that health expenditure per capita followed an overall increasing trend with an average growth rate of 11% from 1981 to 2010 with a corresponding reduction of infant mortality rate by 1.64%, under-five mortality by 1.76% and an increase in life expectancy with an average growth of 0.17%. However, VAR results revealed that the past values of public health expenditure have no effect on under-five mortality rates but affects infant mortality rate.

Some studies on the other hand examine the impact of both public and private health care financing on health outcomes. For instance, Novignon, Olakojo and Nonvignon, (2012) examined the effects of health care expenditure on population health status as well as the effect by public and private expenditure sources using panel data from 1995 to 2010 covering 44 countries in Sub Saharan Africa (SSA). The study revealed that health expenditure significantly influences health status through improving life expectancy at birth, reducing death and infant mortality rates. Also, both public and private health care spending showed strong positive association with health status even though public health care spending had relatively higher impact.

Rezapour et al., (2019) also examined the public and private health expenditure and their effects on health indicators in countries with moderate and high income level from 2000 to 2015. The findings of the study indicated that public health expenditure had a significant effect on health indicators on all the groups, thus an increase in public health expenditure led to increasing life expectancy and decrease in infant and under five mortality rates in all groups. Also, the study found that the group with the highest share of health expenditure had a greater impact on life expectancy and infant mortality and infant mortality, however, in regards to the under-five mortality rates, it was contrary. Further, the effect of private health expenditure was different and, in most cases, it had no significant effect.

Meanwhile, Nicholas, Edward and Bernadin, (2016) examined the effects of public and private health expenditures on selected maternal and child health outcomes in 40 Sub Saharan African (SSA) countries utilising data spanning the period 2000-2010. The study found that public health expenditure was inversely and significantly related to infant mortality rates and under five mortality rates in SSA. However, private health expenditure did not prove to be significant in improving maternal and child health outcomes (infant mortality rate, under five mortality rate and maternal mortality rate in SSA.

Using the General Method of Moments (GMM) technique, Ssozi and Amlani (2015) examined the effectiveness of health expenditure from 1995 to 2011 in 43 nations of Sub-Saharan Africa. The authors categorised health expenditure into resources to government and non-government entities, private not out-of-pocket, and private out-of-pocket, and the study found that effectiveness of total health expenditure scaled by GDP is associated with an increase in life expectancy by 0.032 percentage points and with a decrease in infant and child mortality by 0.028 percentage points and 0.048 percentage points respectively. However, when total expenditure is broken down into the private and public components, the public component is significant only in relation to child mortality while the private component is significant in relation to both life expectancy and infant mortality. They recommended that public health expenditure could be more effective in Sub Saharan Africa if Governments improves public service delivery, political stability, female education, and design health care systems targeted especially at the poor.

Other studies on the impact of public health expenditure on health outcomes focused on the impact of governance. For example, Yaqub, Ojapinwa and Yussuff, (2012) examined the impact of public health expenditure on health outcomes in Nigeria with a focus on the impact of governance. The study revealed that public health expenditure has a negative effect on infant mortality and under five mortality when the governance indicators are included whereas it has wrong signs without the governance indicators. As the level of corruption goes down and value of corruption index rises, there is an improvement in health status since infant and under five mortality declines and life expectancy rises.

Similarly, Rajkumar and Swaroop (2008) examined the role of governance measured by the level of corruption and the quality of bureaucracy in determining the efficacy of public spending in improving human development outcomes. The study found that a 1 percentage point increase in the share of public health spending in GDP lowers the under-five mortality rates by 0.32 percent in countries with good governance (as measured by a corruption index), a 0.2 percent in countries with good governance, and has no impact in countries with weak governance. The authors argue that the differences in the efficacy of spending could arise due to a variety of reasons including corruption, patronage, and crowding out effect (Ssozi and Amlani, 2015).

Makuta and O'Hare (2015) also investigated whether or not the quality of governance (QoG) has a modifying effect on the impact of public spending on health outcomes, measured by

under-five mortality and life expectancy at birth in Sub Saharan Africa. The study found that public spending on health has a statistically significant impact in improving health outcomes. Its direct elasticity with respect to under five mortality was found to be between -0.09 and -0.11 while its semi elasticity with respect to life expectancy was between 0.35 and 0.6. After allowing for indirect effect of public spending on health via interaction with quality of governance, the study found that an improvement in quality of governance enhances the overall impact of public spending on health. In countries with higher quality of governance, the overall elasticity of public spending on health with respect to under five mortality was between -0.17 and -0.09 while in countries with lower quality of governance, it was found to be about -0.09.

While some studies do not find a strong link between increased public spending on health and improved health outcomes, others find strong positive effects. For instance, Mustapha, Onikosi-Alliyu and Babalolo, (2021) examined the impact of Government health expenditure on health outcomes on 13 countries from the West African sub region for the period 2000 to 2005. The study found a statistically significant negative relationship between Government expenditure on health (GEH) and under five mortality rate (U5MR). A one unit increase in Government expenditure on health resulted in 2.86 units fall in under-five mortality rate.

Using data from 1995 to 2018 for 45 countries in the Sub-Saharan Africa, Chireshe and Ocran (2020) examined the effect of health care expenditure on health outcomes. The authors found that health care expenditure as measured by total health care expenditure per capita and public health care expenditure to GDP was negatively and significantly correlated with child health outcomes and positively and significantly correlated with life expectancy.

Bein (2017) also examined the association between health care expenditure and health outcomes for eight East African Countries. The study found a negative relationship between health care expenditure and the number of neonatal, infant and under five death.

Bokhari, Gai and Gottret (2006) provides econometric evidence linking a country's per capita income to two health outcomes: under-five mortality and maternal mortality. Their findings show that, the elasticity of under-five mortality with respect to government expenditures ranges from -0.25 to -0.42 with a mean value of -0.50. According to the authors, for developing countries, the result implies that while economic growth is certainly an important contributor to health outcomes, government spending on health is just as important a factor.

Anyanwu and Erhijakpor (2007) examined whether differences in the resources allocated to health (total and public) can explain the differences in under five and infant mortality rates across African countries. The study revealed that a 10 percent increase in per capita total health expenditure reduces under five mortality rates by 21 percent while a similar 10 percent increase in per capita public health expenditure leads to a reduction of 25 percent in under five mortality rates.

Meanwhile, Raeesi et al., (2018) provide econometric evidence linking countries' health expenditures to three (3) outcomes: (1) infant mortality, (2) under five mortality and (3) life expectancy within four (4) different health care systems. The study found a significant relationship between health expenditures and health indicators. Particularly, the effect of private health expenditures on health outcomes in countries with mixed health financing system and traditional sickness fund insurance was found to be higher than the public expenditures. Also, after comparing the results between different health care systems, the study found that the effect on health expenditure on the health outcomes in countries with national health systems (NHS) was more than other health care systems.

In order to examine the contribution of health care expenditure to health outcomes, Nixon and Ulmann (2006) conducted an econometric analysis using panel data set for the former 15 members of the European Union over the period 1980-1995. The study revealed that increase in health care expenditure are significantly associated with large improvements in infant mortality but only marginally in relation to life expectancy.

Kilanko (2019) also examined the effects of health care expenditure on health outcomes in 14 selected countries in West Africa using panel data set for the period 2000-2018. The study found that a one percentage point increase in health expenditure reduces infant mortality by 2.4 percent, under five mortality by 3.9 percent and maternal mortality by 4.9 percent.

Karaman et al., (2020) conducted a study on the impact of health care spending on health outcomes using data from OECD database and World Bank for 30 OECD countries. The study found that public health care spending per capita has a significant impact on maternal and infant mortality, male and female life expectancy at birth and in 80 years. Also, private health care spending per capita was found to be an important determinant of self-reported health.

Using cross-country data from seven Pacific Island countries for selected years between 1990 and 2002, Gani (2008) studied the relationship between per capita public health

expenditure and three (3) measures of health outcomes (infant and under five mortality rates and crude death rate). The results of the fixed -effects estimation procedure, correcting for AR (1) errors provides strong evidence that per capita health expenditure is an important factor in determining health outcomes. The elasticity of the infant mortality rate with respect to per capita health expenditure was -0.66. The empirical results also provide strong evidence that per capita incomes and immunisation are additional core factors that determine health outcomes.

Berger and Messer (2002) also studied the effects of public financing of health expenditures, insurance coverage and other factors on health outcomes within health production models estimated using OECD Health Database for the period 1960-1992 across OECD countries. The study revealed that the effects of health care expenditure per capita is significantly related to mortality.

Oluwatoyin, Folasade and Fagbeminiyi, (2015) used the Johansen Co-integration and the Vector Error Correction Model (VECM) econometric technique to determine the long run relationship between public spending on health and health outcomes in Nigeria using data for the period 1979 to 2012. The authors found that there is a statistically significant relationship between public health expenditure and health outcomes. The study also showed that government expenditure on health is negatively related to life expectancy.

Edeme (2017) used annual time series data for Nigeria for the period 1981 to 2014 sourced from World Development Indicators and various publications of the World Bank regarding health and health expenditures to assess how public health expenditure contributed to the improvements in health outcomes in Nigeria, using life expectancy at birth and infant mortality rates as health outcomes. The results of the study showed that an increase in public health expenditure improves life expectancy and reduces infant mortality rates. In addition, the study found that urban population and HIV prevalence rate significantly affects health outcomes while per capita income exhibited no effect on health outcomes in Nigeria.

Using time series data for the period 1980 to 2001, Akinkugbe and Mohanoe (2009) examined the extent to which the health status of the people may have benefited from the intervention of government through increases in public expenditure on health and other social services in Lesotho. The study revealed that a 1 percent increase in public expenditure on health increases life expectancy by 0.17 percent.

Ayipe and Tanko (2003) examined the effect of the state health spending on under five mortality using balanced panel data from 20 low income countries in Sub Saharan Africa sourced from the World Development Indicator dataset spanning the year 2000-2019. The results showed that state health spending has significant negative relationship with the under-five mortality rates in low income countries of Sub Saharan Africa. Specifically, for every additional percentage increase in state health spending, under five mortality rates declined by 5.3 units. In addition, total fertility rate, female population, and rural people practicing open defecation were positively associated while immunisation against DPT was negatively associated with under five mortality.

Kim and Lane (2013) analysed the relationship between public health expenditure and national health outcomes among 17 developed countries for the period between 1973 and 2000. The study revealed that there is a statistically significant association between government health expenditure and public health outcomes. Particularly, the findings showed a negative relationship between government health expenditure and infant mortality, and a positive relationship between government health expenditure and life expectancy at birth.

Using annual time series data spanning 1981 to 2014, Igbinedion and Olele, (2018) investigated the nexus between public health expenditure and health outcomes (using maternal mortality as a proxy for the latter) in Nigeria. The result of the analysis revealed that maternal mortality rate declines as both public health spending and private health expenditure rise, suggesting that public health spending does not crowd out private health financing within the Nigerian context. Poverty rate was however, found to contribute significantly to the rising rate of maternal mortality. Additionally, health oriented official development assistance had a negative but insignificant impact on maternal rate in Nigeria.

Akinci et al., (2014) examined the impact of health care expenditures on selected health outcomes for 19 countries in the Middle East and North Africa (MENA) region. The study found that after controlling for confounding factors, both government and private spending on health care significantly improve infant, under-five and maternal mortality in the MENA region. Specifically, the study found that a percentage increase in per capita government expenditure on health reduces the infant mortality rate by 8.6-9.5 deaths per 1,000 live births.

Barenberg, Basu and Soylu (2016) investigated the impact of public health expenditure on infant mortality using a panel data set of Indian States covering the period between 1983-1984 and 2011-2012. The study revealed that public expenditure on health care reduces the

infant mortality rate. An increase in public health expenditure by 1 percent of state level net domestic product was associated with a reduction in the infant mortality rates by about nine (9) infant death per 1,000 live births. The study also found that political competition, female literacy, and urbanisation reduces the infant mortality rates.

Farahani, Subramanian and Canning (2010) studied the effects of state-level public spending on the mortality probability in India using data from the second National Family Health Survey of India conducted in 1998-1999 in all 26 states of India existing at that time. The study revealed that a 10 percent increase in public spending on health in India decreases the average probability of death by about 2% with effects mainly on the young, elderly and women. The study also found that rural residence, household poverty and access to toilet facilities were some of the major factors affecting mortality.

Arthur and Oaikhenan (2017) examined the effects of health expenditure on health outcomes in Sub Saharan Africa (SSA) using data from 1995 to 2014 for 40 SSA countries. The findings of the study indicated that health expenditure has a significant but inelastic effect on health outcomes in SSA, reducing mortality rates and improving life expectancy at birth. Reductions in mortality rates were significantly influenced by public health expenditure whereas improvements in life expectancy at birth were significantly influenced by private health expenditure. The study however, found a strong complementary relationship between public and private health expenditure in SSA despite the dominance of the former over the latter.

Hlafa, Sibanda and Hompashe, (2019) also examined the association between public health expenditure and health outcomes in South Africa's nine provinces from 2002 to 2016. The study findings elucidated that the relationship between public health expenditure and health outcomes varied across provinces depending on provincial management and infrastructure availability.

Ogunjimi and Adebayo (2019) examined the relationship among health expenditure, health outcomes and economic growth in Nigeria for the period between 1981 and 2017. The study revealed that health expenditure had a significant causal relationship with infant mortality, maternal mortality and life expectancy in Nigeria. In the same vein, real GDP had a significant causal relationship with maternal mortality and life expectancy in Nigeria.

Mohanty and Behera (2020) investigated the effects of public health expenditure on various proximate and ultimate health outcomes during 2005-2016 using panel fixed-effects models across 28 Indian States. The empirical results of the study showed that per capita public

health care expenditure resulted in a reduction in infant and child mortality rate, malaria cases, and an increase in life expectancy, immunisation coverage across states.

Meanwhile, Amponsah (2019) studied the core macroeconomic and social determinants of health expenditures as well as the effect of health expenditures on select critical health outcomes (life expectancy, under five mortality and maternal mortality) using data from 46 Sub Saharan African (SSA) countries covering the period 2000-2015. The study found that Gross Domestic Product (GDP) per capita, physician per 1,000 population, population aged above 65 years and under five mortality rates were the most significant determinants of health expenditure in the SSA region. Health expenditure was found to exert a positive and significant impact on all the three health outcomes. Specifically, a 1 percent increase in health expenditure per capita resulted in 0.5 percent reduction in under five mortality and 0.35 percent fall in maternal mortality, while improving life expectancy by 0.06 percent.

Boachie and Ramu (2016) examined the effects of public health expenditure on health status in Ghana using annual time series data on infant mortality rate, real per capita income, literacy levels, and female labour force participation rate for the period 1990-2012. The authors found that real per capita income, public health expenditure, education and female presence in the labour market were negatively related to infant mortality rate. However, the elasticity coefficients of female participation in the labour market and real per capita income were statistically insignificant at 5% level.

Boachie, Ramu and Põlajeva, (2018) re-examined the link between government health expenditures and health outcomes to establish whether government intervention in the health sector improves outcomes. The study used annual data for the period 1980–2014 on Ghana. The authors employed ordinary least squares (OLS) and the two-stage least squares (2SLS) estimators for analyses. The study revealed that, aside from income, public health expenditure contributed to the improvements in health outcomes in Ghana for the period. The study also found that increasing public health expenditure by 10% averts 0.102–4.4 infant and under-five deaths in every 1000 live births while increasing life expectancy at birth by 0.77–47 days in a year.

Finally, Or (2000) investigated the determinants of health outcomes across 21 OECD countries for the period 1970 and 1992. The study found that the coefficient on health expenditure was negative and significant for women, while it was not statistically significant

for men. In addition, a much stronger negative association for both men and women appeared to exist between premature mortality rate and income per capita.

While the foregoing provides evidence of some studies that indicate that increasing health expenditure reduces mortality rates while others don't provide the evidence, literature on the Zambian perspective is very limited. In addition, most studies on public health expenditure and health outcomes have been cross-national. Thus, it is imperative that the effect of public health spending on health outcomes in Zambia is investigated considering the prevailing high incidence of infant and under five mortality rates.

2.3 Theoretical Framework

The theoretical framework for this study is based on the Grossman model of health capital and Mosley and Chen's analytical framework for the study of child survival in developing countries.

2.3.1 Grossman Model of Health Capital

According to Grossman (1972), health is a durable capital stock producing healthy time as an output for both market and non-market activities. This healthy time yields two main benefits: utility and earnings (i.e., non-market and market activities) to the individual. These benefits oblige people to invest in their health following depreciation due to time (i.e., age). Just like the individual, the state also benefits from good health in the form of improved welfare and higher labour-hours and productivity hence the state's investment in health. This theoretical exposition follows the unconstrained utility maximization theory whereby the individual aims to maximize his utility with a given set of resources. Grossman therefore shows that as the individual aims to maximize his/her health, he/she does so by investing in himself or herself to produce the typical health status desired. Essentially, the theory largely explains the nexus between health care spending and health outcomes. Thus, the theory simply presents the individual as one whose demand for health inputs is a derived demand, not necessarily for consumption but to produce a typical health outcome. This the individual does by acquiring health inputs which are either public or private financed (Igbinedion and Olele, 2018; Boachie and Ramu, 2016).

Consumption of healthcare or medical services is considered one of the avenues to invest in health subject to one's budget and time. While healthcare consumption represents the investment in health at the individual level, provision of and improvement in healthcare infrastructure, including healthcare personnel, constitute health investment at the state level. Thus, the state makes available healthcare facilities and personnel whereas individuals utilize these facilities to improve their health status. Thus, individual's investment in health via medical care consumption is dependent on the availability of and access to healthcare services. Within the production function framework, healthcare is considered one of the several inputs in the health production function. Thus, healthcare is seen as an input in the production of the commodity ''good health'' such as low mortality, and higher life expectancy (Wagstaff, 1986). Thus, healthcare is considered an input in producing, for example, zero or low mortality, and higher life expectancy hence the presence of health expenditure in the

health production. Regardless of the approach used, healthcare is one of the means for individuals to improve their health status. However, the ability of individuals to undertake such investment or production activity is dependent on the availability of and access to health resources, whether provided by the public or private (Boachie and Ramu, 2016).

2.3.2 Mosley and Chen Analytical Framework for the Study of Child Survival in Developing Countries

According to Mosley and Chen (1984), socio and economic determinants of child mortality necessarily operates through a common set of biological mechanism, or proximate determinants, to exert an impact on mortality.

The analytical model implies a major reorientation in research approaches by both health and social scientists looking at child mortality. Specifically, it suggests that child mortality should be studied more as a chronic disease process with multifactorial origins than as acute, single-cause phenomenon. Use of the model should therefore facilitate specifications of the different orders of causality and possible interactions among the socioeconomic determinants (Mosley and Chen, 1984);

Basically, Mosley and Chen (1984) modelled the interaction between socioeconomic determinants and proximate determinants of child mortality as follows:

Figure 1: Analytical Framework adapted from Mosley and Chen (1984)

From Figure 1, it can be observed that socio-economic status influences the proximate determinants of health and risk of disease, and these in turn directly influence health and mortality outcomes. The implication of the Mosley-Chen model of mortality is that child mortality should not be treated as a single-cause health outcome and that it may be necessary to specify different orders of causality and study the possible interaction across the socioeconomic determinants.

Following the insights from the Grossman model of health capital and the Mosley and Chen analytical framework for the study of child survival in developing countries, this study uses a model developed by Rajkumar and Swaroop (2008) who modelled outcome of a public programme as follows:

$$Outcome = GDPP^{\alpha} * \left(\frac{pubexp}{GDP}\right)^{\beta} \qquad \alpha > 0, \text{ and } \beta \geq 0 \qquad (1)$$

Where *GDPP* is per capita income, *pubexp* is public expenditure on health, *GDP* is Gross Domestic Product and *Outcome* can be an indicator of health status, such as life expectancy, infant mortality or under-five mortality rates ((Yaqub, Ojapinwa and Yussuff, 2012).

Equation (1) implies that outcome in this case under-five mortality does the following: a) declines with an increase in per capita income; and (b) declines if an increased proportion of the country's resources are spent on health care. Taking the logs of equation (1), we have the linear form of (1) as equation (2) below:

$$InOutcome = \alpha InGDPP + \beta In\left(\frac{pubexp}{GDP}\right) \qquad (2)$$

2.4 Conceptual Framework

This study uses a conceptual framework adapted from Filmer and Pritchett, (1999) which is depicted in figure 2 below:

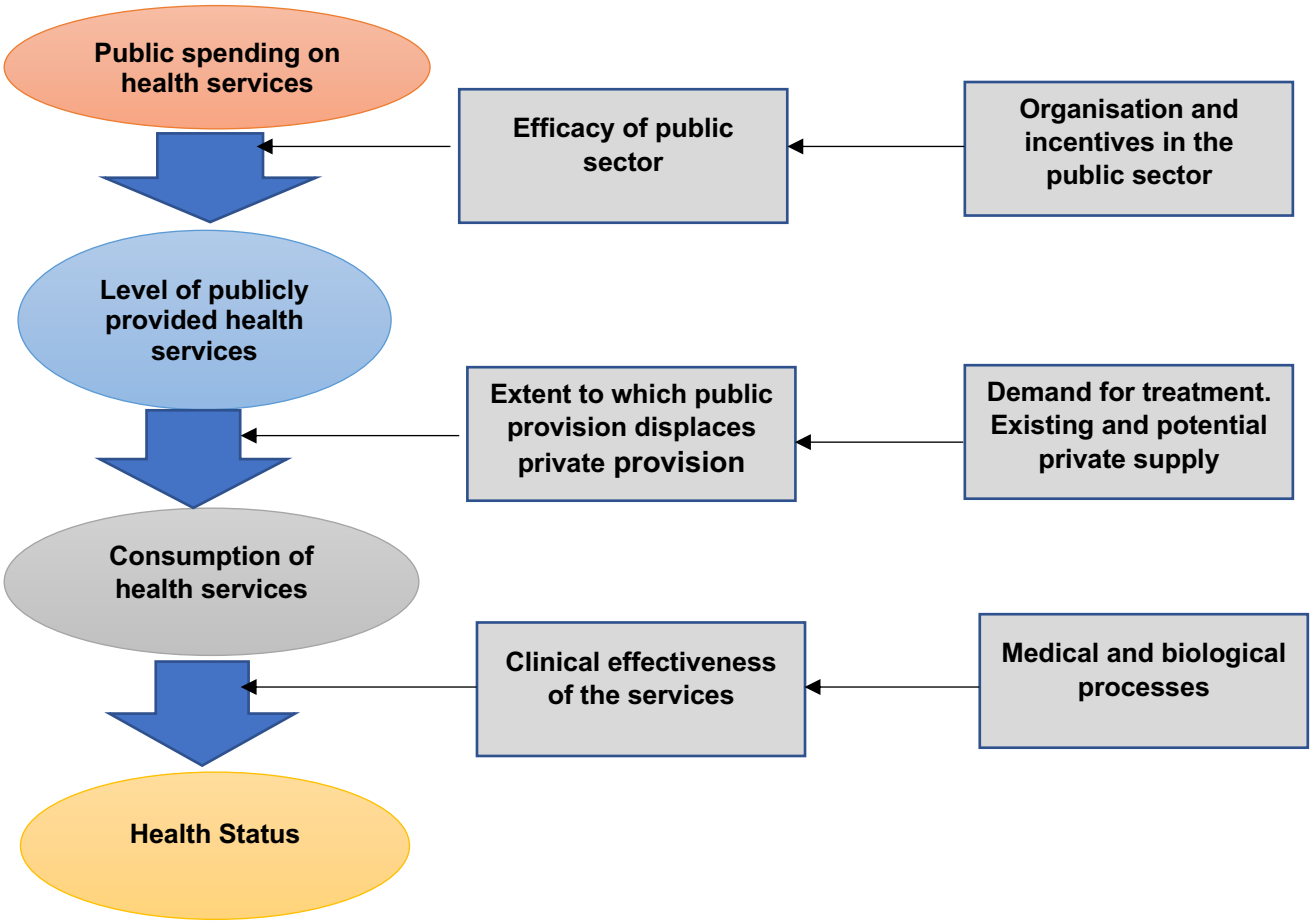


Figure 2: Analytical Framework developed by Filmer and Pritchett (1999)

The theory as depicted in figure 2 above postulates that increases in public spending on health leads to increases in the level of public health services and therefore increased access to public health services provided through increased construction of health facilities, procurement of drugs, vaccines and medical equipment as well as recruitment of health workers among others. However, increased public spending on health can only lead to increased supply of publicly provided health services if the public service is well incentivized to ensure efficiency in the provision of public health services and thus prevent mismanagement of public resources.

Figure 2 also shows that increases in the supply of health services results in an increase in the consumption of health services since the provision of quality health care has been expanded although there is potential for crowding out the provision of private health care.

The increase in the consumption of health services such as immunisation, improved antenatal and post-natal care and increased availability of essential drugs then leads to improved health outcomes such as increased life expectancy and reduced under five mortality provided the health services are effectively and efficiently provided by well skilled human resources.

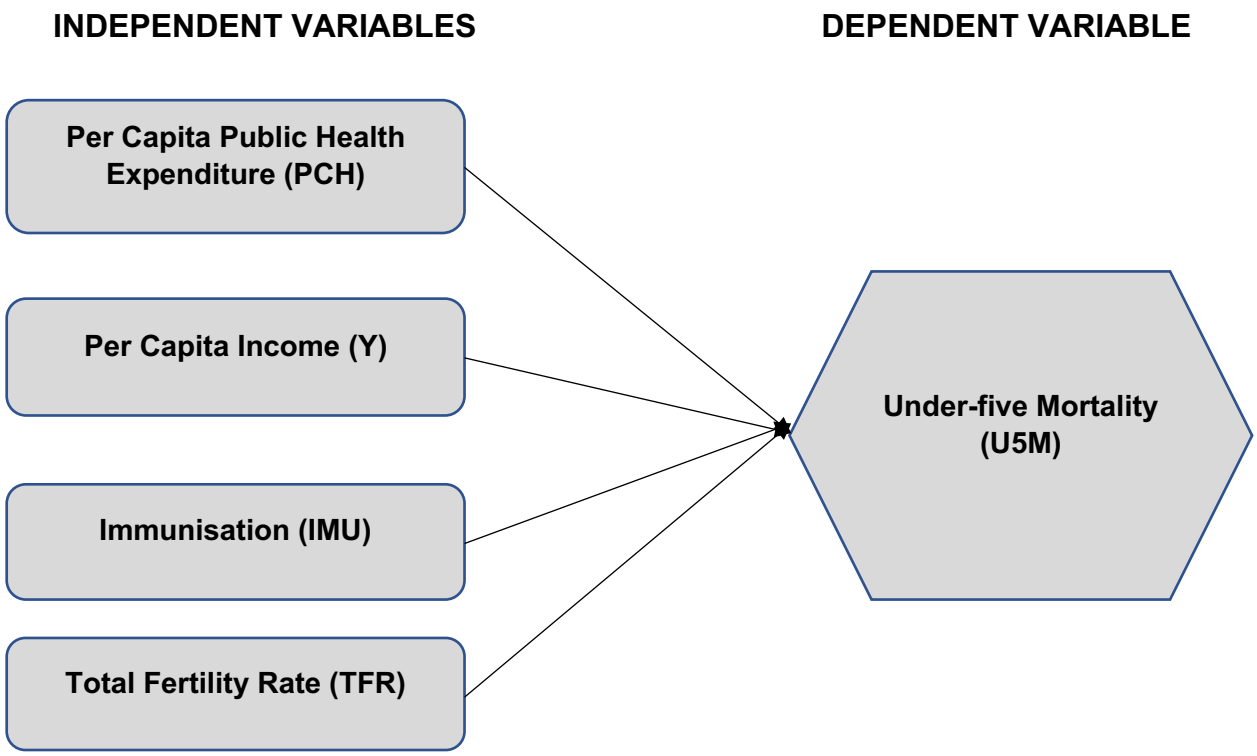


Figure 3: Conceptual Framework

Source: Researcher Construction, 2025

Figure 3 above shows that per capita public health expenditure (PCH), per capita income (Y), immunisation (IMU) and total fertility rate (TFR) are some of the key independent variables that influence under-five mortality rate (U5M) the dependent variable.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter presents the research approach, research design, data sources and data analysis procedures used in this study.

The co-integration technique and the Vector Error Correction mechanism (VECM) was employed in the analysis of the data used in this study because many economic variables are characterized as non-stationary thereby yielding spurious regression results. Non-stationary means that the variables do not have a mean which is constant over time. Therefore, the co-integration technique tends to eliminate this linear trend which makes the series stationary (Oluwatoyin, Folasade and Fagbeminiyi, 2015).

3.2 Research Approach

This study used a quantitative research approach to investigate the impact of public health expenditure on health outcomes in Zambia. Specifically, it used an econometric approach based on time series data regressions in line with the available literature on the subject matter.

This study utilised quantitative data from the World Bank's World Development Indicator. The time series data was analysed to test the hypotheses, make inferences and measure the relationships between the dependent and independent variables. It is worth noting that this approach is consistent with the literature and allows for identification of the channels through which the government expenditure and other policy interventions affect these health outcomes over time (Anyanwu and Erhijakpor, 2007).

3.3 Research Design

This study used a quasi-experimental research design since the study utilised secondary quantitative data. Thus, quantitative methodology was used to examine the impact of public health expenditure on health outcomes. This is consistent with the available literature on the subject matter.

Similar to Anyanwu and Erhijakpor (2007) health outcome was measured by under-five mortality rates while health expenditure data was expressed as per capita public health expenditure. In addition, per capita income, immunisation, and total fertility rates were the control variables used in the study to control for multiple factors that could influence public health outcomes. This is consistent with existing literature where child mortality is as a better

measure of the health status because it is sensitive to changes in social economic factors and the quality of health care provision. In addition, while acknowledging that mortality measures have no means of revealing the actual health conditions of various segments of the population within the country, and fail to account for the quality of life years, the general assumption is that countries with healthy populations will have low mortality (Kim and Moody, 1992; Anyanwu and Erhijakpor, 2007; Novignon, Olakojo, Nonvignon, 2012; Boachie, Ramu, Põlajeva, 2018; Chireshe and Ocran, 2020). Additionally, this approach makes the results of this study comparable with those from previous studies.

Guided by Gani (2009), Boachie, Ramu Põlajeva, (2018) and other empirical literature on the subject matter, the structural equation to examine the impact of Government health expenditure on health outcome in Zambia takes the following general form:

$$Y_t = f(H_t, X_t) \quad (3)$$

Where *Y*, is a health outcome indicator reflecting health status, *H* is per capita public spending on health care; *X* is a vector of socio-economic control variable, and t is the time. Health outcomes are presumed to be primarily a function of per capita health expenditure as well as several other variables as used in many studies. In addition, changes in national health policies that directly affect investment in health capital, particularly in budgetary allocations to the health sector, are likely to show quicker effects in terms of health status of the population than other policy changes (Gani, 2009).

Following the work of Gani (2009) and Boachie and Ramu (2016), equation (3) is expressed in natural logarithmic form so as to correct any skewness in the data. In addition, the advantage of transforming the variables in natural logarithmic form is to achieve stationarity in the lower order of integration (Gani, 2009). Thus, equation (3) is expressed as follows:

$$InU5M_t = \beta_0 + \beta_1 InY_t + \beta_2 InPCH_t + \beta_3 InIMU_t + \beta_4 InTFR_t + \varepsilon_t \quad (4)$$

Where,

U5M is the Under-Five Mortality Rate;

Y is the Per Capita Income;

PCH is the Per Capita Public Health Expenditure;

IMU is Immunization against measles;

TFR is Total Fertility Rate;

$\boldsymbol{\beta_0}$, $\boldsymbol{\beta_1}$, $\boldsymbol{\beta_2}$, $\boldsymbol{\beta_3}$, are the estimated coefficients;

$\boldsymbol{\varepsilon}$ is the Error term;

ln is Log; and

t is Time

3.4 Definition of Variables

Table 1: Definition of variables

No.	Variable	Type of Variable	Definition	Source of Data
1	**Under-five mortality rate**	Dependent	The probability that a new born baby will die before reaching the age of five expressed as a rate per 1,000 live births	World Bank, World Development Indicator, 2024
2	**Per capita income**	Independent	The gross national income per capita in US dollars.	World Bank, World Development Indicator, 2024
3	**Per capita public health expenditure**	Independent	The per capita public health expenditure in US dollars	World Bank, World Development Indicator, 2024
4	**Immunisation (against measles)**	Independent	The percentage of children ages 12-23 months who received one dose of vaccine against measles before 12 months.	World Bank, World Development Indicator, 2024
5	**Total fertility rate**	Independent	The average number of children a woman aged 15-49 will have in her entire reproductive period.	World Bank, World Development Indicator, 2024

3.5 Data Collection

Annual time series data for Zambia for the period 2000 to 2021 on per capita income (Y), per capita public health expenditure (PCH), immunisation (IMU) and total fertility rates (TFR) was sourced from the World Bank's World Development Indicators (WDI) database to investigate the impact of public health expenditure on health outcomes in Zambia. It is worth noting that all the data used are in real terms and their natural logarithms are used in the analysis. In addition, the period was selected because complete data was available for all the variables used in this study.

3.6 Unit Root Test

Most macroeconomics time series data appear to contain unit root (i.e. they are non-stationery). This implies that the mean and the variance is a function of time and they tend to depart from any given value as time progresses (Stock and Watson,1989).

The presence of unit root makes the regression results spurious and thus disturbs the accuracy of the parameters estimated. Therefore, Augmented Dickey Fuller (ADF) test is one of the suitable tests normally used to detect whether the selected time series variables are stationary at their levels or not. If data is not stationary as most of the time series variables are, then one way of achieving stationarity is to difference the time series data until stationarity is achieved (Asteriou and Hall, 2007).

In light of the above, the Augmented Dickey Fuller (ADF) was used to test for stationarity in the variables. The rule of thumb for the test is that the absolute value of the test statistic must be greater than the absolute value at the chosen critical value. In this study, the chosen critical value was 5 percent.

3.7 Cointegration Analysis

Cointegration analysis is commonly used to test the existence of a long run stable relationship amongst variables. Pioneered by Engle and Granger (1987), cointegration in effect attempts to test whether variables are integrated of the same order. A linear combination of them will either be integrated of the same order or lower order. The basic idea behind cointegration is that though macroeconomic variables may tend to move up and down over time, their linear combination may drift together (Dlamin, 2001). Therefore, though individually non-stationary, if they are integrated of the same order, a linear combination of these variables may be stationary. This stationarity attained in a linear combination of these is known as the cointegration equation.

This basic cointegration analysis is attributed to Engle and Granger (1987). However, this study used the Johansen Cointegration because the Johansen test is deemed more superior to the Engle-Granger test because it provides better estimates and test statistics (Arize, 1996). Unlike the Engle and Granger, the Johansen and Juselius method permits testing for cointegration in a multivariate system and can be used for Vector Error Correction Model (VECM) accounting for short-run and long-run dynamics (Maddala, 1992). Further, as the Johansen Maximum Likelihood method is a VAR based technique, less concern is needed over whether the explanatory variables are exogenous or endogenous (Dhliwayo, 1996; Shirvan and Wilbratte 1997).

Furthermore, as Maximum Likelihood estimates (MLE) are invariant to normalization, there is no ambiguity and as such the model does not suffer from misspecification. Additionally, the Johansen methodology offers a unique way to find the number of cointegrating relationships and estimating these relationships. Unlike the Engle-Granger and other methods which tests for stationarity of the residuals to establish cointegration, the Johansen method rely on the relationship between the rank of the matrix and its characteristic roots (Hillier, 1990).

3.8 Johansen and Juselius Cointegration Test

This test is employed to determine the number of co-integrating vectors using Johansen's methodology with two different test statistics namely the trace statistic and the maximum Eigen-value test statistic. The trace statistic tests the null hypothesis that the number of divergent co-integrating relationships is less than or equal to 'r' against the alternative hypothesis of more than 'r' co-integrating relationships, and is defined as:

$$J_{trace} = -T\sum_{i=r+1}^{n} \ln(1-\widehat{\lambda_{\iota}}) \quad (5)$$

The Maximum Likelihood Ratio or the Maximum Eigen-value statistics tests the null hypothesis of r co-integrating relations against the alternative hypothesis of 'r+1' co-integrating vectors, and is defined as:

$$J_{max} = -TIn(1-\hat{\lambda}_{r+1}) \quad (6)$$

Where $\hat{\lambda}$ is the Eigen values, T is the sample size, Johansen argues that, trace and maximum Eigen value statistics have nonstandard distribution under the null hypothesis, and provides approximate critical values for the statistics, generated by Monte Carlo methods. In situations where Trace and Maximum Eigenvalue statistics yield different results, the trace test results should be preferred.

3.9 Vector Error Correction Model (VECM)

If a cointegration relationship has been detected between series, we know that there exists a long-term equilibrium relationship between them, so we apply the VECM in order to estimate the short run properties of the cointegrated series. In an event of no cointegration, VECM is no longer useful instead the Granger causality test is used to establish causal links between variables.

3.10 Data Analysis

This study used STATA software (14.2) to conduct regression analysis to examine the impact of government health expenditure (independent variable) on under five mortality (dependent variable). The study used quantitative data obtained from the World Bank's World Development Indicators for the period 2000 to 2021. Predominantly, the study used inferential analysis in order to draw inferences from the research findings. In addition, descriptive data analysis was used to obtain summary statistics, graphs and tables in order to get an insight from the data.

The collected data was cleaned before using it for analysis. In addition, the study conducted several diagnostic tests including normality, homoscedasticity, multicollinearity, and autocorrelation in order to check the adequacy of the chosen model. Each test detected a particular form of model adequacy. Further, the study used the co-integration technique and the Vector Error Correction Model (VECM) considering that most economic variables are characterized as non-stationary thereby yielding spurious regression results. After achieving stationarity, the model was then estimated using the Ordinary Least Squares (OLS) method.

3.11 Ethical Consideration

This study used secondary data to investigate the impact of public health expenditure on health outcomes and therefore, no personal information was collected which would have otherwise necessitated thorough ethical consideration. Notwithstanding this, ethical clearance (**Ref no: FWA00033228-17112/24**) was granted by the UNILUS-Research Ethics Committee.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS

4.1 Introduction

STATA software was used to estimate the Ordinary Least Squares (OLS) model estimating the relationship between health outcomes and public health expenditure. In this study, the under-five mortality rate (U5MR) was used as a measure of health status because it is mostly used in literature and this indicator is consistently available for Zambia for the period 2000-2021. However, data on per capita public health spending for the period prior to 2000 was not available from the World Development Indicators.

The study also conducted several tests including homoscedasticity, multicollinearity, and autocorrelation before estimating the model in order to ascertain the robustness of the regression estimates.

4.1 DESCRIPTIVE STATISTICS

Table 2 below provides a summary of descriptive statistics of the variables investigated in this study namely, Under-five Mortality rate (U5M), Per Capita Income (Y), Per Capita Public Health Expenditure (PCH), Immunisation (against measles) (IMU) and Total Fertility Rate (TFR) for the period 2000-2021.

Table 2: Summary Statistics of the variables

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
U5M	22	89.28182	30.05776	57.2	156.3
PCH	22	54.17154	25.36624	25.50256	120.8558
Y	22	1121.47	464.9062	359.4295	1820.719
IMU	22	88.36364	5.287411	80	97
TFR	22	5.204909	0.5379371	4.308	5.926

Source: Researcher's Computation

Table 2 above shows that between 2000 and 2021, the average under five mortality rates for Zambia was 89 deaths per 1,000 live births which is above the SDG target of at least 25 deaths per 1,000 live births. During the same period, the minimum under-five mortality was 57 deaths per 1,000 live births while the maximum under-five mortality was 156 deaths per

1,000 live births. During the same period, the average per capita public health expenditure was $54.2. The lowest per capita public health expenditure was $25.5 while the highest per capita public health expenditure was $120.9.

During the period 2000 to 2021, per capita income averaged $1,121.47. In the same period, the highest per capita income was recorded at $1,820.7 while the lowest per capita income was $359.4.

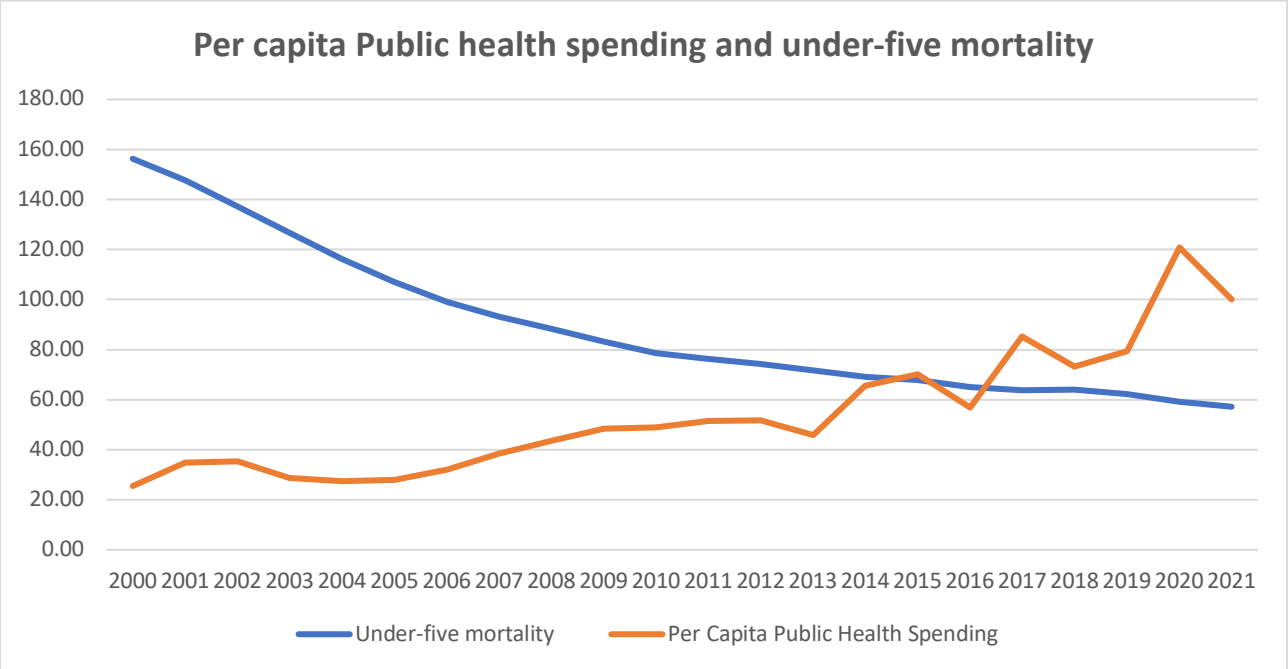
Between 2000 and 2021, the average immunisation (against measles) coverage was 88.4%. The minimum immunisation coverage was 80% while the maximum immunisation coverage was 97%. It can be observed that the performance on immunisation coverage has been consistently high during the period under review.

During the period 2000 and 2021, the average total fertility rate (the average number of children a woman aged 15-49 will have in her entire reproductive period) was 5.2. In the same period, the highest total fertility rate was 5.9 with 4.3 being the lowest total fertility rate.

4.1.1 Per capita public health expenditure and under-five mortality rates in Zambia

Figure 4 below depicts a graphical representation of the relationship between public health expenditure and under-five mortality rates in Zambia for the period 2000-2021.

Figure 4: Relationship between per capita public health expenditure and under-five mortality



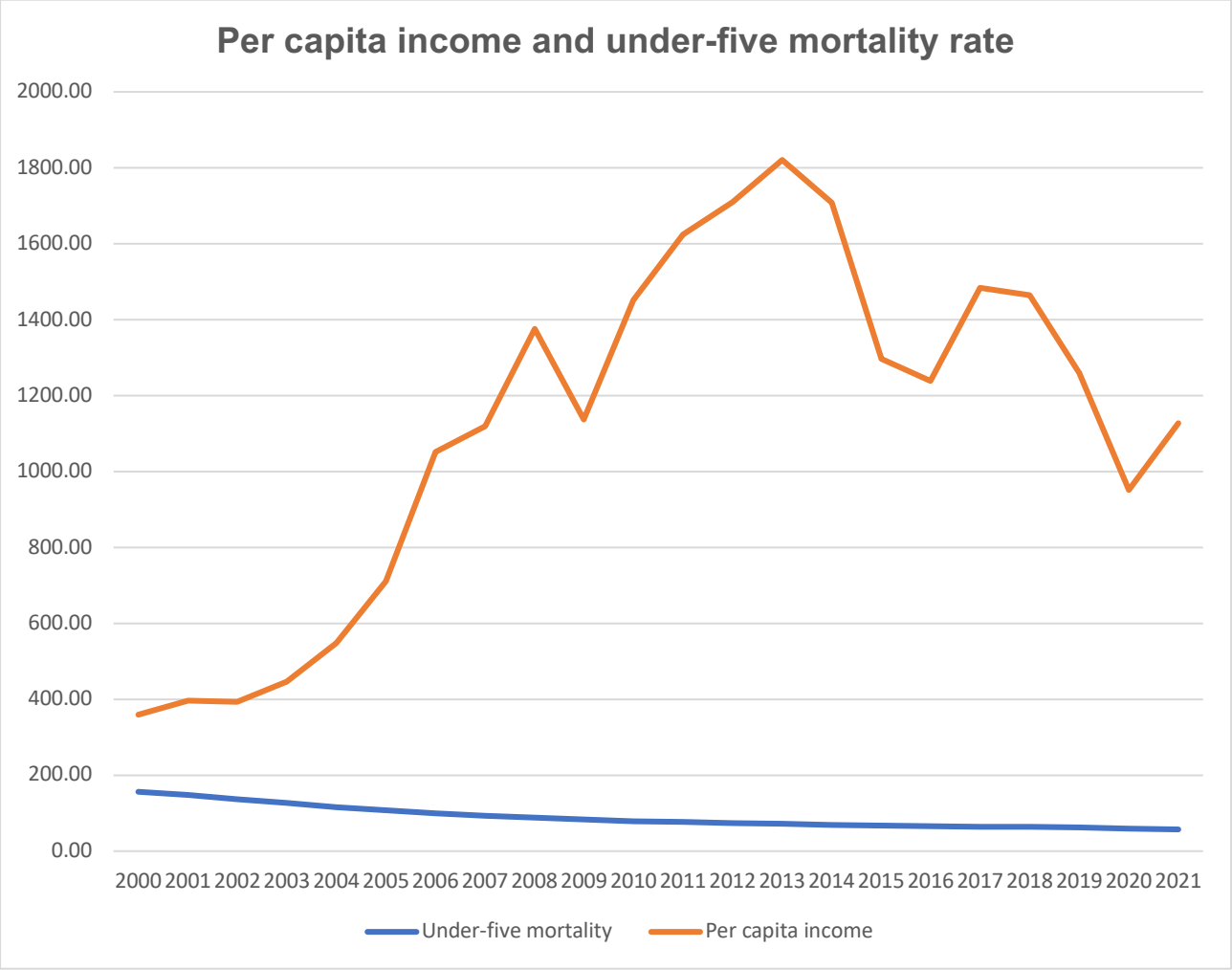
Source: Researcher's Construction

Figure 4 above shows that there is an inverse relationship between per capita public health expenditure (PCH) and under-five mortality rates (U5M). The graph also shows that there has been a steady increase in per capita public health expenditure and at the same time a steady decline in under-five mortality rates.

1.1.2 Per capita income and under-five mortality rates in Zambia

Below is a graphical representation of the relationship between per capita income (Y) and under-five mortality rates (U5M) in Zambia for the period 2000-2021.

Figure 5: Relationship between per capita income and under-five mortality rate



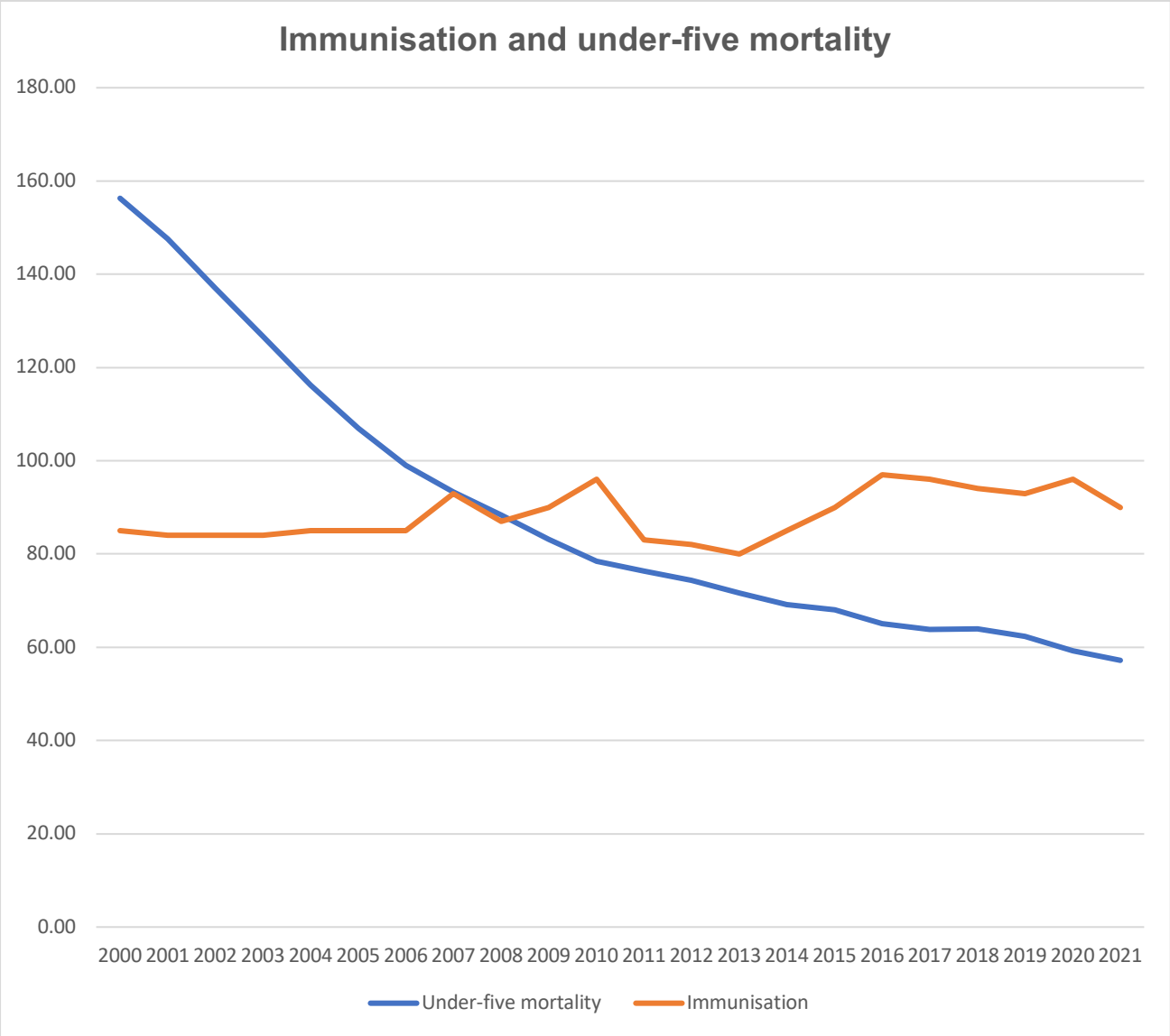
Source: Researcher's Construction

Figure 5 above shows that per capita income for Zambia for the period 2000-2021 has been fluctuating but generally it has been increasing while under-five mortality rates has been declining steadily during the period under review.

4.1.2 Relationship between immunisation and under-five mortality rates in Zambia

Below is a graphical representation of the relationship between immunisation and under-five mortality rates in Zambia for the period 2000-2021.

Figure 6: Relationship between immunisation and under-five mortality rate



Source: Researcher's Construction

Figure 6 above shows that the immunisation coverage has been consistently above 80 percent while at the same time the under-five mortality rates has been declining during the period under review.

4.1.3 Ministry of Health Budgetary Allocation, 2004-2021

Table 3 below presents the budgetary allocation to the Zambian Ministry of Health compared to the total national budget for the period 2004-2021.

Table 3: Ministry of Health Budgetary Allocation, 2004-2021

Year	Ministry of Health Budget (K)	National Budget (K)	% of National Budget
2004	719,823,443,933.00	8,328,934,463,897.00	8.6
2005	899,791,554,231.00	9,779,025,370,413.00	9.2
2006	1,080,816,841,047.00	10,190,378,586,892.00	10.6
2007	1,218,289,707,432.00	12,034,409,035,760.00	10.1
2008	1,512,340,942,914.00	13,761,400,894,438.00	11.0
2009	1,804,792,357,570.00	15,279,037,268,317.00	11.8
2010	1,371,692,096,312.00	16,717,767,817,121.00	8.2
2011	1,758,592,077,757.00	20,537,358,046,564.00	8.6
2012	2,566,933,794,819.00	27,698,281,929,835.00	9.3
2013	2,053,383,288.48 [1]	32,212,160,295.39	6.4
2014	2,646,390,446.00	42,682,034,134.00	6.2
2015	2,758,080,222.00	37,251,406,292.00	7.4
2016	4,436,592,856.00	53,135,825,364.00	8.3
2017	5,732,842,152.00	64,675,302,308.00	8.9
2018	6,824,169,820.00	71,662,385,976.00	9.5
2019	7,519,930,916.00	86,807,894,727.00	8.7
2020	8,656,381,044.00	106,007,612,236.00	8.2
2021	9,230,638,999.00	119,616,011,615.00	7.7

Source: MoFNP, 2024

From table 3 above, it can be observed that between 2004 and 2021, the budgetary allocations to the Ministry of Health did not meet the Abuja Declaration commitment requiring AU member states to allocate at least 15 percent of their total national budget. The average budgetary allocation to the ministry of health as a share of the total national budget is 8.8 percent. The highest budgetary allocation as a share of the total budget was recorded in 2009

[1] The Zambian Government rebased its currency in 2012, thus all the figures post 2012 are rebased.

at 11.8 percent while the lowest allocation as a share of the total budget was recorded in 2014 at 6.2 percent.

4.2 Diagnostic Tests

Conducting diagnostic tests is an essential step in time series modelling. The tests are useful in detecting model misspecification. Therefore, this study conducted diagnostic tests namely, test for normality, multicollinearity, heteroscedasticity and autocorrelation (*see appendix 2*). The objective of the tests was to assess the adequacy of the model employed in this study and thus ascertain the robustness of the regression estimates.

4.2.1 Test for Normality

Test for normality is essential because most of the diagnostic tests depend on it. In addition, inference from the regression results is valid when the errors are normally distributed. Therefore, the Skewness and Kurtosis test for normality was conducted. The Skewness and Kurtosis test determines whether or not the skewness and kurtosis of a variable is consistent with the normal distribution.

The skewness and kurtosis test showed that the probability of skewness which is 0.6754 is asymptotically normally distributed since the p-value of skewness is greater than 0.05. Similarly, the probability of kurtosis indicates that the kurtosis is also asymptotically distributed since the p-value of kurtosis (0.3379) is greater than 0.05. Therefore, according to the skewness and kurtosis test for normality, residuals show normal distribution.

4.2.2 Test for Multicollinearity

Multicollinearity refers to the existence of a linear relationship between or among explanatory variables. Testing for multicollinearity is important because if present, the results obtained from the OLS estimation may be misleading.

To test for multicollinearity, auxiliary regressions were performed. Each explanatory variable was regressed on the remaining explanatory variables. The coefficients of determination (R-squared) from the auxiliary regressions were then obtained and compared to the overall R-squared in the model. The following regression are auxiliary to the main regression.

$$InY = \beta_0 + \beta_1 InPCH + \beta_2 InIMU \quad (7)$$

$$InPCH = In\beta_0 + \beta_1 InY + \beta_2 InIMU \quad (8)$$

$$InIMU = \beta_0 + \beta_1 InY + \beta_2 PCH \quad (9)$$

The output results for the auxiliary regressions are given in the appendix while the coefficients of determination (R-squared) obtained from the auxiliary regressions are given in table 4 below:

Table 4: Multicollinearity Test Results

Equation	Computed R-squared	F-Statistic	Prob>F
7	0.3845	5.93	0.0100
8	0.5686	12.52	0.0003
9	0.3651	5.46	0.0134

Table 4 above shows that there is very low multicollinearity considering the computed R-squared and the F-statistics for equation (7), (8) and (9) since the computed F-statistics does not exceed the critical F at 5% significance levels.

4.2.3 Test for Heteroscedasticity

Heteroscedasticity occurs when the error term is not constant. Testing for heteroscedasticity is important because OLS in the presence of heteroscedasticity results in making inferences that are misleading. For this reason, this paper used White's General Heteroscedasticity Test to detect heteroscedasticity. This test was used because unlike other tests it does not rely on the normality assumption.

The test statistic is given by $nR^2 \sim \times^2_{df}$ which implies that the sample size (n) times R^2 obtained from the auxiliary regression asymptotically follows the chi-square distribution with df equal to the number of regressors (excluding the constant term) in the auxiliary regression.

In this study the computed $\times^2$ is 9.42 with a probability of 0.0935. The 5% critical chi-square value is 11.071. Since the computed chi-square value does not exceed the critical chi-square value at 5%, the conclusion on the basis of the White test is that there is no heteroscedasticity.

4.2.4 Test for Autocorrelation

Autocorrelation refers to the correlation between member of series of observation ordered in time (as in time series data) or space (as in cross sectional data). Applying the usual OLS method in the presence of autocorrelation to compute the variances and standard errors of

the OLS estimators may give misleading results. For this reason, the test for autocorrelation was performed. Specifically, the Breusch-Godfrey LM test is used in this paper because unlike the Durban Watson test it is less sensitive to the assumption that the distribution of residuals is normal.

Following the Breusch-Godfrey LM test, the p value for the computed chi square is greater than 0.05, therefore, we can't reject the null hypothesis. In other words, there is no auto correlation in between the residuals in the model.

4.2.5 Unit Root Test

Augmented Dickey Fuller test (ADF Test) is a common statistical test used to test whether a given time series is stationery or not in order to avoid spurious regression results. In this regard, the study conducted the ADF test for unit root in the time series data for the period from 2000 to 2021. Table 5 below provides the results:

Table 5: ADF Test for Unit Root

Variable	ADF-Statistics	
	t-stat	5% c.v
Log_Y	-2.19	-3.000
log_IMU	-2.211	-3.000
Log_TFR	3.05	-3.000
Log_PCH	-0.899	-3.000
Log_U5M	-5.693	-3.000
d_log_Y	-3.405	-3.000
d_log_IMU	-4.942	-3.000
d_log_PCH	-6.232	-3.000

As it can be seen from table 5 above, the three variables in their logarithm form have a unit root or are non-stationary as the absolute value of the t statistics is less than the absolute value at the critical value. These findings suggest that the three variables, namely; Log_Y, Log_IMU, and Log_PCH are integrated of order 1 (that is, they become stationary only after differencing once) except the Log_U5M and Log_TFR which is 1(0). Therefore, the regression run would have spurious results. Therefore, to achieve stationarity, the variables were differenced at first order.

4.2.6 Lag Length Selection Test

The requisite for the lags arises because values in the past affect today's values for a given variable. This implies that the variable in question is persistent. There are numerous methods to determine how many lags to use. The two prominent methods frequently encountered in time series analysis are the Akaike Information Criterion (AIC) and the Schwarz Bayesian Information Criterion (SBIC). Therefore, to determine the number of lags to use in our model, table 6 below provides results for the Final Prediction Error (FPE), Akaike's Information Criterion (AIC), Schwarz's Bayesian Information Criterion (SBIC), the Hannan Quinn Information Criterion (HQIC), the Log Likelihood (LL) and Likelihood-ratio (LR).

Table 6: Lag Length Test Results

Lag	LL	LR	FPE	AIC	SBIC	HQIC
0	94.25168	NA	9.15e-11	-8.925168	-8.676235	-8.876574
1	231.6829	192.4037	1.32e-15	-20.16829	-18.67469	-19.87672
2	275.7561	39.66589*	3.53e-16*	-22.07561*	-19.33735*	-21.54107*

*indicates lag order selected by the criterion

Source: Researcher's Computation

The results in table 6 above shows that the LR, FPE, AIC, HQIC and the SBIC tests all chose two lags. Following the determination of the number of lags, the next step was to test for cointegration amongst the variables.

4.2.7 Johansen Cointegration Test

Table 7 below shows cointegration test results based on Johansen Maximum Likelihood method.

Table 7: Johansen Cointegration Test Results

rank	parms	LL	eigen value	trace statistics	5% c.v
0	30	211.73788		128.0421	65.520
1	39	239.15404	0.93553	73.2098	47.210
2	46	258.18527	0.8509	35.1473	29.680
3	51	269.24868	0.669223	13.0205*	15.41
4	54	274.53514	0.41060	2.4476	3.760
5	55	275.75892	0.11519		

Source: Researcher's Computation

Given that the trace statistic at r=0 of 128.0421 exceeds its critical value of 65.520 we reject the null hypothesis of no integrating equations. Similarly, because the trace statistic at r=1 of 73.2098 exceeds its critical value of 47.210, we reject the null hypothesis that there is one or fewer cointegrating equations. In addition, because the trace statistic at r=2 of 35.1473 exceeds its critical value of 29.680, we reject the null hypothesis that there is two or fewer cointegrating equations. In contrast, because the trace statistic at r=3 of 13.0205 is less its critical value of 15.41, we cannot reject the null hypothesis that there are three or fewer cointegrating equations.

Because Johansen's method for estimating r is to accept as $\hat{r}$ the first r for which the null hypothesis is not rejected, we accept r=3 as our estimate of the number of cointegrating equations between these four variables.

4.2.8 Vector Error Correction Model (VECM)

The presence of cointegration between variables suggests a long-term relationship among our variables of interest. The VECM test results for the model used in this study are presented in the table below:

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_log_U5M	7	.013618	0.9574	292.1189	0.0000
D_log_Y	7	.149471	0.5763	17.68151	0.0135
D_log_IMU	7	.062029	0.1422	2.155652	0.9507
D_log_PCH	7	.133873	0.6772	27.26991	0.0003
D_log_TFR	7	.004026	0.9626	334.659	0.0000

Source: Researcher's Computation

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
log_U5M	1	.	.	.	.	.
log_Y	.555705	.0701231	7.92	0.000	.4182662	.6931439
log_IMU	6.853931	.8201478	8.36	0.000	5.246471	8.461391
log_PCH	-4.16174	.3793572	-10.97	0.000	-4.905266	-3.418213
log_TFR	-14.33636	.9934232	-14.43	0.000	-16.28343	-12.38928
_cons	-.5557483	.	.	.	.	.

Source: Researcher's Computation

4.3 Model Estimation

The study proceeds to estimate the parameters using the Ordinary Least Squares (OLS) method since stationarity is achieved through the use of the Johansen Co-integration and the Vector Error Correction Model (VECM) econometric technique. Thus equation 2 is now estimated in its differenced form. Table 8 below provides the results from the regression analysis (see annex 3 for detailed results).

Table 8: Empirical Results

Variable	Coefficient	P-Value
d_log_PCH	-0.0301594	0.671
d_log_Y	-0.2960742	0.000
d_log_IMU	-0.397516	0.073
d_log_TFR	1.493253	0.000
_cons	5.934982	0.000

R-Squared=0.9836
Adj R-squared=0.9795

Source: Researcher's Computation

Table 8 above shows that all the coefficients have the correct sign as expected. However, per capita public expenditure on health and immunisation are statistically insignificant at 5% significance level.

The computed R-squared of 0.9836 implies that immunisation, per capita income, per capita public health expenditure, and total fertility rate explains about 98.36 percent of the variations in under-five mortality. This indicates that the model is highly effective in explaining and predicting changes in under five mortality considering that the maximum value of R-squared is 1.

CHAPTER 5: DISCUSSION OF RESULTS AND FINDINGS

5.1 Introduction

This chapter presents the discussion of the results obtained from investigating the impact of public health expenditure on health outcomes. Specifically, it presents a discussion of the results from the OLS estimation technique for the three objectives of the study.

5.2 Discussion of Results and Findings

All the coefficients of the explanatory variables have the expected sign as shown in table 5. In addition, the model is well fitted given a high R-squared of 0.9836 which implies that per capita health expenditure, per capita income, immunisation and total fertility rate explains about 98.36 percent of the variations in under-five mortality rate. However, the regression results for per capital public health expenditure and immunisation are insignificant at 5 % significance level. These results are similar to the findings by Bhalotra (2007), and Akinlo and Sulola (2019).

The findings of this study can be attributed to a smaller sample size used in the investigation which the researcher had no control of considering that there was no data on the per capita public health expenditure (the main variable) for the period prior to 2000. In addition, the results may indicate that the funding allocation to the health sector was inadequate to bring about significant improvement in health outcomes considering that the budget allocation to the health sector did not meet the Abuja Declaration target requiring AU member states to allocate at least 15% of national budgets during the period under review (*see table 3*). Further, the funding allocation could have been poorly targeted with most of the resources going towards emoluments and capital projects and thus leaving very little funding for procurement of vaccines, drugs, medical equipment and other medical supplies. Lastly, the findings could suggest that there was misappropriation of public health allocations during the study period which could have affected the efficacy of public health spending. In fact, Baldacci, et al., (2008), Yaqub, Ojapinwa, Yussuff (2012) and Asongu (2014) argue that increasing public expenditure on health is less likely to improve health outcomes unless corruption is curbed (Ssozi and Amlani, 2015).

5.2.1 Per Capita Public Health Expenditure

The coefficient for the per capita public health expenditure has the correct sign as expected, negative for under five mortality rates. However, it is statistically insignificant since p values of 0.624 is greater than 0.05.

The coefficient of per capita health expenditure is -0.035. This means that a 10 percent increase in per capita public health expenditure will result in a 0.35 percent decline in the under-five mortality holding immunisation, per capita income and total fertility rate constant. Thus, as Government increases its spending on health, under-five mortality declines. However, considering that per capita public health expenditure is statistically insignificant it may suggest that public health allocations in Zambia were not efficiently utilised to bring about improved health outcomes.

5.2.2 Per Capita Income

The coefficient for the per capita income variable has the correct sign as expected, negative for under five mortality rates. It is also statistically significant.

The coefficient of per capita income is -0.29. This means that a 10 percent increase in per capita income results in a 2.9 percent reduction in under-five mortality holding immunisation, per capita health expenditure and total fertility rate constant.

The result implies that, a growth in the productive capacity of the economy (economic growth) as measured by real per capita income can enable the Government to sustainably increase its budgetary allocations to the health sector thereby increasing the level of investment in capital items, drugs, vaccines, medical equipment and medical supplies thus ensuring the effectiveness of available human resources and quality health care provision and consequently improve health outcomes.

5.2.3 Immunisation

The coefficient for immunisation has the correct sign as expected, negative for under-five mortality rate. However, it is statistically insignificant since the p values of 0.113 is greater than 0.05.

The coefficient of immunisation is -0.34. This means that a 10 percent increase in immunisation rates will result in a 3.4 percent decline in the under-five mortality holding per capita health expenditure, per capita income and total fertility rate constant.

In general, the OLS estimates shows that increases in per capita income reduces under-five mortality rate and thereby improving health outcomes. From a theoretical point of view, public health expenditure is key in improving health outcomes. However, this study has shown that public health expenditure is not a sufficient condition in improving health outcomes. Thus, other policy measures such as increasing real GDP per capita, increasing access to water and sanitation, and ensuring food security should also be considered by policy makers if health outcomes are to improve.

CHAPTER 6: CONCLUSION

The central focus of this study was to examine whether government expenditure allocations to the health sector improves health outcomes in Zambia. In doing so, this study utilized time series data for Zambia for the period 2000 to 2021 for which data was readily available for public spending on health on a per capita basis together with selected control variables that determine health outcomes namely, per capita income, immunisation and total fertility rate. It is worth noting that data on per capita public health spending for Zambia was not available for the period prior to 2000.

This study used under-five mortality rate as an indicator of health outcomes for empirical analysis. The regression results have shown that per capita public health spending is not a key determinant of health outcomes in Zambia. Instead, the results indicate that per capita income improves health outcomes in Zambia. Based on the elasticity of under-five mortality rates, it was shown that a 10 percent increase in per capita income reduces under five mortality by 2.9 percent.

This study points to the need for the Government to implement strategies and measures that are aimed at ensuring sustainable economic growth reflected through increased real per capita income. It has shown that increasing per capita income improves health outcomes. This is because economic growth increases the capacity of the Government to allocate more resources to the health sector. In addition, economic growth has the potential to reduce poverty, improve nutrition, and to improve access to water and sanitation and thereby improve health outcomes such as reduced under-five mortality.

Like other countries, Zambia is always pressed to bring the national budget into balance. In this process government budgetary allocation may be cut without much thought to the health sector specific outcomes. However, this study has shown that adequate resources needs to be channeled to the health sector for the funds to have a positive and significant improvement in health outcomes. Thus, there is need for policy makers to consider the impact of health expenditures on health outcomes in the budgetary formulation process and allocate resources to the health sector accordingly.

The study had its limitations. The major limitation surrounds the choice of variables and data. Published data on per capita public expenditure was nonexistent for the period prior to 2000 and thus limiting the sample size to 22. However, this is a drawback which the researcher had no control of. It is a well-known fact that a small sample size is problematic because it

often results in multicollinearity and consequently misleading results. In addition, some of the key variables of interest largely to do with socio-economic characteristics that may affect health outcomes such as female literacy rate was not available for Zambia for the period under review. Additionally, a potential limitation lies in the fact that this study does not control for private health expenditure. Past studies have indicated that private health expenditure and private health insurance does play a role in supplementing public health care (Costa and Garcia, 2002). Zambia has a number of private health care facilities through private hospitals or private health practitioners especially in the urban areas. Data on these forms of private health care services is not available. Hence, the model tested here does not include private health care expenditure.

The factors considered in this study which determine health outcomes are not exhaustive since many other factors influence health outcomes as evidenced in the literature review. Several factors do affect the health of an individual and/or that of an entire population. For instance, lifestyle and health behaviours like physical activity, and alcohol and tobacco consumption were uncaptured due to lack of data. These health behaviours have a high potential to affect health outcomes and may constrain the health effect of the spending. Additionally, the efficacy of government health spending may be influenced by the quality of governance and existing institutional structures and level of infrastructural development; these issues were not addressed by the study (Boachie, Ramu, and Põlajeva, 2018). Thus, further studies should endeavor to include other factors not considered in this study.

Finally, while acknowledging the limitations of this study, the empirical findings of this study indicate that per capita health expenditure does not improve health outcomes in Zambia. Instead, per capita income has been found to be a key determinant in improving health outcomes in Zambia. Therefore, this study points to the fact that the Government of Zambia certainly needs to increase its budgetary allocations to the health sector in line with the Abuja Declaration considering that the current allocations are inadequate to bring about significant changes in the health outcomes of its citizenry.

CHAPTER 7: RECOMMENDATIONS

Based on the findings of the study, below are some of the key recommendations:

a) Government to implement policies and strategies aimed at increasing the GDP per capita (real per capita income) in order to ensure that increased allocations to the health sector are sustained which will allow for increased level of investment in capital items, drugs, vaccines and medical supplies thus ensuring the effectiveness of available human resources and quality health care provision.

b) There is need to increase the Government budgetary allocation to the health sector to a minimum of 15 percent of the total national budget in line with the Abuja Declaration in order to ensure improved health outcomes. This will result in increased access to quality health services through increased construction of health facilities, procurement of drugs, vaccines and medical equipment as well as recruitment of health workers.

c) Considering the high elasticity of immunisation in reducing under five mortality, the Government should prioritise funding to immunisation programmes. This will ensure that the country continues to achieve high immunisation coverage.

d) There is need to strengthen financial management in order to ensure appropriate and efficient use of public sector health funds so that the resources disbursed by Government to the sector are utilized according to the intended purpose for improved health outcomes.

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APPENDIX 1: DATA SET

Year	U5M	Y[2]	PHC[3]	IMU	TFR
2000	156.30	359.43	25.50	85.00	5.93
2001	147.60	396.55	34.81	84.00	5.86
2002	137.10	393.86	35.33	84.00	5.79
2003	126.60	446.29	28.61	84.00	5.73
2004	116.30	548.69	27.57	85.00	5.72
2005	107.00	710.98	27.88	85.00	5.71
2006	99.00	1051.72	32.01	85.00	5.69
2007	93.30	1118.73	38.50	93.00	5.61
2008	88.30	1375.50	43.48	87.00	5.54
2009	83.10	1136.24	48.53	90.00	5.45
2010	78.50	1451.11	48.92	96.00	5.36
2011	76.30	1624.87	51.41	83.00	5.27
2012	74.30	1710.05	51.78	82.00	5.15
2013	71.60	1820.72	45.93	80.00	5.03
2014	69.20	1707.49	65.59	85.00	4.90
2015	68.00	1295.88	70.09	90.00	4.79
2016	65.10	1239.09	56.96	97.00	4.71
2017	63.80	1483.47	85.24	96.00	4.61
2018	64.00	1463.90	73.24	94.00	4.54
2019	62.30	1258.99	79.37	93.00	4.45
2020	59.30	951.64	120.86	96.00	4.38
2021	57.20	1127.16	100.15	90.00	4.31

Source: World Bank Development Indicators, 2024

Where;

U5M = Under-five mortality rate

Y = Per capita income

PCH = Per capita health expenditure

IMU = Immunization

TFR = Total Fertility Rate

[2] Data is in current US dollars
[3] Data is in current US dollars

APPENDIX 2: DIAGNOSTIC TESTS

2.1 Test for Normality

```
                    Skewness/Kurtosis tests for Normality
                                                              ------- joint ------
    Variable |    Obs    Pr(Skewness)   Pr(Kurtosis)  adj chi2(2)    Prob>chi2
-------------+-------------------------------------------------------------------
       resid |     22      0.6754         0.3379         1.19         0.5519
```

2.2 Test for Multicollinearity

```
. regress log_Y log_PCH log_IMU

      Source |       SS       df       MS              Number of obs =      22
-------------+------------------------------           F(  2,    19) =    5.93
       Model |  2.23848978     2  1.11924489           Prob > F      =  0.0100
    Residual |  3.58387255    19  .188624871           R-squared     =  0.3845
-------------+------------------------------           Adj R-squared =  0.3197
       Total |  5.82236233    21  .277255349           Root MSE      =  .43431

------------------------------------------------------------------------------
       log_Y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     log_PCH |   .8194583   .2663403     3.08   0.006     .2620017    1.376915
     log_IMU |  -1.158549   1.983657    -0.58   0.566    -5.310391    2.993293
       _cons |   8.907657    8.31166     1.07   0.297    -8.488848    26.30416
------------------------------------------------------------------------------

. regress log_PCH log_Y log_IMU

      Source |       SS       df       MS              Number of obs =      22
-------------+------------------------------           F(  2,    19) =   12.52
       Model |  2.33939066     2  1.16969533           Prob > F      =  0.0003
    Residual |  1.77479354    19  .093410186           R-squared     =  0.5686
-------------+------------------------------           Adj R-squared =  0.5232
       Total |   4.1141842    21  .195913533           Root MSE      =  .30563

------------------------------------------------------------------------------
     log_PCH |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       log_Y |   .4058095   .1318962     3.08   0.006     .1297476    .6818713
     log_IMU |   3.426551    1.16861     2.93   0.009     .9806217     5.87248
       _cons |  -14.25822   5.057633    -2.82   0.011    -24.84397   -3.672475
------------------------------------------------------------------------------

. regress log_IMU log_Y log_PCH

      Source |       SS       df       MS              Number of obs =      22
-------------+------------------------------           F(  2,    19) =    5.46
       Model |  .027078319     2   .01353916           Prob > F      =  0.0134
    Residual |  .047090996    19  .002478473           R-squared     =  0.3651
-------------+------------------------------           Adj R-squared =  0.2983
```

```
       Total |  .074169316    21  .003531872           Root MSE      =  .04978

------------------------------------------------------------------------------
     log_IMU |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       log_Y |   -.015223   .0260647    -0.58   0.566    -.0697769     .039331
     log_PCH |   .0909174    .031007     2.93   0.009     .0260191    .1558158
       _cons |   4.230728   .1433744    29.51   0.000     3.930641    4.530814
------------------------------------------------------------------------------
```

2.3 Test for Heteroscedasticity

```
White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(5)      =      9.42
         Prob > chi2  =    0.0935
Cameron & Trivedi's decomposition of IM-test

---------------------------------------------------
              Source |       chi2     df      p
---------------------+-----------------------------
  Heteroskedasticity |       9.42      5    0.0935
            Skewness |       1.14      2    0.5661
            Kurtosis |       0.42      1    0.5191
---------------------+-----------------------------
               Total |      10.97      8    0.2033
---------------------------------------------------
```

2.4 Test for Autocorrelation

```
. estat bgodfrey

Breusch-Godfrey LM test for autocorrelation
------------------------------------------------------------------------------
    lags(p)  |          chi2               df                 Prob > chi2
-------------+----------------------------------------------------------------
       1     |          3.333               1                   0.0679
------------------------------------------------------------------------------
                       H0: no serial correlation
```

APPENDIX 3: MODEL ESTIMATION RESULTS

```
. regress d_log_U5M d_log_PCH d_log_Y d_log_IMU d_log_TFR

      Source |       SS           df       MS      Number of obs   =        21
-------------+----------------------------------   F(4, 16)        =    240.05
       Model |  1.82721708         4   .45680427   Prob > F        =    0.0000
    Residual |  .030446947        16  .001902934   R-squared       =    0.9836
-------------+----------------------------------   Adj R-squared   =    0.9795
       Total |  1.85766403        20  .092883201   Root MSE        =    .04362

------------------------------------------------------------------------------
   d_log_U5M |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   d_log_PCH |  -.0301594   .0697183    -0.43   0.671    -.1779556    .1176368
     d_log_Y |  -.2960742   .0241428   -12.26   0.000    -.3472547   -.2448937
   d_log_IMU |   -.397516   .2070018    -1.92   0.073    -.8363402    .0413083
   d_log_TFR |   1.493253   .2884663     5.18   0.000     .8817314    2.104774
       _cons |   5.934982   1.198124     4.95   0.000     3.395073    8.474891
------------------------------------------------------------------------------
```