THE IMPACT OF HEALTH INVESTMENTS ON CHILD MORTALITY

IN WEST AFRICA

(1992-2012)

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CERTIFICATION

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DEDICATION

To the Almighty God and Heavenly Father who has been there for me.

To my loving parents and siblings.

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ABSTRACT

This study examines how various health investments culminate in child health outcomes in Africa, case study the ECOWAS region. The main objectives of the study includes evaluating the impact of health inputs to health on child mortality in developing and advanced nations, and to determine if socioeconomic status has significant impact on child mortality. The study used panel data gathered from the World Bank World Development Indicators database. Data analysis relied on the use of techniques such as fixed effects estimations and ordinary pooled OLS. Results reveal that there is a significant relationship between some health investments and child mortality, and health investments culminate in greater child health outcomes in developing countries than in the developed world. Also, socioeconomic status was found to impact on child mortality.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The health of a child has futuristic effects on the productivity of that individual at adulthood. Several illnesses that affect children spread out into the learning ability of such a child, and so skills acquisition may not be as efficient as it would be in a healthier child. Also, physical deformities (such as those caused by poliomyelitis) can affect a child's (and later on, the adult's) ability to function properly. This reduces the level of physical productivity of such an individual (Report of the Partnership for Maternal Newborn and Child Health 2013). Also, a child's health directly affects an economy in aggregate terms, as more is saved, which would have been spent on medical care for the sick child. Also, more can be spent on educating the child, and so the child can attain higher levels of literacy and be more useful in the economy. Furthermore, a healthy child frees up time for the parents to work, adding to productivity and sick-free days at work. Children can be seen to contribute to productive capacity in Africa, as poverty has made it necessary for children to work as well as attend school. This emphasizes the need for improved child health in this part of the world.

The health of an individual, especially at the early years, is hence very crucial for the proper development and performance of such a person, and for the economy as a whole. Several factors may affect the health of children, such as the socioeconomic status of the parents (Boco, 2010; Rasella *et. al* 2013). This is a broad determinant, as the income level of the parents determines the health status of the parents, the level of nutrition the child receives, access to sanitation facilities and safe drinking water (Gunther and Fink 2010; Wolfgang *et. al* 2013) as well as

access to primary health care such as immunizations and vaccinations against diseases such as measles, poliomyelitis and others, which all impact on the health of a child.

Another determinant of the health of a child may be the level of spending on health care both by individuals and by the government (Novignon 2012; Yaqub 2002). Also, the health and education background of the mother to a large extent influences the health of a child (Chen and Li, 2006; Ewald and Boughton 2002; Desai and Alva 1998). These determining factors all represent investments in the health of children at the individual and family level.

According to the United Nations Children's Fund (UNICEF), West Africa accounted for over 40 percent of Africa's child deaths. The major cause of these deaths has been attributed to neonatal diseases and malaria, both linked to malnutrition and poor environmental health. Although the numbers have decreased in recent years, 41 percent of our children under the age of five are still stunted, 23 percent are still underweight. Malnutrition is concentrated in the rural areas, and primarily effects poor women and children. The underlying problems leading to such high levels of malnutrition include maternal malnutrition, lack of education, poor breastfeeding practices and lack of access to effective health services (State of Africa's Children, 2008).

The prevalence of HIV/AIDS in the African region over the last decade has shown little improvement, and in some countries there has been a worsening. In 2000, about 2,989 out of 100,000 persons had HIV in Africa. By 2009, the figure dropped to 2,740.In Senegal the figure rose from 300 to 472 out of 100,000 persons. In Sierra Leone in rose from 490 to 860 between 2000 and 2009. Others showed marked improvement. Liberia showed a drop from 1,827 to 937 per 100,000.

As regards immunization and vaccination, coverage for DPT (diphtheria and pertussis and tetanus toxoids) vaccine in the African region has improved. In Africa generally, the percentage coverage was 57% in 1999, and it rose to 71% in 2011. However, some countries have shown a drop in percentage coverage. Equatorial Guinea showed a decline from 77% to 33%, likewise Gabon, with a drop from 78% to 45%. Other countries showed improvement; Guinea had a percentage increase from 17% to 59% between 1999 and 2011 and Mali moved from 42% to 72%.

Hepatitis B vaccination has also risen by leaps in the African region. Most nations in West Africa in the year 2000 had zero percentage coverage, but by 2011 showed percentages above 50%, with the exception of Chad (22%), Gabon (45%) and Liberia (49%). Measles and Poliomyelitis vaccinations have also risen in the past decade.

1.2 STATEMENT OF RESEARCH PROBLEM:

The Millennium Development Goals (MDGs) have set targets for development in African nations that signed up for the program. Of the set targets, the MDG 4 is centered on reducing child mortality by two-thirds, by the year 2015. The target was set in 1990. With the current rate of decline in child mortality rates in Africa, south of the Sahara, the target rate of child deaths will not be achieved.

There has been a myriad of initiatives and programs geared towards improving the health status of Africans. Some of the programs include Coca Cola Africa Foundation, with special focus on malaria and HIV/AIDS, Global Aliance for Africa, with special focus on women and children, Action Health Incorporated (AHI), aimed at improving the health of adolescents, the UNICEF strategy called Integrated Maternal, Newborn and Child Health (IMNCH) and several others.

With all these put in place, child mortality still remains a challenge in West Africa, and health is necessary for economic growth, especially in a country like Nigeria with the majority of the rural population, including children, are actively involved in agricultural and other labor-intensive means of sustenance.

Brussels (2013), concerning health investments in the European Union and other parts of the world, said that the greater the expenditure, the lower the improvement in health status as a result of its increase. Countries vary significantly (especially between the developing and the developed world) in their ability to translate a similar level of resources into health outcomes; comparisons show that the same amount of per capita health expenditure results in varying health outcomes even after taking into account differences in lifestyle and socioeconomic realities in different countries.

Amiri and Gerdtham (2013) stated that the effect of health investments on health outcomes is stronger in countries where generally the level of health is lower (developing countries), implying that developing countries (LDCs) tend to have greater health outcomes from corresponding health investments than advanced nations (DCs), because of the poor state of health in LDCs, compared to DCs. Several studies are in the affirmative (Anderson and Hague, 2007; Novignon, *et. al*, 2012) and others disagree (Filmer and Pritchett, 1997; Yaqub *et. al*, 2008).

The literature is hence inconclusive on the issue of health investments and corresponding health outcomes, and this study seeks to revisit the issue of health investments and child mortality in Africa, case study on the ECOWAS region, and make comparison with Europe, an advanced continent, using the European Union (EU) to capture the continent.

1.3 RESEARCH QUESTIONS

Based on the observed levels and trends in the various determinants of child health and the corresponding child mortality rates in the African region, the study seeks to answer these questions:

1. Does improvement in immunization coverage culminate in improved child health outcomes in West Africa?
2. Does the income level of individuals affect the impact of their health investments on child mortality?
3. Do health investments in developing nations have greater impact in reducing child mortality than in advanced nations?

With these in mind, this study seeks to study the effect of health investments on child mortality in the ECOWAS region.

1.4 OBJECTIVES OF THE STUDY

There have been mixed changes in the levels and trends of various health investments across entities, with improvements in some and declines in others. The overall objective of this study is to examine the long run impact that these health investments have on the rate of child deaths in West Africa. The specific objectives include:

I. To determine the effect of immunization on child health outcomes.

II. To determine to what extent the income levels of West Africans affects children's health.

III. To compare the magnitude of the impact in the developing and the developed world.

1.5 RESEARCH HYPOTHESES

1. H_0: immunization has no impact on child health status in West Africa.

   H_1: immunization has impact on child health status in West Africa.

2. H_0: income level has no impact on child health status in West Africa.

   H_1: income level has impact on child health status in West Africa.

3. H_0: returns on health investments are larger in developed regions than in developing regions.

   H_1: returns on health investments are larger in developing regions than in developed regions.

1.6 SCOPE OF THE STUDY

The purpose of the study is to determine the impact of health investments on child mortality rates in the ECOWAS region and the EU. The ECOWAS region consists of all the countries in Western Africa, with the exception of Equatorial Guinea, Gabon, Mauritania and Cameroon, which are not members of the ECOWAS body anymore. They are fifteen countries in all, namely Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. The EU consists of twenty-eight member countries, namely Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy,

Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden and the United Kingdom. To do this, the study will run regressions using panel data analysis for both regions, for a period of 20 years, 1992-2012.

1.7 JUSTIFICATION OF THE STUDY

There could be several hindering factors preventing health investments from resulting in improved health conditions. The socioeconomic status of individuals is a possible limitation in the African context, which is characterized by low levels of per capita incomes and high levels of inequality. Other limiting factors may be effectiveness of policies, corruption, environmental challenges, and cultural beliefs. This study will analyze the impact environmental, socioeconomic and family level health investments have on child health in developing countries, and compare it to what obtains in advanced nations.

In the event that health investments are seen to positively impact the health of children by reducing the under-five mortality rates in the region, suitable programs improvements and policies can be put in place to ensure greater health investments both at the household and community levels. Also, on the issue of poverty, if it is concluded that poverty does affect the health of children by raising the rates of child mortality, suitable policies can be addressed to key poverty areas which affect children directly, such as policies to improve the health of mothers, policies to improve literacy of mothers, policies and programs to increase accessibility to primary health care facilities in deprived parts of the country, environmental policies and a host of others.

1.8 SOURCES OF DATA

The data used for this study will be obtained from the World Bank, World Development Indicators (2014).

1.9 STRUCTURE OF THE STUDY

The study has five chapters. Chapter one is basically an introductory chapter that includes the background of the study ,statement of problem , objectives of the study, justification of study, objective of the study , research hypothesis , scope of the study. Chapter two deals with theoretical review as well as the literature review of relevant literatures on health investments and health outcomes. In Chapter three we considered the research methodology. In this chapter the model that captured the relationship between health inputs and child mortality was specified. A brief description of relevant variables used in study is also included, with the a priori expectations. Chapter four also includes analysis and presentation of the results of our estimated model. Chapter five summarizes the major findings emerging in this study and offers policy recommendations.

1.10 DEFINITION OF TERMS

Childhood: The period from when a child is born to the time the child is independent of the parents, usually around 20. However, this study focuses on the early years from age 0-5, due to the dearth of childhood deaths within this age bracket in West Africa.

Mortality: this refers to a permanent disappearance of all evidence of life at any time after the birth has taken place (WHO, 1999, 2012). Mortality rate is the number of deaths, expressed in units of deaths per 1,000 of the population per year.

Child mortality rate: this is usually referred to as under-5 mortality (U5M) rate. It measures the probability of children dying before they clock five, measured as number of children dying before five years of age, per 1,000 live births, in a given year.

Health investment: This refers to the various factors both endogenously and exogenously determined that determine health, such as maternal health and literacy level, socioeconomic status, availability of primary health care facilities like immunizations and vaccinations, environmental health like availability of sanitation facilities and safe drinking water, as well as depreciating factors that impact on health which are usually diseases and illnesses like measles, malaria, polio among others.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

A microeconomic view of health sees health as having two functions; on one hand, good health is seen to have value in itself. Hence people seek to attain perfect health as much as possible. On the other hand, there are other desirable things in life, which if pursued sometimes jeopardize ones' health. Hence, the probability of being healthy in the future is often sacrificed for present satisfaction (Zweifel *et. al*, 1997). That being said, it is important to note that the state of health is not fully under the individual's control. Other factors affect ones' health, which are outside the control of the individual (uncontrollable forces).

Some controllable factors that determine ones' health are lifestyle, habits, occupation, health care service and income level. Ones' lifestyle which may affect ones' health constitute of one's diet or nutrition, whether or not one gets enough and adequate exercise and sleep, one's precautionary safety measures such as crossing the road, switching off appliances in the home, staying away from radioactive and ultraviolet rays, et cetera. Also, one's habits affect may affect the health. A smoker or drinker reduces his chances of living in good physical health in the future. A cocaine addict may experience deterioration in his mental health.

In terms of one's occupation, some jobs are hazardous to one's health. People working in factories and labs have to be extra cautious, as they come in contact with dangerous substances or machinery. People working in electrical companies, construction companies or mining business face risk of physical damage and even death every day. Lastly, one's income level also

affects the health. Low income levels imply an inability to provide adequately one's basic needs of food, clothing and shelter. One is thus more exposed to the hunger, harsh weather conditions, etc. A major environmental factor affecting health is water quality, especially for the health of infants and children in developing countries. Studies show that in developed countries, the lack of neighborhood recreational space that includes the natural environment leads to lower levels of neighborhood satisfaction and higher levels of obesity; therefore, lower overall well being.

Other factors are uncontrollable, in the sense that they cannot be determined by the individual. These include one's genetic make-up, the environment one lives in, one's age, et cetera. A person living in an industrial environment is exposed to pollutants, which may be dangerous to the health. On a broader scale, the tropics provide a good breeding ground for all sorts of parasites like the common mosquitoes, tsetse flies and others. These increase the chances of contracting the diseases they carry. Also in terms of one's environment, the population density also affects one's health condition. A place with many people living closely together increases the chances of contracting a disease from someone, especially airborne diseases. The magnitude of the impact of various environmental conditions on human health is determined by, among other factors, the household economy (i.e. socioeconomic status), family hygiene, water quality and availability as well as the presence of environmental services at the household and community levels (Usman *et. al* 2009).

This chapter constitutes a review of relevant literature which includes methodologies, empirical evidences, theories, propositions, findings and conclusions of other scientific works and writings related to this research.

2.2 CONCEPTUAL ISSUES AND STYLIZED FACTS

2.2.1 Health Investments

Health investments are determining factors affecting health which are controllable by the individuals or groups concerned and can be positive or negative. At the microeconomic level, they may be seen as investments made by individuals consciously or otherwise, towards their health status. Someone that smokes can be seen as making negative investments to the person's stock of health, likewise those that take alcohol, hard drugs and other dangerous addictive substances (Mcpake, Kumarayanake and Normand, 2002). This is at the individual level. In relation to the health of children, at the household level, the parents may make conscious investments in the child's health by ensuring proper feeding, preventive medical care such as vaccinations and immunizations, adequate sanitation and hygiene and other inputs.

Unconsciously, they may invest in children's health through adequate educational attainment (Jacobson, 2000), health care for the mother especially during pregnancy, and others. Other investments that cannot be controlled by the parents include their socioeconomic status, the availability of health care facilities and skilled health care professionals and generic drugs, environmental health, research and development, and other exogenously determined investments. These are at the macroeconomic level, and are determined by the government and by the state of the economy. There have been increased efforts by the UNICEF to increase immunization coverage, access to safe water and sanitation facilities, and other forms of health care and preventive care.

According to Casanovas, Rivera and Currais (2005), improvements in health status can be justified on economic grounds. Good health increases human capital levels, and so productivity of workers is increased by a reduction of incapacity and number of sick days, and this bounces back by high economic growth rates. Good health also affects one's education, as it provides a forum for increased levels of schooling and better academic performance. Furthermore, good health frees up monies that would have been spent on medical care to be saved or used for something else. They also pointed to the effect of health improvements on poverty and inequality in developing countries. This means that investing in health not only brings about higher levels of output, but also leads to inclusive growth and in the long run, development, as welfare is improved.

'The socioeconomic status is probably the most important determinant, as it affects child health throughout the life course. Young children seem to be particularly vulnerable to the effects of adverse socioeconomic status and poverty. Poverty and low socioeconomic status of mothers are associated with higher risk of death in infancy and childhood, chronic childhood illness and many acute illnesses. They are also closely linked with birth weight and child mental health problems' (Spencer, 2000; Spencer 2003).

Poverty exists when the resources of the families or an individual are inadequate to provide a socially acceptable standard of living (Martins, 1969). This definition suggests scarcity of even the essential (food, clothing and shelter). The poor hence face deprivation and are prone to all sorts of environmental and health hazards, due to exposure. They tend to have low education because they cannot afford it, and also tend to have poorer health than the rest of the population (United Nations Development Program Report, 2004), because they have no access to health care facilities, for they cannot afford it.

Poverty affects child health and survival through various channels. One of these is that children from poor families (or poor countries) have limited access to preventive, curative or emergency care (Ahmed, 2007). Poverty also affects child health majorly through malnutrition, as poor families are unable to acquire the necessary foods and supplements for the child to grow healthily. Also, poor and unhealthy mothers' breast milk may not be nutritious enough (in antibodies) to help the child fight pathogens through the early years, and so the child is susceptible to all sorts of diseases.

Health Investments in Africa and Europe

Prior to the introduction of routine child immunization, vaccine-preventable diseases were the leading causes of childhood deaths all around the world (European Immunization Week report), prominent among which is measles. Increasing access to immunization in developing countries is a key reason for the decline in under-5 mortality. More infants are immunized than ever before. According to new data, 106 million were immunized in 2008. Despite the progress made toward reducing child mortality and expanding access to immunizations, under-5 mortality is concentrated among poorer regions and countries; 93 percent of all under-5 deaths occur in Africa and Asia. A report of the UNICEF says that about thirty million children in Africa are unimmunized either because vaccines are unavailable, health care providers few or health services are poorly provided due to lack of information dissemination. Measles alone killed over half a million children in 2003.

In developed countries, providing vaccines to infants and young children is widespread and common. Protection against deadly diseases such as tetanus, measles, and diphtheria that are now rare in developed countries is still out of reach for many children in developing countries. Vaccination coverage for measles in Europe is about 94%. However, it has been found that the

socioeconomically disadvantaged people lack access to health services. Also, some rural parts of European countries do better than their urban counterparts, as regards measles immunization coverage.

Nutrition, another health investment, has immediate and long-term impact on the health of a child, and one of such benefits is improved cognitive ability and increased concentration at school. In West Africa, the percentage of children that were underweight between 2000-2006 was twenty-eight percent, and thirty-six percent were severely stunted due to undernourishment.

Eating habits in the UK are generally poor, as the intake of fruits and vegetables is generally low. Statistics show that one in every seven children never eats fruits. There has been increased consumption of highly processed and fast foods in the last two decades. As a result, obesity has become a growing menace even among children. Also, iron deficiency anemia and dental caries have resulted from high consumption of sugary foods in children.

The health of the mother is also a determining factor of child health. Generally it is observed that healthier mothers have healthier babies, given other factors. According to the WHO Africa report on maternal mortality, 99 percent of all maternal deaths occur in developing countries, and two-thirds of these deaths are from the sub-Saharan region. About 287,000 women died in child birth in 2010 in Africa, according to a report of the Life for African Women Initiative. This has been attributed to the dearth of skilled health workers like midwives and trained nurses. Other reasons include poverty, lack of information, lack of proximity, inadequate services and cultural or traditional practices.

In Europe and Central Asia, there has been a downward trend in maternal mortality (United Nations Population Fund, UNFPA Report). The migrant population present in countries like

Portugal is more prone to health challenges, especially the women who suffer from emotional and psychological distress and generally poor feeding. This translates into poor health for their children. Also, there is recorded higher maternal morbidity among immigrants than the Portuguese population.

The environmental factors in the European Union have improved over the years, considerably more than in the developing parts. In Portugal, about fifty percent of the population has access to improved water source at home. In Latvia, the percentage is close to sixty, Croatia has about sixty-five, Belgium ninety and the UK has about ninety-eight percent. Access to improved sanitation facilities is less spread than improved water source, with Croatia having about fifty percent, Spain having the highest percentage at ninety-two percent, and Latvia having about fifty-three percent.

In Africa, 300 million of the population is without access to water supply, and even worse for access to sanitation facilities, according to the African Development Bank Initiative for Rural Water Supply and Sanitation. 62 percent of the African populace had access to water supply, and 60 percent to sanitation facilities in the year 2000. The level of access, as recorded by the AFDB is very low. The largest increases in access to improved water sources were in Angola, Rwanda and Central African Republic, and improved sanitation facilities is even worse, with ten countries still having 15 percent, West Africa having the worst percentages. A lot of funds in form of developmental aid by the AfDB have been pumped into the region, to help manage this and similar challenges. It includes the Official Development Assistance (ODAs), Other Official Flows (OOFs) and Private Flows (PFs). A report even records that some of these countries run their budgets on foreign aid expectations. Despite the monetary contribution, improved access still remains a challenge in the region.

2.2.2 Child Health

Children's health refers to the extents to which individual children or groups of children are able to realize their potential, satisfy their needs and develop the capacities to allow them interact successfully with their biological, physical and social environment. It implies the promotion of bodily and mental vigor, strength and alertness, as well as the prevention of disease and correction of remedial defects (Bolt 1925). According to the Populations Reference Bureau, lack of access to quality health care and clean water and sanitation, under-nutrition, and other preventable or treatable causes lead to the deaths of tens of thousands of children worldwide every day.

The first five years of life are the most crucial to the physical and intellectual development of children, and can determine their potential to learn and be productive throughout their life time. This explains the inclusion among the Millennium Development Goals of a reduction in childhood mortality by the year 2015 (Iyewumi and Ofoegby, 2013). Children's health is a potentially valuable economic investment (as the long run benefits outweigh the short run costs). The impact of child health is channeled by improved cognitive ability, higher school participation rates and enhanced educational attainments. Such investments may be nutritional, medical, social, environmental or economic.

There are indirect benefits of improving child health, which include lowered costs of medical care, higher participation of the parents in the labor market, increased participation in economic or other activities in the home, and a higher propensity to save. These culminate into a healthier work force (with less sick days) and generally more productive adults that earn higher wages.

This will lead to higher levels of national income, and in the long run, economic growth (Anderson and Hague, 2007).

In 2012, 6.6 million children below the age of five died in Africa, and about 71 percent of the deaths were preventable. About 45 percent of all the deaths were linked to malnutrition. Children below age five in sub-Saharan Africa are sixteen times more likely to die than those in developed countries like European countries.

According to the State of the World's Children (2012) UNICEF report, the members of the European Union have the lowest under-five mortality rates in the world, with the exception of Bulgaria and Romania,

2.3 REVIEW OF THEORETICAL ISSUES

2.3.1 Health Demand Theory

The economic approach to the issue of health is the demand for health approach, which views the individual as demanding for health as a commodity. It has three main foundations in economics, namely the indifference curve/map, the health production function and the budget constraint. The first and last concepts are not of immediate interest in this study. Of more relevance is the production function for health. The Grossman model of health production is a human capital model of the demand for health, which has been adopted to examine various relationships with health such as socioeconomic status and inequality (Case and Deaton 2005). Health capital is seen as a stock of human capital, with a given level of education. Health is seen as a durable capital stock which yields output of healthy time. There is an initial stock of health capital at the onset of time, which depreciates with age and appreciates with investment.

Medical care is thus one investment in the health production function of a household. Other forms of investment exist, such as diet, exercise, income, environment and the time factor.

The efficiency or productivity of these inputs determines the health outcomes of individuals' access to formal education, medical care and others affect the efficiency of the inputs. Health demand consists of consumption and investment effects. The investment effect sees health as demanded for its ability to increase the individual's healthy work or leisure days, as an indirect utility.

The basic Grossman model shows how much health output can be obtained from the available health inputs, given a level of education/knowledge. Health is both demanded and produced by the consumer, and equilibrium refers to the amount of utility a consumer of health can get from the health inputs, given the budget constraint. This means he will seek to attain the highest indifference curve available to him, given his budget line.

The theory assumes diminishing returns between health investments and health outcomes; as the level of health capital increases, it is increasingly difficult to generate health from inputs. This implies that less healthy individuals gain more health outcomes than healthier individuals. This can be applied on an aggregate scale; countries experiencing more health challenges derive greater health outcomes from health investments than countries with relatively healthier populace.

This assumption backs up the finding of Amiri *et. al* (2012), 'that the higher human capital level of richer countries compared to poorer countries implies that an equal reduction in maternal and child mortality will cause GDP to increase more in richer countries than in

poorer countries. In essence, the effect of marginal health investments on health outcomes is stronger at low GDP levels, i.e. in countries where generally the level of health is lower'.

The Grossman model is dynamic in nature; it takes into account the change factor; time. This is why most empirical tests which were run initially did not support its theoretical postulations, for they were mostly cross-sectional (Wagstaff 1982;1984, Zweifel and Breiyer 1997, Erbsland *et. al* 1995). Now however, longitudinal estimations have been run, using panel data, to test the empirical validity of the model (Wagstaff (1993), Doorslaer (1987), Nocera (1998)), and they have proved the model to be valid, although they still have their reservations.

Efforts at longitudinal estimations are very useful because they allow one to take account of the effects of unmeasured variables such as the rate of depreciation and of reverse causality from health at early stages in the life cycle to the amount of formal schooling completed. In addition, one can relax the assumption that there are no costs of adjustment, so that the lagged stock of health becomes a relevant determinant of the current stock of health.

2.4 REVIEW OF EMPIRICAL ISSUES

Several studies have been carried out both on the economic and medical platform to analyze various aspects of child health. Some have studied the impact of child health on economic growth, while others have studied the determinants of child health in different parts of the world. This review contains studies carried out to analyze the effect of health investments of all sorts on health in general, and child health in particular in developing and developed parts of the world. It was discovered that the literature on various health investments and child mortality is scanty for the European region as a whole, possibly due to the fact that child mortality is not as

big a challenge in the region as it is in developing countries of Africa and Asia. Few studies however exist for specific states and countries in the region.

Amiri and Gerdtham (2013) studied the role poverty played in affecting the relationship between maternal and child health and economic growth in both developing and developed countries. The variables included child mortality, maternal mortality, population growth, government final consumption expenditure and GDP growth rates. These were used in a Barro framework. Using a large panel of 180 countries, as regards causality, it was found that the relationship is two-way, meaning that higher GDP levels also affect child mortality rates in most of the countries. As regards magnitude, the effect of lowered child mortality rates on the GDP level was found to be larger in richer countries than what obtained in the poorer ones. However, the magnitude of the impact of higher levels of GDP on child mortality was found to be higher in poorer than in richer countries.

Novignon (2012) assessed the impact of both public and private health expenditure on health in sub-Saharan Africa, owing to the low level of expenditure recorded in these countries over the decades. He attested to the fact that most of these countries depend on aids and grants to finance their health sectors. Also, richer countries were seen to spend more on health care than poorer countries (Poullier *et. al* 2002; Novignon 2012).

The model took into consideration both public and private health expenditure, population age group, per capita GDP, hospital beds, improved sanitation and water source and the prevalence of HIV. However, they failed to account for maternal health or even literacy level in the model. Making use of longitudinal data, he concluded that increasing the expenditure on health in sub-Saharan countries is a big step towards reducing infant mortality rates and raising the life expectancy.

Yaqub *et. al* (2008) ran similar estimations, but limited their scope to Nigeria. They accounted for the governance factor, in determining the impact the health spending had on health of Nigerians. They pointed out that the budgetary allocations in the country have over time failed to culminate in improved health status. The study ran Ordinary Least Squares estimations regressing public and private spending and corruption perception index on various measures of health, including under-five mortality rates.

This is criticized on two grounds. First, the use of OLS technique of estimation is not quite appropriate for estimating long run effects, which is the case here with time-series analysis. Secondly, the model excludes several other relevant variables that can affect the health of children. The results showed that the various health expenditures had negative impact on health status when governance was accounted for, and positive when it was unaccounted for, thus supporting the claims of Filmer and Pritchett (2000) that corruption and patronage have negative effect on the relationship.

Strittmatter and Sunde (2011), in a study done to show the importance of public health care to economic development in Europe, used a panel of 12 countries over a period of about 200 years. They sought to study the causal effects of changes in mortality on per capita output. They ran Ordinary Least Squares (OLS) regressions of GDP per capita growth, population growth and aggregate GDP growth on crude death rates and infant mortality rates. They found that when public healthcare systems were introduced into the countries, infant mortality dropped by about 5.7%, at 5% significance level. Crude death was also found to drop in the first ten years of the public health care programs. Also, when infant mortality dropped by 1%, GDP per capita growth rose by 0.6% and GDP growth fell by 0.8%.

Their results thus showed that the effect of infant mortality on GDP and per capita GDP growth is negative, which is in contrast with the expectation that improved child health conditions would result in increased growth (GDP growth) and welfare (GDP per capita growth) of the population.

Franz and Fitzroy (2006) studied child mortality and fertility, through the channels of poverty and the environment in developing countries. They ran cross-country regressions in the Central Asian Republics, where agriculture is highly modernized and industrialized, and so environmental pollution is common. They hypothesized that factors linked to environmental degradation caused the attendant high rates of infant and child mortality. They expressed that the reason why a unified solution to the problem of child mortality has not been agreed upon is due to the varying socioeconomic, geographical and cultural factors that determine child survival in different parts of the world.

The health of the environment was reported to explain child health to a large extent in Asia; variations in the rates of infant and child mortality were found to be explained largely by 'infectious, parasitic, respiratory and digestive conditions', which are linked to environmental pollution and socioeconomic conditions (referring to poverty levels).

From this it can be deduced that poverty also has a role to play in determining child health status in Asia. It was also pointed out that the decline in health expenditure, medical supplies and medical equipment in rural Asia has resulted in reduced health of women and children. Hence, health expenditure in Asia is an important determinant of maternal and child health.

To estimate the effects of socioeconomic factors on mortality, he adopted the framework of Mosley and Chen (1984), in which economic determinants and traditional medical causes of

morbidity in children are combined to determine child survival. This is a form of health production function, with infant and under-5 mortality as the dependent variables, and fertility, absolute and relative incomes, environmental health and nutritional determinants as explanatory variables. Two sets of regressions were run. The first was to derive an estimate of total fertility, which was then incorporated into the child health equation, to act as an instrumental variable. OLS method was used in running the regressions.

The results showed that both infant and child mortality rates were significant, but the infant mortality rates had lower explanatory power than child mortality, which had an adjusted R-square of 0.75. This implies that infant mortality has a lower impact on growth than child mortality in Asia. Also, female literacy was found to have the strongest effect on child mortality in the Central Asian Republics.

Smith *et. al* (2007) studied the effect of socioeconomic inequality on premature births in the UK. The study was ecological in nature, covering about five hundred thousand births from 1994 to 2003. It was found that those from poorer backgrounds stood a higher chance of suffering preterm births than the relatively wealthier families. There was hence a deprivation gap, which did not change over the ten-year period, indicating persistent socioeconomic inequalities in Trent, UK, where the study was conducted.

Reagan *et. al* (undated) studied the effects of maternal literacy on child health in Wales, UK. They took into consideration various factors affecting the health of a child, including maternal education (which was used as a proxy for socioeconomic status, occupation and lifestyle), prenatal effects, immunization, breastfeeding on the children's health and educational attainment. The latter affects intelligence, vocabulary and cognition.

Evidence suggests that low educational attainment is associated with increased infant mortality. It was also found that poorer families had more children dying from accidents, mental disorder and respiratory infections (as poorer mothers are observed to smoke more than richer mothers). Breastfeeding rates in the UK are found to be lowest in Europe. Poorer women were found to be less likely to have their children immunized.

Boco (2010) examined the effect that various determining factors both at the individual and community level have on child health in Sub-Saharan Africa. The key variable of interest is the socioeconomic status at both levels, as access to health care services, which is important for child survival is generally low in African countries. It was found that child mortality is lower in sub-Saharan Africa, and the highest rates were found to be in West Africa, except for Ghana.

The countries with high mortality rates also had low health center attendance, and most of the children in the countries lived in rural areas. Level of education was also accounted for, and was seen to be very low in the countries. It was found that male children in countries except for Sierra Leone experienced higher mortality in male than in female children. Also, the older the mother was, the higher the observed chances of child survival past the age of five. Furthermore, the higher the literacy of the mother, the lower the mortality rate in that community. However, some countries like Congo, Ghana and Burkina Faso showed non-significant relationship between maternal education and child health. Another factor was the wealth of parents. Wealthier families had higher chances of child survival than poorer ones.

Rasella *et. al* (2013) assessed the effects of a conditional cash transfer program to poor Brazilian households upon condition of compliance with set conditions related to health and education. The study sought to see if these cash transfers helped to reduce child mortality in the various local governments in Brazil. The aim of the Bolsa Familia (Family Allowance)

program was to alleviate poverty in Brazil and to also incentivize the locals to patronize available health care services and to invest in adequate education. The finding was that child mortality in general and specifically related to poverty was reduced with more cash transfer spread in the municipalities.

Strauss and Thomas (1998) analyzed the relationship between health and development, via nutrition. The study was conducted to determine health and labor outcomes, to know if health and productivity are correlated at the individual level, opining that health affects labor outcomes more in developing countries than in higher developed countries, as the diseases prevalent in the former, coupled with high poverty levels and illiteracy, and an underlying labor-intensive agrarian economy tend to cause more serious damage put together. He used nutrition as a channel because he felt that in poorer countries, adults are more likely to have health problems and such problems usually stemmed from their childhood. He looked at developing nations because in such nations, the work seems to rely on physical strength, to which health is important.

The paper serves as a major contribution to the theoretical literature on health demand and economic outcomes. Prior to the study, the general consensus was that income had strong effects on demand for health. The paper thus broke new grounds, in that it ascertained the relationship in the reverse.

Kandala *et. al* (2011) in a study on malnutrition in Congo sought to find out if geographical location influenced the nutrition of children below five years. The literacy level of the mother was found to significantly and positively impact on the health of the child. Also, male children were found to suffer more from malnutrition than female children. It was found that malnutrition is significantly higher in rural than in urban areas, suggesting that geographical

location is a determinant of nutritional status in children. Food production in Congo has actually been very low and has been declining, even with the country's wide expanse of arable land.

Gunther and Fink (2010) studied the effect of water and sanitation on diarrhea in children in 172 countries. Access to sanitation, as pointed out, is still a major issue in the developing world, especially sub-Saharan Africa. Apart from diarrhea, other water-borne diseases mainly caused by worms like the flatworm and the helminthes, as well as eye diseases like trachoma, which is also a water-borne disease. Data on improved sanitary facilities and improved access to safe drinking water was gathered from the Demographic health survey (DHS). It was found that improved water and sanitary facilities had greater impact on child mortality directly than through diarrhea. It was also found that sanitary facilities had more impact than water on diarrhea, implying the need for improved water conditions alongside improved hygiene, and not just water improvements alone.

Wolfgang *et. al* (2013) also studied environmental hygiene and health in Cote d'Ivoire. They studied sanitation, water and population health. They collected data from various health centers in Youpougon on cases of malaria, diarrhea and acute respiratory infections. It was found that about 90 percent of the inhabitants had access to safe water, but diarrhea was responsible for 43 percent of morbidity in the town. This was attributed to the poor hygiene of the inhabitants, as waste was not properly disposed of, and the towns were seen to be highly populated due to migration. It was also found that malaria and respiratory infections were more rampant during the rains than in dry season.

Bryce *et. al* (2010) undertook an evaluation of the impact of a child survival program of UNICEF on child mortality in West Africa. The program ran from 2001 to 2005, and entailed proper treatment of several diseases like malaria, pneumonia and diarrhea, immunizations,

antenatal care as well as improved nutrition in children. They made use of data from the Demographic Health Surveys. They compared the level of spread of the program in Ghana, Mali, Benin and Senegal, the nutritional status and the mortality rates in the various nations. Not all of the countries showed positive response to the program. Mali and Benin Republic showed little progress in terms of a quickened pace of child survival, as the other countries showed in the study. Also, Benin, Mali and Ghana showed no improvement in nutritional status of children.

2.5 REVIEW OF METHODOLOGICAL ISSUES

This section contains a review of studies conducted in relation to this study that made use of longitudinal/panel data analyses using both fixed and random effects, as well as studies which based their model on the Grossman health production function.

Fassiya (2008) made use of the health production function developed by Grossman (1972) in estimating health status in sub Saharan Africa. The main objective was to determine what factors are relevant to health status in the region, in line with the Grossman model. He included socioeconomic, political and environmental factors. The theoretical model treats them as inputs in the production function.

$h=F(Y, S, V)$

where h is the stock of health, Y is a vector of economic variables, S is a vector of social variables and V is a vector of environmental variables. The Y variables included were GDP per capita, health expenditure per capita and food availability. S variables were education, lifestyle, and population. V variables were urbanization and carbon emissions.

Panel data analysis was conducted and relevant tests were run to determine the appropriate technique of estimation. The GLS method for the two-way random effects model was found to be more suited to the data. The results showed that food availability, literacy rate and alcohol consumption (measure of lifestyle) had strong positive impact on health status, while health expenditure, carbon emissions and urbanization had negative impacts on life expectancy.

Strauss and Thomas (1998) conducted a study to determine the nature of the relationship between health and economic development, via the channel of nutrition. Using average adult height as an indicator for nutrition levels over time, they ran correlations on the heights of males and females in the US, Brazil, Cote d'Ivoire and Vietnam over a period of a hundred years and found American men to be the tallest. They also found that average heights increased over the century, indicating overall improved levels of nutrition and health. They employed Gary Becker's household production function, which shows the link between labor outcomes and health as well as Grossman's production function

$H = H(N,L; A,B',D,\mu,\varepsilon_h)$

Where H represents measured health outcomes, N is a vector of health inputs, and L is labor supply. A represents socio-demographic characteristics like gender, B' refers to family background like parental health, and then the environmental factors such as disease environment, D. N and L are under the control of the individual. N has a positive relationship while L has a negative relationship with H. μ represents the inherent healthiness of the individual (Strauss and Thomas 1998) and ε_h is the error term.

They looked at the possibility of feedbacks between health and income, if better health led to higher productivity, more work hours or a higher probability of working, and if in turn, higher

income levels led to higher investments in health by spending more on health-augmenting inputs, quality or quantity wise (Strauss and Thomas 1998).

Having considered the health production function, they saw an individual's utility as determined by his labor supply L, consumption of purchased goods C, health outputs H, schooling S and family background B which are observable, as well as some unobservable variables like tastes, captured in ξ:

$U = U(C,L,H; S,A,B, \xi)$.

These models were applied to a panel of countries, capturing American Brazilian and Asian male and female height variations, which was representative of their initial health stock at childhood. They also captured several other countries like Vietnam and developing countries like Cote d'Ivoire. It was a very broad panel, covering all the regions of the world. Average heights were used to capture nutrition. They found that the Brazilian male grew taller and faster than the American male. Some variations were attributed to genetic build, such as the stunted growth patterns of the Asian males.

The height factor was also used as a proxy for quantity and quality of schooling. This is a far-fetched assumption, that every poor child in all these parts of the world studied would experience stunted growth; making the heights a good enough measure for educational attainment. Also, weights would be a better measure of nutrition, as it is not subject to genetic variation, as height.

Jacobson (2000) sees the family as the producer of health, not just each producing their own health, but also determining the health of the other members. The paper is aimed at developing a family health demand model by extending the model for the individual health production. It was

pointed out as a point of divergence from the model that while the Grossman model saw productivity as determined by the individual's education, this family-as-an-economic-unit perspective sees an individual's productivity as determined by the education of other family members.

$U_t = u(H_t, Z_t)$

Where U is the utility function of an individual derived from his health, H and from consuming other commodities, Z. Depreciation reduces the health stock and investments increase it:

$dH_t/dt = I_t - \delta_t H_t$

where I is health investments and δ is depreciation. He proceeded to develop equations for each of the variables of interest, linking them to the health of a child. It was found that poorer families value child health higher than richer families. Also, a child with unhealthy parents would most likely be in ill health, as resources that go into medical care are split between parents and child.

Rasella *et. al* (2013) in the study on conditional cash transfer program and childhood mortality, ran multivariate panel regressions using a fixed effects model. The unit of analysis in this study was not country, but municipality, as mentioned. Also, various causes of death in children were accounted for by classification of child mortality into four causes, namely diarrhea, malnutrition, lower respiratory diseases and external causes like accidents, as a control.

The study included an index for vaccination coverage for children less than a year old, and it was segmented into vaccination for measles, polio and tetanus. They regressed per capita income, proportion of local government eligible for a cash transfer, prevalence of illiteracy,

access to adequate sanitary facilities, total fertility rate and rate of admission into hospitals on child mortality.

Kandala *et. al* (2011) developed a special model made to suit the purpose of determining the effect of distal variables like geography and the environment on child health. Through the use of the model, they were able to capture the concept of space (geography) and still determine the net effects of this variable, unlike previous studies had accomplished. Primary data collected from the demographic health survey for Congo was used. Nine thousand households were sampled for data on nutritional status of mothers and children.

To capture nutrition, three types of malnutrition were accounted for, namely stunting, wasting and underweight. The other variables included were sex of child, age of child, mother's marital status, literacy level, wealth index, place of delivery, preceding birth interval, household size and number of children.

Gunther and Fink (2010) regressed water, sanitation and diarrhea prevalence on child morbidity and mortality. The panel data model used is as follows

$$CV_{icjt} = a_{11} + b_{11}latrine_{icjt} + b_{12}flush_{icjt} + c_{11}pump_{icjt} + c_{12}\ piped_{icjt} + \delta_1 X_{icjt} + d_{jt} + e_{icjt}$$

CV is the child variable, latrine represents the basic sanitation technology, flush is access to water closet toilets, pump and pipe are access to pumped and pipe-borne water, X represents control variables, namely mothers' education and age, marital status, household size, rural or urban locality, and poverty levels. Controls for child health were also included, such as vaccinations, age and gender of the child and data on breastfeeding. The control variables make for more robust results, as they are more tightly specified than previous studies in the area. They ran ordinary least squares (OLS) and Logit regressions.

Amiri and Gerdtham (2013) in analyzing maternal and child health and economic growth, sought to establish a two-way relationship, and to determine the economic returns to GDP of improving in maternal and child health using Granger and Data Envelopment Analysis (DEA) respectively. The Granger causality test was to determine if there is a two-way relationship between economic growth and health as measured by child mortality rates, while the DEA was conducted to determine the efficiency. This was conducted on a panel of 180 countries for 20 years.

2.6 CONCLUSION

These studies have all focused on one or some of the determining factors affecting child health. Several studies take into account some variables that affect child health, while leaving out others. Few studies have considered several factors in the same model. This study will make use of the health production function propounded by Michael Grossman (1972) to take into consideration several investments in child health, thus overcoming omitted variable bias in determining how each input affects child mortality in West Africa. All these studies have also made use of panel data analysis, some primarily and others secondarily sourced, and various tests have been conducted to determine robustness and validity of their models. This study will proceed to run panel data regressions, with a Hausman test to determine whether it will be a fixed or random effects model.

CHAPTER THREE

RESEARCH METHOD

3.1 INTRODUCTION

This section contains an overview and discussion of the theory the study is based on, and the model being adopted in the research work, the research method and design to be used, model specification as well as provides information regarding the sources of the various data sets to be used and the estimation techniques to be used. Also, the a priori expectations for each of the variables in the adopted model will be stated and the criteria for decision making will be spelled out.

3.2 THEORETICAL FRAMEWORK

3.2.1 Health Demand Theory

In analyzing the impact of health inputs on health outcomes, the health demand theory will be leaned on. The Grossman model is based on the human capital theory which shows how individuals invest in themselves via health, education and skills acquisition to increase their productivity. Grossman's theory of health demand is a health production function of the form

$H\ Stock_t = H\ Stock_{t-1} - dep'n\ (d) + inv.\ in\ H\ (I)$

Where $H\ Stock_t$ is the current stock of health which can be aggregated

$H\ Stock_{t-1}$ is the initial health stock,

dep'n (d) is depreciation of health with age

and *inv. in H (I)* is investment in health

The initial stock of health can be added to by investment, and reduced by depreciation. Health investments include medical care (access to medical care), income (socioeconomic status), environment (sanitation), and other investments such as diet and exercise. Health may depreciate due to age, illness and disease, carelessness, accidents and other things. Education reduces depreciation rate and increases efficiency of production of health investments.

3.3 MODEL SPECIFICATION

The fixed effects model controls for all time-invariant differences between the countries, so the estimated coefficients of the model cannot be biased for such characteristics as culture, gender, race etc, which are omitted from the model. In general, it is specified as follows

$Y_{it} = \beta_k X_{k,it} + \alpha_i + w_{it}$

Where – α_i (i=1….n) is the unknown intercept for each entity (n-entity-specific intercepts).

– Y_{it} is the dependent variable (DV) where i = entity and t = time.

– $X_{k,it}$ represents a vector of independent variables (IVs),

– β_k is the vector of coefficients for each IV,

– w_{it} is the error term

Following the Grossman health production function, health stock (measured by child health) is a function of initial health stock (measured by life expectancy at birth), investment in medical care (measured by childhood immunization), socioeconomic status (measured by per capita income), nutrition (prevalence of undernourishment), maternal health (maternal morbidity rates), maternal literacy (female primary school enrollment rate) and environmental health

(measured by access to improved sanitation facilities and water source). The model is specified as a linear health production function.

Child mortality = f (life expectancy at birth, maternal morbidity, maternal literacy, immunization, per capita income, nutrition, improved sanitary facilities, improved water source).

The functional form of the model is

$CH_{it} = f (MM_{it}, ML_{it}, IM_{it}, PCI_{it}, PU_{it}, ISF_{it}, IWS_{it})$

The stochastic form of the model is

$$CH_{it} = \alpha_0 + \alpha_1 LEB_{it} + \alpha_2 MM_{it} + \alpha_3 ML_{it} + \alpha_4 IM_{it} + \alpha_5 PCI_{it} + \alpha_6 PU_{it} + \alpha_7 ISF_{it} + \alpha_8 IWS_{it} + w_{it} \quad \ldots\ldots\ldots (1)$$

$$w_{it} = v_{it} + \mu_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots (2)$$

Where CH_{it} : child health in country i at time t

MH_{it} :maternal health in country i at time t

ML_{it} : maternal literacy in country i at time t

IM_{it} : childhood immunization coverage in country i at time t

PCI_{it} : per capita income in country i at time t

ISF_{it} : improved sanitary facilities in country i at time t

IWS_{it} : improved water source in country i at time t

PU_{it} : prevalence of undernourishment in children below the age of 5

w_{it} : a compound error term comprising of the unobserved country-specific effect v_{it}, unobserved time-specific effect μ_{it}, and the zero mean constant variance random disturbance term ε_{it}.

Child health will be captured by under-five mortality rates for each country. This is used to capture child health because a high mortality rate in children and infants is an indicator of inadequate health care at the tender age, which can be a result of any number of factors ranging from the knowledge of the mother about child health care to the income level of the household.

Life expectancy at birth represents the initial stock of health of a child. It is a good measure of initial stock of child health as mortality, morbidity, disability and other health indicators are considered in its measurement (Novignon 2012).

Maternal health is captured by women's share of population living with HIV, which is an indicator of morbidity in women. The health status of the mother is relevant to the model because it directly affects the health of a child, especially diseases like HIV, which can be transmitted to the unborn child.

Maternal literacy is measured by female primary school enrollment rates. This variable is relevant as the education status of the mother determines her knowledge about child care. It hence represents an investment in the health of a child.

Immunization coverage is measured by percentage of children ages 12-23 months that are immunized against measles. Immunization coverage is relevant because it is an indicator of a preventive health care intervention in children, which is an investment in the health of the child, and measles is a killer disease occurring more in the early years.

Per capita income is included in the model as a measure of the parents' income levels. This measures the socio-economic status, and is relevant because it determines how much can be invested into child health care, both medical and otherwise. It is hence an underlying factor responsible for child health.

Access to improved sanitary facilities and improved water source are measured by the percentage of the population with access. Both variables are included in the model to capture the environmental health, which is also a determinant of child health. Poor environmental health can cause diseases such as diarrhea, cholera and malaria.

3.4 A PRIORI EXPECTATIONS

In the two models, the expected direction of the relationship between each explanatory variable and the dependent variable is presented in the table below.

Variable	Description	A priori expectation
CH	Dependent variable. Child health, captured by under-five mortality rate.	
IM	Independent variable. Immunization coverage	Negative relationship
LEB	Independent variable. Life expectancy at birth.	Negative relationship
MM	Independent variable. Maternal morbidity.	Positive relationship
PCI	Independent variable. Real per capita income (a measure of socioeconomic status).	negative relationship
PU	Independent variable. Prevalence of undernourishment.	Positive relationship
ISF	Independent variable. Improved sanitary facilities.	negative relationship
IWS	Independent variable. Improved water source.	Negative relationship

3.5 TECHNIQUE OF ESTIMATION

The panel of 15 countries over a period of 20 years is fitted into the model. The Hausman test was run on Stata to determine whether fixed or random effects will be used. Fixed effect was then chosen based on the results of the test. The appropriateness of the model will be tested using the R^2 technique. Also, tests will be run on the data set to check for multicollinearity, and if found necessary adjustments will be carried out to rid the model of the problem (Ogundipe and Ogundipe, 2013).

3.6 DATA SOURCES

The data used for the study are secondary data covering the ECOWAS region, for the period from 1990-2012. This comprises of a period of 22 years. Data was sourced from the World Development Indicators (2014) database. This is a reliable source of data

3.7 DATA PRESENTATION AND ANALYSIS

The decision making as to the statistical significance of the various variables under study will be base on the following criteria:

1. **Parameter signs and magnitudes**: The sign expectation is the economic a priori condition set by economic theory and usually refers to sign of parameters of economic relationships, and the magnitude refers to the size of the coefficients of these parameters. The parameters in the model are expected to have signs that conform to economic theory, if they do they are accepted, otherwise they are rejected, unless there is an explanation to believe that in the prevailing circumstance, the principles of economic theory do not hold.

2. **Coefficient of Determination**: This is a measure of the goodness of fit of the model in use. It indicates the percentage variation in *y* that is explained by changes in the explanatory variables. The adjusted coefficient of determination (adjusted for changes in the degree of freedom, upon addition of other explanatory variables) will be used as well to determine how well the model fits the data. A high R square is preferable as it is indicative of a good fit of the model to the data under study, while a low R square implies that the model is a poor fit. Should this be the case, a revision of the model specification will be required (in terms of its functional form, variables present, etc).

3. **F-statistic**: This tests the overall significance of the model. It checks the statistical significance of all the explanatory variables together. The level of significance to be used is 5%. Hence, if the probability is ≤ 0.05, the explanatory variables' parameter estimates will be conclusively jointly significant statistically. Any value greater than 5% makes them jointly statistically insignificant.

4. **T-test**: This tests the individual statistical significance of the parameters in the model. They will be tested at 1% and 5% levels of significance. As a rule of thumb, a t test value ≥ 2 is acceptable as statistically significant. Any value less than 2 is insignificant.

5. **Standard error**: This measures the standard error of the disturbance. If the magnitude of the coefficients are greater than a doubled value of their individual standard errors when they are taken in absolute values, the model's disturbance term is "ok".

6. **VIF**: To test for the problem of multicollinearity (a situation in multiple regressions whereby one or more explanatory variables can be explained or is linearly dependent on other explanatory variables), the variance inflating factor (VIF) test will be run using

Stata 10.0 Version. If the value for any parameter is < 10, it suffers from multicollinearity and if greater than 10, it is free from multicollinearity. The VIF test will be run instead of the Pearson test due to more reliability.

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION

4.1 INTRODUCTION

This is a very important aspect of the research work as it comprises of the empirical analyses carried out on the models as well as the economic interpretation of findings obtained from the study. In achieving the major project objective of determining whether health investments culminate in improved child health outcomes, and determining whether the marginal effect is higher in advanced nations than in the developing world, this chapter contains two major aspects, the descriptive and the empirical analysis. The descriptive analysis focuses on the statistical characteristics of the variables, while the empirical analysis comprises of the Ordinary Least Squares regressions, Hausman test, Variance Inflation Factor Test, Fixed Effects estimation and Robust Standard Errors under Fixed Effects.

4.2 PRESENTATION OF RESULTS

Table 4.1: Summary Statistics

Var.	Obs	Mean	St. dev.	Min.	Max.
CM	315	142.6	55.5	22.2	312.6
LEB	315	53.3	6.8	35.8	74.2
MM	315	57.9	3.8	41.7	61.8
ML	276	71.6	28.8	20.4	147.8
IM	315	62.2	22.5	0	97
PCI	315	823.3	1124.9	50.0	7628.7
IWS	301	22.1	16.6	4.3	67.7
ISF	311	62.8	14.1	29.8	89.3
PU	315	20.1	9.1	5.0	41.9

Table one above is a presentation of the summary statistics for the variables, containing the mean, standard deviations from the mean, and the minimum and maximum values of each

observation. The child mortality (CM) variable had a mean of 142.6 deaths per 100,000 of the population, and a standard deviation (SD) of 55.5 from the mean. Per capita income (PCI) had a mean value of 823.3 USD, and a standard deviation of 1,124.9. The prevalence of undernourishment (PU) had a mean of 20.1 and SD of 9.1. Life expectancy at birth (LEB) had mean of 53.3 years and SD 6.8. Maternal literacy (ML) had a mean of 7.16 and SD 28.8, while maternal morbidity (MM) had mean of 57.9 and SD 3.8. Immunization coverage (IM) had a mean of 62.2 and SD of 22.5, access to improved sanitation facilities and water source had means of 22.1 and 62.8 and standard deviations of 16.6 and 14.1 respectively.

Table 4.2: Hausman Test

CHI2	28.48
PROB>CHI2	0.0002

This test is used to show whether the fixed effects or the random effects model is to be used. The decision criterion is as follows.

H_0: random effect is equal to simple OLS regression.

H_1: random effect significantly differs from simple OLS regression.

If the probability is found to be significant, the null hypothesis is rejected. If found to be insignificant, we fail to reject the null hypothesis.

From table 2 above, the probability value is 0.0002, which is statistically significant at 1% level. Hence, there is evidence of panel effects in the model, and fixed effect is found to be efficient and consistent with the model. Therefore, the fixed effects model is proceeded with in the rest of the estimation.

Table 4.3a: Fixed Effects Estimation

R-square (overall)	0.8017
Prob>F	0.0000
Corr (u_i)	0.3777

Table 4.3b: Fixed Effects Estimation

Var.	**Coef.**	**S.E.**	**t**	**P > |t|**
LEB	-4.05	0.34	-11.98	0.000
MM	-0.32	0.07	-4.51	0.000
ML	-3.08	0.47	-6.55	0.000
IM	0.18	0.12	1.53	0.126
PCI	-0.01	0.00	-4.94	0.000
IWS	0.66	0.12	5.25	0.000
ISF	-1.40	0.20	-7.08	0.000
PU	-0.05	0.24	-1.20	0.839

From the results shown in table 3 above, corr (u_i) = 0.3777 shows that there is positive correlation between the errors and the explanatory variable in the fixed effects model.

The probability of the f-statistic is 0.0000. This is highly statistically significant; hence the model is 'okay'. It shows that all the coefficients in the model are different than zero.

The R-square shows that about 80% variations in cm is explained by the explanatory variables.

Life expectancy at birth (LEB) has a negative relationship with Child Mortality (CM). This is as expected. Hence, on average, a unit increase in LEB, holding other variables constant, will result in about 4.05 unit decrease in CM. The t value in absolute terms is 11.98. This is significantly greater than 2, at a probability of 0.0000. Hence, the coefficient is highly statistically significant. Also, LEB has the highest t value, indicating its top ranking in order of relevance to the regressand. This means that the healthier a child is at birth, the less likely the child is to die before the age of five.

Maternal Morbidity (MM) has a negative relationship with Child Mortality (CM). This does not go with the expectation. Hence, units increase in MM results in about 3.08 decrease in CM on the average, ceteris paribus. The t value is 6.55, in absolute terms. This is significantly greater than two, at a probability of 0.0000. Hence, the coefficient is statistically significant. Regarding the health status of the mother (maternal morbidity), the worse off a mother's health is, the higher the likelihood of the child dying before the age of five. as measured by prevalence of HIV in women, what was observed differed from the expectation. The expectation is that higher rates of maternal morbidity will result in higher rates of child morbidity and hence child deaths. In this case, HIV is a transferrable disease, and so the influence should be greater. It was however observed that the higher the prevalence of HIV in women in the West African region, the lower the child mortality rates. An explanation for this unexpected behavior between the two variables could be because of improvements in technology, which has made it possible for HIV-infected women to give birth to HIV-free children. In this sense, a sick mother does not necessarily lead to a sick child that may die of the cause in question, before the age of five.

Maternal Literacy (ML) has a negative relationship with Child Mortality (CM). This is expected. A unit increase in ML on the average results in a 0.32 unit decrease in CM, other variables held constant. The t value is $|4.51| > 2$, at probability of 0.0000. This coefficient is statistically significant. Hence, the higher the literacy of the mother, the lower the chances of the child dying before the age of five.

Immunization for measles (IM) has a positive relationship with Child Mortality (CM), which is against the expectation. A unit increase in IM results in about 0.18 unit increase in CM. However, the probability value is 0.126, and the t value is 1.53, which is less than 2. Hence, the coefficient has a statistically insignificant influence on CM. It implies that the wider the

coverage of immunization for children, the higher the mortality rates in children under-5, where as the expectation is that wider immunization coverage will reduce the rate of child deaths in the region. We hence fail to reject the null hypothesis, as immunization coverage is seen to have an insignificant impact on child mortality.

This may be due to any number of factors, one of which could be the beliefs of Africans in their traditional treatments for diseases, and superstitious beliefs regarding modern preventive healthcare, of which immunization is a major aspect. This is most common among the rural dwellers, and they have been observed to bear the bulk of diseases in Africa. Also, it is possible that in a bid to increase the coverage of immunization, quality was sacrificed for quantity (equity-efficiency trade-off). A study by Miller and Goldman (2011) done to determine if vaccination increases infant mortality rates in a country found positive relationship. The higher the number of vaccine doses, the higher the mortality rates in the various groups of countries.

Per capita Income (PCI) has a negative coefficient, as expected. The magnitude shows that an increase in the PCI by 1 unit will result in about 0.01 decrease in Child Mortality CM, on the average. The t value in absolute terms is 4.94, and the probability is significant at 1% level. Hence, the variable has significant influence on the regressand. It means that the higher the income level of the family, the lower the child mortality rates. The magnitude of the impact in both regions was little though. This implies that the socioeconomic status of parents influences the health of a child, but not a substantial effect. Hence, we reject the null hypothesis and accept the alternative hypothesis that income level has significant impact on child mortality.

Improved Sanitation Facilities (ISF) has a positive relationship with Child Mortality CM. This goes against the a priori expectation. A unit increase in ISF will result in about 0.66 unit decrease in CM, ceteris paribus. The t value is 5.25>2. Hence, the coefficient is statistically

significant. The literature on determinants of mortality finds a strong negative correlation between access to water, improved sanitation and child survival (Schultz, 1980). However, within-and between-country variation presents great barriers to controlling for health risks associated with poor access to potable water and adequate sanitation (Balint, 1999; Buckley, 2003). In a multivariate, cross-country analysis, therefore, the explanatory power of these variables has been weak when other socio-economic variables are included (Filmer & Pritchett, 1999).

Improved Water Source (IWS) has a negative coefficient sign, as expected. A unit increase in IWS, on average and holding the other variables constant, will result in a 1.40 unit decrease in Child Mortality. the t value is 7.08, in absolute terms, with a probability value of 0.0000. Hence the coefficient has significant influence on CM.

Prevalence of Undernourishment (PU) has a negative relationship with Chile Mortality. This does not go with the a priori expectation. A unit increase in PU will result in a 0.05 unit decrease in CM, on the average. The t value itself is insignificant, at |1.20|, and a probability of 0.839. Hence, the coefficient has a statistically insignificant influence on the dependent variable. The prevalence of undernourishment was seen to influence child mortality negatively. Ideally, a higher rate of undernourishment in children should result in higher rates of child deaths, but the opposite case was observed for the region. A plausible explanation could be the fact that children are able to adapt to situations, even those involving inadequate feeding. They get used to the situation and their bodies over time develop resistance, and they are able to work even when poorly fed. Hence, they do not tend to die off again. Another explanation for this may be that the standard for determining undernourishment may be quite high, such that children who do not attain that level of nourishment are still able to function properly.

Table 4.4: Test For Multicollinearity

variable	vif	1/vif
IWS	3.24	0.31
IM	2.38	0.42
LEB	2.15	0.46
ISF	1.94	0.52
PU	1.81	0.55
ML	1.76	0.57
PCI	1.65	0.60
MM	1.27	0.79

The variance inflation factor (VIF) test for multicollinearity was run via Stata, and the results are presented in table 4 above. From the results, the VIF for each parameter is less than 5, and the tolerance of VIF (1/ VIF) are all greater than 0.5. Hence, the model is free of multicollinearity (Ogundipe, Alege and Ogundipe, 2014).

Table 4.5: Fixed Effects with Initial and Robust Standard Errors

Variable	Initial se	Robust se	Bias
LEB	0.34	0.35	0.01
MM	0.47	0.61	0.14
ML	0.07	0.08	0.01
IM	0.12	0.12	0.00
PCI	0.00	0.00	0.00
IWS	0.20	0.17	-0.03
ISF	0.24	0.21	-0.03

Table 5 above shows the results for fixed effects estimation with robust standard errors, to correct for possible heteroscedasticity in the model. When compared to the standard errors in the initial estimation (table 3) without the robust, it can be observed that there was a downward bias in the standard errors. Initially, LEB had a standard error (se) of 0.338, but the robust se is 0.347, which is higher than the initial value. MM had a bias difference of 0.144, ML had a difference of 0.011, IM a difference of 0.008 and so on.

Table 4.6: ECOWAS And EU Pooled OLS Results

Regions	**ECOWAS**				**EU**			
Variables	**Coef.**	**s.e.**	**|t|**	**P > |t|**	**Coef.**	**s.e.**	**|t|**	**P > |t|**
LEB	-3.98	0.34	11.73	0.000	-0.83	0.07	11.11	0.000
MM	-3.72	0.45	8.27	0.000	0.11	0.03	4.43	0.000
ML	-0.38	0.07	5.41	0.000	0.05	0.04	0.83	0.405
IM	0.01	0.11	0.08	0.935	-0.06	0.02	2.04	0.042
PCI	-0.01	0.00	3.43	0.001	-0.00	0.00	4.87	0.000
IWS	0.68	0.13	5.41	0.000	-0.20	0.03	6.89	0.000
ISF	-1.49	0.20	7.54	0.000	-0.20	0.05	4.06	0.000
PU	0.24	0.24	1.01	0.313	dropped	-	-	-

In order to compare the effects of health investments on child health in developing and advanced nations, a pooled OLS regression was carried out on the model for both the ECOWAS (representing developing nations) and EU (representing advanced nations) regions. The results are presented in table 6 of the previous sub-section. The key summary statistic of interest in making the comparison is the parameter coefficient. What should be analyzed is the magnitude and direction by which each variable impact on the dependent variable in both regions of the world.

For the EU, Life expectancy at birth, LEB is found to have an inverse relationship with Child Mortality, CM. A unit increase in LEB results in a 0.83 unit decrease in CM in this region, where as in the ECOWAS region, the magnitude of the decrease is observed to be higher, at 3.98.

In the EU, Maternal Mortality (MM) had a positive relationship with CM, hence a unit increase in MM results in a 0.11 unit increase in cm. In the ECOWAS region, there was a positive relationship found, with a greater magnitude of 3.72.

For Maternal Literacy (ML) in the EU, there was also observed a positive relationship. A unit increase in ML results in a 0.05 unit increase in CM. In ECOWAS, the coefficient had the expected sign, and had a greater magnitude of 0.38.

Immunization for Measles (IM) for the EU was seen to have a negative relationship with Child Mortality (CM), with a magnitude of 0.06, meaning that a unit increase in IM would result in a 0.06 unit decrease in CM. In ECOWAS, there was an observed positive relationship, with a lesser magnitude of 0.01.

Per capita Income (PCI) in the EU had a negative relationship with child mortality (CM), but the magnitude was approximately 0.00, indicative of little or no effect of PCI on CM, even though the direction is known. In the ECOWAS region, PCI had a greater magnitude of 0.01.

Both environmental health parameters (Improved sanitation facilities ISF and water sources IWS) for the EU had negative relationships with the dependent variable, with magnitudes of 0.20 each. In the ECOWAS region, there was an observed greater magnitude of impact of these variables on Child Mortality, with IWS having a magnitude of 0.68 and ISF 1.49. However, the direction of the coefficient for IWS showed a positive relationship between IWS and CM.

From the comparative analysis of the coefficient estimates for both developing and advanced nations, a few observations have been drawn out. One is that poorer countries (represented by the ECOWAS region) were found to have greater impact of socioeconomic status (measured by pci) on child mortality than advanced nations. Also, maternal literacy (measured by female primary school enrollment ratios) was observed to have no significant influence on child mortality in the EU. Furthermore, disease-specific immunization was found to have no significant influence on child mortality in poorer countries. The first observation supports the

finding of Amiri and Gerdtham (2013) that health investments resulted in higher health outcomes in developing countries than in advanced nations.

We thus reject the null hypothesis and accept the alternate hypothesis that returns to health investments in developing countries are higher than in developed countries.

4.3 CONCLUSION:

In this section of the work, the results from the estimated model have been presented, interpreted and discussed. Based on the findings, it can be inferred that some health investments have positive impact on child mortality in the region, while others have negative impact in the West African region, which is understandable because the region, due to its peculiar characteristics (poverty, African traditional religion, high population), may not be expected to behave in the same way other regions do.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY

This study explored the relationship between various health investments and child mortality in two regions of the world, one from Africa, a developing continent, and the other from Europe, an advanced continent. Attempts have been made to establish the relationship between health investments and child health outcomes. Making use of a Grossman aggregate production function for health, the fixed effects estimation was used to accomplish the stated objectives of the study. Analyses have shown that improvement in both the quality and the quantity of health some health investments at different levels (family, community and nation) can lower the child mortality rates in the West African region, hence increasing welfare and in the long run, ensuring sustainable economic development. Results have also shown that health investments in the developing region have greater child health outcomes than the developed region of the world.

5.2 CONCLUSION

A review of studies and reports, as discussed in the second chapter, has revealed that the level of child mortality is highest in African countries and lowest in the European Union. Also, it was also discussed that the levels of health investments in European countries in particular, and the European Union in general is higher than what obtains in West Africa in particular and Africa in general. Immunization coverage, access to improved water source and sanitation facilities and income levels are way better in Europe than in Africa. Based on the findings of the study, it can be said that the effect of marginal health investments on child health in Europe is lower than the

effect in West Africa. Africa is still experiencing increasing returns to health investments, as the returns are still increasing at an increasing rate, for some investments. This implies that there is a lot of room for improvement in Africa, till we get to the point of near constant returns, as Europe now is situated. Investments in a child's health, specifically the literacy level of the mother and the environmental health in terms of improved water sources, will lead to marked improvements in child health outcomes, specifically decreased child mortality rates.

Hence, the objectives of comparing child health outcomes between the ECOWAS and EU regions was fulfilled, and so were the objectives of evaluating the impact of health investments in West Africa and the contribution of income level and immunization coverage to child health in the region.

The study was limited for a number of reasons. One of them is the scanty data on choice variables, which would have better captured the variables in the Grossman health production function.

5.3 RECOMMENDATIONS

Based on the objectives and the findings of the study, the following policies can be put in place to increase the possibility of reduced child mortality rates in the region. Some of these policies have worked for the developed countries, and may hence be the way forward for Africa. Others are specifically specified for the African region, having taken into consideration the unique characteristics of the political, socioeconomic and environmental/ecological environment in Africa.

For one thing, it is of a certainty that increasing the quantity of health investments is not enough to result in improved health outcomes. There must be attendant improvement in the quality. If

quantity is increased at the detriment of quality, the result can be more detrimental than helpful. This is in general terms.

More specifically, policies that would be aimed at increasing the total expenditure on health should ensure that these expenditures are spent on specific things, both capital and recurrent, in the sector, to actually improve health status. Investments should be made in the necessary technologies that prevent the transmission of HIV from a pregnant mother to her unborn child. Other technologies that enable proper prenatal care should be invested in, to ensure the health and safety of the mother and the fetus. Generic drugs that are original and not fake need to be invested in as well and the governments would do well to work with the necessary bodies in charge in the countries to root out fake drugs. Primary health care workers, midwives and nurses should be paid adequately, especially those working in the rural areas, so that they are incentivized to do the work well, and discouraged from migrating to urban areas, in search of 'greener pastures', there by neglecting the villages and small towns.

Poverty has been identified as an underlying factor responsible for child deaths in the region. Hence, policies aimed at reducing the poverty levels will automatically reduce the mortality rates. There has been an observed two-way relationship between poverty and health. However, in this study, poverty was seen to impact little on child health. Hence, policies aimed at reducing poverty rates will increase welfare of citizens, but may not achieve the desired reduction in child mortality. It must not, however, be completely neglected, as improving health status will also help to reduce the poverty levels in the long run. Poor mothers are unable to access health care facilities or procure the needed drugs. Hence, there needs be assistance by the health sector of the various countries to to support the poor with supplements such as vitamin A

(for measles) for children under five, iron supplements for 6-23 months, zinc supplements (for diarrhea), iodine, as well as nutritional support for HIV infected children.

The health of the mother is important to the health of the child, and so is the literacy level of the mother. The majority of illiterate women dwell in the rural parts. At the primary school level, Primary Health Education is taught. There needs to be adequate education of women in these parts on basic maternal and child health care. To achieve this, health educators and instructors need to be harnessed and sent to the rural areas to properly educate women. They must be educated on proper nutrition for pregnant mothers and children, personal hygiene and environmental sanitation to prevent mosquitoes from breeding in stagnant waters and bushes, and also contacting of cholera and diarrhea. In a community, there can be arranged home-visiting programs, to create awareness and to sensitize the people. Already this is ongoing in some parts of Nigeria, precisely the northern parts.

Another important investment that can be made at the community and national level is further improved access to safe drinking (pipe-borne) water and toilet (water-flushing) facilities in rural areas, so as to reduce the incidence of childhood diarrhea. Not only should the toilet and other sanitation facilities be made available, but they must be maintained adequately, so as not to create a greater avenue for disease to breed.

5.4 SUGGESTIONS FOR FURTHER STUDY

This study included socioeconomic status as a variable in a single model, and sought to determine if the variable in question had a significant influence on the relationship between health investments and child health outcomes, but was only able to determine the effect of socioeconomic status on child health, not on the relationship. For a better analysis, a

simultaneous equation model can be developed, which sees health investments as a function of socioeconomic status, and child health as a function of health investments. This would give a clearer picture of the influence of the variable on the relationship.

Also, data on poverty as a measure of socioeconomic status for the countries was too scanty to make meaningful conclusions based on, and so per capita income was used instead. This has been criticized on the grounds that it does not take into cognizance the inequality within each entity. As a way of furthering this study, data on poverty may be collected and used in place of per capita incomes, or then inequality must be accounted for in the model.

Furthermore, in order to robust the findings of the study, further tests should be run on the data sets. This will allow for more accurate predictions of the behavior of both sets of countries' economies in the long run. Other techniques of estimation can be used to test the relationship between the variables.

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APPENDIX

Appendix 1: Descriptive statistics:

```
sum logcm logmm logim logpci logisf logiws logpu logpop
```

Variable	Obs	Mean	Std. Dev.	Min	Max
logcm	315	4.863506	.4840921	3.100092	5.744925
logmm	315	4.055756	.0666396	3.730501	4.245634
logim	299	4.140071	.3062635	2.944439	4.574711
logpci	315	6.306204	.812685	3.912867	8.939675
logisf	301	2.860859	.6665356	1.458615	4.215086
logiws	311	4.112499	.2370938	3.394508	4.492002
logpu	315	2.881344	.5118379	1.609438	3.735286
logpop	315	3.794168	.0462746	3.653074	3.911859

Appendix 2: Fixed effects estimation for ECOWAS:

```
Fixed-effects (within) regression               Number of obs      =       262
Group variable: year                            Number of groups   =        21

R-sq:  within  = 0.7649                         Obs per group: min =        10
       between = 0.9693                                        avg =      12.5
       overall = 0.8017                                        max =        15

                                                F(8,233)           =     94.76
corr(u_i, Xb)  = 0.3777                         Prob > F           =    0.0000
```

cm	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
leb	-4.046047	.3376839	-11.98	0.000	-4.711351	-3.380743
mm	-3.077135	.4701408	-6.55	0.000	-4.003405	-2.150864
ml	-.3229546	.0716735	-4.51	0.000	-.4641656	-.1817435
im	.1780959	.1160718	1.53	0.126	-.0505885	.4067802
pci	-.0094983	.001924	-4.94	0.000	-.0132889	-.0057077
isf	.6551438	.1246834	5.25	0.000	.4094929	.9007947
iws	-1.403311	.1981726	-7.08	0.000	-1.79375	-1.012872
pu	-.0497402	.2443517	-0.20	0.839	-.5311612	.4316809
_cons	631.9065	32.86414	19.23	0.000	567.1577	696.6554
sigma_u	10.491947					
sigma_e	24.410364					
rho	.15593378	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(20, 233) =     1.36                 Prob > F = 0.1442
```

Appendix 3: Ordinary pooled OLS for ECOWAS:

Source	SS	df	MS		
Model	662230.839	8	82778.8549	Number of obs	262
Residual	155036.783	253	612.793607	F(8, 253)	135.08
				Prob > F	0.0000
				R-squared	0.8103
				Adj R-squared	0.8043
Total	817267.622	261	3131.29357	Root MSE	24.755

cm	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
leb	-3.976178	.3390139	-11.73	0.000	-4.643827	-3.30853
mm	-3.722458	.4501359	-8.27	0.000	-4.608949	-2.835967
ml	-.380452	.070388	-5.41	0.000	-.519073	-.2418309
im	.0090572	.1106992	0.08	0.935	-.2089521	.2270666
pci	-.0062106	.00181	-3.43	0.001	-.0097752	-.0026461
isf	.6794538	.1256706	5.41	0.000	.4319601	.9269476
iws	-1.485037	.1968505	-7.54	0.000	-1.872711	-1.097362
pu	.2401326	.2374213	1.01	0.313	-.2274414	.7077066
_cons	676.4466	31.42758	21.52	0.000	614.5536	738.3396

Appendix 4: Ordinary pooled OLS for EU:

Source	SS	df	MS		
Model	7723.50389	6	1287.25065	Number of obs	444
Residual	5488.49781	437	12.5594915	F(6, 437)	102.49
				Prob > F	0.0000
				R-squared	0.5846
				Adj R-squared	0.5789
Total	13212.0017	443	29.8239316	Root MSE	3.5439

cm	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
mm	.087163	.0281866	3.09	0.002	.031765	.1425611
ml	-.0348415	.0417986	-0.83	0.405	-.1169927	.0473098
im	-.0389691	.0191319	-2.04	0.042	-.0765711	-.0013671
pci	-.0001618	.000014	-11.56	0.000	-.0001893	-.0001343
iws	-.309779	.0300695	-10.30	0.000	-.3688779	-.2506801
isf	-.3471067	.0527379	-6.58	0.000	-.4507581	-.2434552
pu	(dropped)					
_cons	81.52695	6.825886	11.94	0.000	68.1113	94.9426

Appendix 5: FE with Robust Standard Errors:

```
Fixed-effects (within) regression               Number of obs      =       272
Group variable: year                            Number of groups   =        21

R-sq:  within  = 0.7516                         Obs per group: min =        11
       between = 0.9805                                        avg =      13.0
       overall = 0.7888                                        max =        15

                                                F(7,244)           =    170.62
corr(u_i, Xb)  = 0.3854                         Prob > F           =    0.0000

                                    (Std. Err. adjusted for clustering on year)
------------------------------------------------------------------------------
             |               Robust
          cm |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         leb |  -3.889276   .3470256   -11.21   0.000    -4.572824   -3.205728
          mm |  -2.932948   .6142153    -4.78   0.000    -4.142789   -1.723107
          ml |  -.3181446   .0833567    -3.82   0.000    -.4823351   -.1539541
          im |    .138188   .1236712     1.12   0.265    -.1054112    .3817873
         pci |  -.0061993   .0013062    -4.75   0.000    -.0087722   -.0036263
         iws |  -1.198271    .168093    -7.13   0.000    -1.529369   -.8671722
          pu |  -.3705289   .2052008    -1.81   0.072    -.7747199     .033662
       _cons |   622.9898     45.54     13.68   0.000     533.2881    712.6915
-------------+----------------------------------------------------------------
     sigma_u |  10.818375
     sigma_e |  25.440257
         rho |  .15314122   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Appendix 6: Hausman test:

```
             ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re          Difference          S.E.
-------------+----------------------------------------------------------------
       logmm |    .9808757     .6937716        .2871041        .0437146
       logim |    -.262735    -.3696734        .1069383        .0208717
      logpci |   -.2428751     -.195271       -.0476042         .007266
      logisf |   -.0248647    -.0194356        -.005429               .
      logiws |   -.5199687    -.6947899        .1748212         .030434
       logpu |   -.0955611    -.0260641        -.069497        .0104603
      logpop |    1.843829     1.289491        .5543374        .0865707
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

 Test:  Ho:  difference in coefficients not systematic

               chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                       =       28.48
             Prob>chi2 =      0.0002
             (V_b-V_B is not positive definite)
```

Appendix 7: Variance Inflation Factor (VIF) test:

Variable	VIF	1/VIF
iws	3.24	0.308252
im	2.38	0.420248
leb	2.15	0.464834
isf	1.94	0.516522
pu	1.81	0.551153
ml	1.76	0.569284
pci	1.65	0.604317
mm	1.27	0.787449
Mean VIF	2.03	